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Higher Education Learning Methodologies and Technologies Online

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Book of Abstracts

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The 8th International Conference on Higher Education Learning Methodologies and Technologies Online (HELMeTO 2026), hosted by the University of Cagliari from 28 to 30 September 2026, takes place at a moment when digital education can no longer be regarded as a separate or merely technical domain of academic life. Artificial Intelligence (AI), data analytics, immersive environments, recorded lectures, virtual exchange and hybrid mobility have entered the ordinary practices in Higher Education. Their growing presence, however, does not make educational choices automatic. On the contrary, it makes pedagogical judgement even more necessary: technologies must be designed, interpreted and governed in relation to the people who use them, the contexts in which learning occurs and the purposes that Higher Education is called upon to serve. This perspective has guided HELMeTO since its first edition and is particularly visible in the breadth of its 2026 programme. The conference received 220 submissions involving more than 480 individual authors from 30 countries: Albania, Belgium, Canada, Croatia, Cyprus, Estonia, Germany, Greece, Hungary, India, Ireland, Italy, Kazakhstan, Latvia, Malta, Mexico, Montenegro, Morocco, North Macedonia, Norway, Palestine, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Ukraine, the United Kingdom and the United States. These figures describe more than numerical growth. They indicate a community in which different disciplinary traditions, institutional settings and educational cultures can meet around a shared question: how can innovation strengthen learning without reducing education to the simple adoption of new tools? The conference, held at the Sa Duchessa Campus of the University of Cagliari, is organised into two General Tracks, fifteen Special Tracks and a Doctoral Consortium. Together, they connect research on online pedagogy and learning design with studies of learning technologies, educational data, artificial intelligence and emerging forms of academic participation. The Doctoral Consortium complements this structure by providing early-stage researchers with a space in which to discuss developing projects, methodological choices and research questions with a wider scholarly community.

General Track 1 — Online pedagogy and learning methodologies gathers research on the pedagogical models, teaching strategies and forms of interaction that shape online, blended and hybrid learning. Its contributions address the quality of learning design, the changing roles of teachers and students, accessibility, assessment and the creation of educational environments capable of sustaining participation rather than merely delivering content.

General Track 2 — Learning technologies, data analytics and educational big data mining as well as applications examines the infrastructures and methods through which educational processes can be observed, supported and redesigned. Learning analytics, artificial intelligence and data-intensive approaches offer important possibilities for feedback and personalisation, but they also require transparency, interpretability and responsible use if evidence is to inform, rather than replace, educational judgement.

The fifteen Special Tracks develop these questions within distinct yet closely connected areas of inquiry.

Special Track 1 — Active Online Assessment in Higher Education: Pedagogical Models, Digital Practices and Evidence-Based Approaches considers assessment as an integral part of learning. It focuses on active and formative approaches, timely feedback, student agency and evidence-based digital practices that can make assessment more inclusive, meaningful and sustainable, including in large and distributed learning environments.

Special Track 2 — Rethink Education: The Opportunities and Challenges of Artificial Intelligence addresses the tension that runs through contemporary debates on AI in education. Personalisation, automation and new forms of support must be examined together with bias, privacy, unequal access and the changing role of the teacher. The issue is therefore not whether AI is intrinsically beneficial or harmful, but under what pedagogical and ethical conditions it can contribute to learning.

Special Track 3 — Human rights-based approach and practices for preventing and countering online hate speech: digital strategies and educational challenges in Higher Education places digital citizenship within a human-rights framework. It explores how universities can develop critical literacy, institutional responsibility and participatory practices capable of preventing and countering online hate speech while protecting dignity, freedom of expression and democratic dialogue.

Special Track 4 — Press Start to Research! Exploring Artificial Intelligence and Gamification for Social Inclusion brings together AI, game-based approaches and research on social inclusion. It investigates how engaging and adaptive environments may support learners affected by disability, migration or socioeconomic disadvantage, while remaining alert to the ways in which automated systems and game mechanics can reproduce exclusion when they are not critically designed.

Special Track 5 — The Digital Self: Creative Practices and Non-Linear Languages for Building Socio-Emotional and Affective Skills in the Age of AI turns attention to the formation of identity, emotion and relationships in digitally mediated environments. Creative practices, artistic languages and embodied forms of cognition offer ways to preserve complexity, alterity and personal agency at a time when experience is increasingly organised through algorithmic systems.

Special Track 6 — Exploring the Role of "Expressive Mediators" in Inclusive Higher Education within Digital and Hybrid Environments examines the educational potential of narrative, art, play, performance and other multimodal mediators. These languages can widen access to knowledge and

enable different modes of participation, particularly when inclusive design moves beyond compensation and recognises the plurality of ways in which students perceive, express and construct meaning.

Special Track 7 — Embodied and Adaptive Learning Environments: Serious Games, Educational Robotics and AI for Personalized Education explores how serious games, robotics and intelligent feedback can support adaptive learning without losing sight of its embodied and situated character. Personalisation becomes pedagogically valuable when it opens possibilities for action, collaboration and reflection, not when it confines learners within profiles generated by data alone.

Special Track 8 — Pedagogy and participatory technologies in the post-digital era challenges the idea that technologies are neutral instruments added to otherwise unchanged educational practices. From a post-digital perspective, infrastructures, platforms and algorithms participate in shaping relationships, forms of agency and institutional cultures. The track therefore asks how participation can be genuinely designed and how responsibility should be distributed between human and technological actors.

Special Track 9 — Extended Reality for Higher Education: Design, Assessment and AI-Generated Immersive Learning focuses on augmented, virtual and mixed reality, including environments enriched through generative AI. Its contributions examine how immersion can support exploration, simulation and experiential learning, while also addressing accessibility, assessment, cognitive load and the need to connect technological novelty with explicit educational purposes.

Special Track 10 — Beyond the Recorded Lecture: Reframing Video-Based Teaching as a Distinct Pedagogical Practice treats asynchronous video not as a lesser substitute for classroom teaching but as a medium with its own grammar. Questions of presence, embodiment, attention, narrative structure and active engagement become central to the design of video-based learning that is more than the passive transmission of a recorded lesson.

Special Track 11 — Pedagogy of Artificial Intelligence: changing leadership roles, innovation learning, community well-being expands the discussion of AI from the classroom to academic governance and organisational life. It considers how leadership, professional learning and institutional decision-making must evolve so that innovation is accompanied by ethical responsibility, shared competence and attention to the well-being of educational communities.

Special Track 12 — AI-augmented E-learning for Mathematics Education at University Level investigates the specific contribution of intelligent systems to the teaching and learning of mathematics. Adaptive feedback, learning analytics and generative tools may support understanding and participation,

provided that they are integrated with disciplinary ways of thinking, sound didactical strategies and an appropriate balance between digital and traditional resources.

Special Track 13 — Gameful learning in higher education: experiences, methodologies and best practices brings together research and practice on play, game-based learning and gamification across university and professional contexts. Beyond engagement as an immediate effect, the track asks how gameful approaches can support sustained learning, inclusion, well-being, curriculum development and the preparation of teachers and other professionals. Special Track 14 — European University Alliances, Virtual Exchange and Blended Mobility in Higher Education addresses the new educational spaces created by cross-border collaboration. Virtual exchange and blended mobility can widen participation and intercultural dialogue, but their long-term value also depends on quality assurance, recognition of learning, inclusive access and the capacity of institutions to sustain shared pathways beyond individual projects.

Special Track 15 — AI in Physical Exercise, Kinesiology and Sport: Innovations for Higher Education examines AI both as emerging disciplinary content and as an educational methodology. Biomechanical analysis, wearable devices, predictive models and virtual coaching can enrich university teaching and professional preparation, but their integration must continue to support, rather than displace, the embodied, experiential and relational nature of movement and sport education.

Read together, these tracks show a field that has moved beyond the question of whether technology belongs in higher education. The more demanding question concerns the kind of education that technologies help us to imagine and enact. Across the contributions gathered in this Book of Abstracts, innovation appears neither as an autonomous force nor as a ready-made solution. Its educational meaning emerges through design, evidence, critical reflection and the relationships that connect teachers, students, institutions and communities. HELMeTO 2026 therefore offers a space not only for presenting results but also for comparing perspectives and making visible the assumptions that guide technological choices. The conference invites its participants to hold together experimentation and responsibility, data and interpretation, personalisation and participation, digital mediation and embodied presence. It is in this productive tension - not in a simple opposition between enthusiasm and resistance - that Higher Education can develop forms of innovation attentive to learning, inclusion and human agency.

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General Track 1

Online pedagogy and learning methodologies

Exploring Pedagogical Prior Knowledge of Artificial Intelligence in Higher Education

Vilmos Vass[1], Tímea Laboda[1], József Zoltán Málik[1], Gabriella Németh[1] and Kinga Szálkai[1]

[1] Budapest Metropolitan University, 1148, Nagy Lajos király útja 1-9, Hungary
vvass@metropolitan.hu

1 Background and Introduction

The rapid spread of artificial intelligence is not only creating new educational tools but also transforming existing conceptions of knowledge, learning, assess-ment and academic responsibility. This is particularly important in online and hybrid education, where a substantial part of curriculum development, student communication, feedback and assessment takes place in digital environments. The effective use of generative AI therefore depends not only on technological access but also on the pedagogical aims, opportunities and risks that faculty members associate with it. Research on teachers' beliefs and pedagogical prior knowledge suggests that educators' previously formed views, experiences and personal theories funda-mentally influence how they interpret new pedagogical situations and which methods they adopt [1–5].

Pedagogical prior knowledge therefore encompasses more than factual knowledge. It also includes faculty members' experiences, beliefs, attitudes and personal theories of education. A substantial part of the literature on the use of artificial intelligence in higher education focuses on technology use, student competencies, educational applications and institutional transformation [6–15]. Less attention has been paid to the prior knowledge and pedagogical beliefs on the basis of which faculty members decide whether to adopt, restrict or reject AI. The present research builds directly on earlier work examining the relationship between artificial intelligence and knowledge transfer [16], as well as a study analysing the role of AI in the trans-formational shift of higher education from a VUCA environment to a FLUX world [17]. Building on these foundations, the current study examines the faculty perspective of this transformation.

2 Objective

The study aims to explore the pedagogical prior knowledge of artificial intelligence held by faculty members working in three organisational units of Budapest Metropolitan University: the Institute of Marketing and Communication, the Institute of Social Sciences and International Studies, and the FinTech, AI and Digitalisation Institute.

The central research question is: *What knowledge, experiences, beliefs, attitudes and teaching practices constitute the pedagogical prior knowledge of artificial intelligence held by faculty members across the three institutes?*

The study distinguishes between factual knowledge of the operation and limitations of AI, experience gained through using AI tools, beliefs and attitudes concerning their educational application, actual teaching practices, and conceptions of how knowledge, learning, assessment, student autonomy and academic responsibility are changing. Particular attention is paid to online feedback, digital curriculum development, personalised learning support and online assessment.

3 Methodology

This study adopts an exploratory, sequential mixed-methods design at Budapest Metropolitan University. Approximately 25 faculty members from three institutes are participating in the study, providing near-complete coverage of the organisational population under investigation. Individual structured interviews will combine closed and open-ended questions addressing participants' AI knowledge, experience, attitudes, pedagogical beliefs and teaching practices. Closed responses will be analysed using descriptive statistics, while open responses will undergo thematic analysis with NVivo, ChatGPT, and Python. The interviews will be followed by two or three focus groups examining how participants support, challenge or modify one another's views during professional discussion. Although the study provides detailed institutional insight, its single-institution setting and small absolute population limit wider generalisability.

4 Results

As data collection is ongoing, final empirical results are not yet available. The analysis will examine relationships between faculty members' factual knowledge of AI, their self-assessed competence, actual use of AI tools and underlying pedagogical beliefs. It will distinguish between using AI primarily as a technical or time-saving instrument and integrating it into teaching through deliberate, reflective pedagogical design. The study will also explore how faculty members' conceptions of knowledge, learning, assessment, student autonomy and academic responsibility shape their adoption, restriction or rejection of AI. In addition, the research is expected to identify transferable practices for online and hybrid education, including AI-supported feedback, digital curriculum development, personalised learning support and activities promoting student reflection. Finally, it will map faculty members' needs for methodological, technical, ethical and legal guidance, providing an evidence-based foundation for targeted professional development and appropriate institutional AI policies within higher education.

5 Conclusion

AI integration depends on faculty members' pedagogical beliefs as well as their technological knowledge. The study distinguishes frequent AI use from genuinely reflective pedagogical competence. Despite its limited setting, the findings may support targeted faculty development and institutional AI guidelines.

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Mini-MOOCs For Teachers' Professional Development On Digital Education: The Experience Of The University Of Florence

Alice Roffi[0000-0002-2683-3743], Maria Ranieri[0000-0002-8080-5436], Francesca Pezzati, Catia Battista, Gabriele Renzini, and Jonida Shtylla

University of Florence, Florence, Italy
alice.roffi@unifi.it; maria.ranieri@unifi.it; francesca.pezzati@unifi.it; catia.battista@unifi.it; gabriele.renzini@unifi.it; jonida.shtylla@unifi.it

1 Introduction

The integration of advanced digital tools into university teaching is now a reality, so the question is no longer whether to integrate them but how to do so and how to promote their effective use in disciplinary teaching [1]. Therefore, if, on the one hand, their use is to be encouraged, on the other hand, it is necessary to create the conditions for their effective integration, especially from the point of view of the professional development of university teachers [1]. One of the critical issues in this field concerns the difficulty of participating in training for logistical reasons (distance of courses or timetable organization) [2]. In this context, the use of MOOCs (Massive Open Online Courses) could be useful in overcoming spatial and temporal challenges. MOOCs, in fact, are online courses that can be accessed asynchronously, thus ensuring flexibility, and their potential for teacher training has been highlighted in several studies as a means of professional development [2-5]. The University of Florence was involved in a National Recovery and Resilience Plan project "Digital Education Hub – Advanced Learning Multimedia Alliance for Inclusive Academic Innovation" (ALMA), a consortium of fourteen Italian universities dedicated to creating high-quality online professional development in higher education. According to this, online learning is conceived as a key modality to respond to students' and teachers' needs for flexibility (in terms of time and organization). In this context, the University of Florence designed and released 8 self-paced mini–MOOCs [6]. This paper presented the results of the University of Florence study on users' perceptions of the MOOC learning experience, in terms of technical aspects, the quality of materials, and the relevance of both products.

2 Methodology

The design and production of miniMOOC was realized with the main purpose of integrating theoretical and practical aspects to face the digital transformation, thus focusing on the most innovative digital tools and pedagogical strategies for innovating university teaching. All miniMOOCs were structured into four phases (Activation,

Documentation, Application, Integration, inspired to Merrills' Instructional Principles [7]) for an overall duration of 6 hours. In Table 1, the 8 mini-MOOCs developed are reported: 2 on blended learning and online teaching, 2 on AI applications in teaching practice, 2 on the use of Moodle, 1 on innovative teaching strategies (gamified learning), and 1 on assessment approaches. A satisfaction survey explored the learners' perceptions about usability, content quality, perceived relevance and overall value of the formative experience using a Likert scale from completely disagree (1) to completely agree (10), and it was completed by 641 users. The mean and standard deviation were calculated for each dimension considered in the satisfaction questionnaire.

Table 1. MOOCs implemented, and the number of participants

	MOOC Title	**N**
MOOC 1	Blended Learning in a University Context	46
MOOC 2	Online teaching methods and techniques	50
MOOC 3	Gamification for learning at university	221
MOOC 4	Integrating AI into teaching: tools and strategy	185
MOOC 5	Designing educational Chatbots with AI: Methodological approaches and Implementation strategies	54
MOOC 6	Moodle: activities for communicating, interacting, evaluating and monitoring	22
MOOC 7	Getting Started with Moodle: Content Organization and Management	39
MOOC 8	Assessing learning with innovative approaches	24

3 Results

The results showed overall satisfaction among users with mini-MOOC experience: participants reported little to no technical discomfort. The appreciation of the material (texts, videos, and tests) and its usefulness ranged from 7,9 to 9,1, with MOOCs 1 and 4 reaching the highest values. Regarding the topic addressed by the mini-MOOCs, the participants agreed that they met the teachers' expectations, were useful for practice, and were new, respecting the initial users' knowledge (scores from 7,1 to 9,1). Users' comments highlighted satisfaction with the course, as it was interesting, well-designed, engaging, and provided useful practical examples. Some further comments indicated areas for future improvement, asking for more interactivity in the textual materials, more images or schemes, and more practical exercises.

4 Conclusion

Overall, the findings highlighted the positive impact of mini-MOOCs on users' professional development, offering both theoretical and practical dimensions and achieving a high level of satisfaction among participants. Future studies should be designed and implemented (with different research designs) to measure the impact on teachers' learning and engagement.

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From Shadow Facilitator to Learning Ecosystem Designer: Reconceptualising the Teacher's Role in MOOC-Enhanced Blended Learning

Chiara Panciroli[1[0000-0001-7173-670X]], Salvatore Messina[1[0000-0003-2591-707X]], Anita Macauda[1[0000-0003-1522-5440]], and Paola Rigoni[1[0000-0001-7229-5467]]

[1] University of Bologna, Bologna, Italy
chiara.panciroli@unibo.it
salvatore.messina10@unibo.it
anita.macauda@unibo.it
paola.rigoni3@unibo.it

1 Introduction

The rise of MOOCs in higher education has drawn sustained attention to the "unbundling" of academic roles [1, 2], whereby responsibilities once concentrated in a single instructor are redistributed across instructional designers, media specialists, and platform providers [3]. From the early connectivist experiments (cMOOCs) through the massification of content-driven platforms (xMOOCs), MOOCs have moved closer to the core of university teaching, making the question of the teacher's role increasingly pressing.

Yet most analyses have examined unbundling at the stage of course production, treating MOOCs as self-contained products. Far less attention has been paid to what happens when MOOCs become embedded within formal university teaching. When incorporated into blended designs, they reshape the pedagogical space within which teachers operate and redefine the expertise required to orchestrate learning across multiple environments.

This paper addresses this gap. Drawing on the A.C.A. MOOC Model (Anticipatory, Consolidating, Amplifying) [4], developed within the Digital Education Hub Edvance and informed by Situated Learning Episodes [5], the Conversational Framework [6], and the CLAS ecosystemic model [7], we argue that MOOC integration is better understood not as unbundling but as purposeful re-bundling [8], through which teaching expertise is reorganised around ecosystem design.

2 From Unbundling to Re-Bundling

White, White, and Borthwick [1] showed that MOOC production at three British universities substantially unbundled the conventional educator role, distributing functions to learning designers and other actors. Macfarlane [2] theorised this as the rise of "para-academics," while Cliff et al. [8] offered a Cultural-Historical Activity Theory perspective suggesting that unbundling entails a complex recontextualisation of pedagogical labour.

Yet unbundling risks portraying the teacher as a diminished figure. The Edvance Digital Education Hub suggests a different trajectory. When MOOCs serve as structural mediators within blended teaching—anticipatory, consolidating, or amplifying [4]—

the teacher's design work does not contract: it expands. Laurillard's [9] conception of teaching as a design science provides the foundational lens: MOOCs as components multiply the design variables requiring intentional orchestration.

3 Five Design Dimensions of the Learning Ecosystem Designer

Drawing on the intersection of the A.C.A. MOOC Model with the design challenges encountered in the DEH Edvance faculty development programme, we identify five interconnected dimensions that characterise the teacher's reconceptualised role.

Curriculum Curation and Network Design. The teacher selects, sequences, and connects MOOCs within the curriculum, making explicit the relationships between course units and open resources, consistent with connectivist principles [10] and emerging proposals for reticular navigation architectures.

Assessment Architecture. The teacher designs a coherent assessment strategy spanning online and face-to-face environments, aligning diagnostic, formative, and summative practices across the anticipatory, consolidating, and amplifying phases [11, 12].

AI Literacy Mediation. As MOOCs incorporate AI-based tools for personalisation and feedback, the teacher becomes a critical mediator, ensuring that AI use is ethically grounded, pedagogically intentional, and aligned with institutional policies [13].

Institutional Pathway Design. MOOC integration extends beyond individual courses to orientation, prerequisite alignment, professional development, and micro-credentialing. The teacher operates at the interface between course design and institutional strategy [14, 15].

Community Engagement. The teacher fosters learning communities beyond the enrolled class, promoting peer interaction and cross-institutional collaboration, in line with e-moderation principles [16] and the participatory culture paradigm [17].

4 Discussion and Implications

The framework shifts the focus from what MOOCs do to who orchestrates their integration. The five dimensions interact systemically, reflecting the ecosystemic conception of the CLAS model [7], mapping a design space within which teachers operate with different emphases depending on disciplinary context and institutional maturity.

The framework carries practical implications at three levels: for university teachers, a conceptual map for the transition toward ecosystem-centred design; for instructional designers, clarified collaborative interfaces; for institutional leaders, evidence that MOOC integration demands coordinated support structures. Regarding empirical validation, comparative case studies across the Edvance consortium and longitudinal tracking of design practices would test the framework's explanatory power and capacity to inform faculty development.

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Cybersecurity education in schools: The experience of the Italian pilot within the SuperCyberKids project

Giorgia Bassi[1] and Ilaria Matteucci[1]

[1] IIT-CNR, Pisa, Italy
giorgia.bassi@iit.cnr.it, ilaria.matteucci@iit.cnr.it

As children increasingly engage with digital technologies from an early age, cybersecurity education has become an essential component of digital literacy, digital citizenship, and online safety. There is therefore a growing need for educational approaches that can engage young learners while also supporting teachers in addressing cybersecurity topics effectively in the classroom. Previous research has highlighted the importance of introducing cybersecurity and online safety education at an early stage and embedding these topics within school curricula to strengthen responsible online behavior, awareness of digital risks, and cyber resilience [1,2,3,4]. Recent studies have further emphasized that educational interventions should not focus exclusively on technical knowledge but should also foster responsible digital practices and resilience among children and adolescents [5,6,7].

The Erasmus+ SuperCyberKids project [8] addresses this challenge through the design, development, and evaluation of an innovative and holistic educational ecosystem that integrates cybersecurity education, game-based learning, curriculum-aligned teaching resources, and teacher professional development. Unlike approaches based on standalone learning materials or serious games, SuperCyberKids combines a pedagogically grounded learning framework, structured lesson plans, interactive game-based experiences, and dedicated teacher training within a unified environment. This approach is intended to support the effective and sustainable integration of cybersecurity education into school settings.

The use of game-based learning is supported by a substantial body of research demonstrating the effectiveness of serious games in improving learner engagement, motivation, and knowledge acquisition [9,10,11]. At the same time, teacher professional development represents a critical success factor in the effective integration of cybersecurity topics into classroom practice [12], while curriculum-supported approaches contribute to the long-term sustainability of cybersecurity education initiatives [2,3].

Evaluation Phase: The Italian Pilot

The main target of the project are teachers. To evaluate its effectiveness, usability, and educational impact, four pilot initiatives were organized: one Europe-wide pilot delivered in English and three national pilots implemented in local languages in Italy,

Estonia, and Germany. All pilots followed a common implementation framework and timeline, running from January to November 2025, and included teacher training activities, classroom implementation, and final evaluation and reporting. Hereafter, we report on the Italian pilot results.

The pilot was implemented through a hybrid model combining online teacher training with classroom-based application of the educational resources. To assess the effectiveness of the training activities, two questionnaires were designed and administered to participating teachers. A pre-training questionnaire was used to establish a baseline by evaluating teachers' prior knowledge and competencies in cybersecurity, as well as their familiarity with game-based learning methodologies. Following the training, participants completed a post-training questionnaire aimed at measuring perceived improvements in cybersecurity education competencies and collecting feedback on the pedagogical approaches, educational resources, and teaching tools presented during the programme. The questionnaire also explored teachers' willingness and preparedness to integrate these methodologies into their classroom practice.

Training sessions were delivered through both online and face-to-face modalities, depending on local requirements and organizational constraints. The first training phase was conducted between the 30^{ty} April and 31st October 2025, while a second training phase took place between 11th and 18th November 2025. Teachers participated in a structured professional development programme consisting of three two-hour webinars covering the SuperCyberKids pedagogical framework, the available lesson plans, and the functionalities of the gamification platform. The initiative attracted significant interest from the educational community, exceeding the original participation targets (30 teachers). Overall, 24 schools and 52 teachers attended the training activities.

The second piloting phase involved 10 schools and 14 teachers, reaching a total of 315 students. To evaluate the implementation and impact of this phase, a post-pilot questionnaire was administered to participating teachers. The questionnaire aimed to assess the use of the SuperCyberKids platform in classroom settings, examining how the available resources were integrated into teaching activities and evaluating the platform's overall effectiveness, usability, and user satisfaction. The results of the assessment phase are described in the project deliverables, which are available on the project website [8]. The impact on the secondary target group, i.e., students, was assessed through knowledge assessment questionnaires embedded within the platform. Teachers administered these questionnaires collectively to their classes before and after the implementation of the selected lesson plans. This pre- and post-assessment approach enabled the evaluation of students' understanding of specific cybersecurity topics and provided evidence of their learning progress.

Conclusion

This paper presents the training and piloting activities of the SuperCyberKids project, focusing on the pedagogical framework and resources developed for cybersecurity education. The study examines the competencies acquired by teachers in game-based

learning, gamification, and cybersecurity instruction, as well as the impact of the training on their knowledge and awareness. Results demonstrate the effectiveness of an integrated approach combining teacher training, curriculum-aligned resources, and digital game-based learning. The cross-national pilot implementation provides evidence of the model's scalability and transferability across diverse educational contexts. Overall, the findings highlight the potential of the SuperCyberKids ecosystem to support cybersecurity education while enhancing student engagement and digital resilience.

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Evaluating a University-Wide Blended Learning Project: from educational support to evidence of impact

Helga Ballardini[1[0000-0002-3603-9551]] and Ligia Tomazin[1[0000-0002-9753-3246]], Daniele Agostini[1[0000-0002-9919-5391]], Elena Benini[1[0009-0000-4549-3572]], Silvia Perzolli[1[0000-0002-8878-932X]], Giorgia Dossi[1], Maria Valeria Ceraolo[1], Chiara Eberle[1], Sara Sighel[1], Anna Serbati[1[0000-0002-3528-2488]], Paola Venuti[1[0000-0002-1827-0549]]

[1] Università degli Studi di Trento, Trento, Italy
helga.ballardini@unitn.it

1 Theoretical Framework and Methodological Approach

As higher education institutions increasingly seek flexible and learner-centered educational models, Blended Learning (BL) has emerged as a strategic approach that combines face-to-face teaching with online learning opportunities [1]. In this context, the University of Trento (Italy) launched a university-wide BL pilot during the a.y. 2025-26 involving bachelor and master programmes. The BL project aimed at promoting a more flexible, inclusive and student-centered educational model. The project, on a voluntary basis, involved 62 instructors and students from 70 courses of 13 academic departments. The pedagogical framework [2] involved complementary: Flipped Classroom (FC), Individual Active Learning (IAL), and Group Active Learning (GAL) [3, 4, 5].

Faculty training was delivered through a series of hands-on webinars addressing several aspects of BL implementation and the integration with the Moodle environment [6]. Participants received personalised support from instructional designers and from peers in the online community of practice; furthermore, selected tutors were trained for BL. The second phase of the project focuses on impact evaluation using a mixed-methods research design. The present contribution reports quantitative and qualitative findings derived from pre-and post-implementation surveys to both faculty members and students exploring expectations, benefits, challenges and satisfaction with BL.

2 Research Tools and Data Collection

At the beginning and the end of the semester Faculty members completed the Higher Education Approaches to Teaching (HEAT) Scale [7] to assess their teaching approaches and a 16-item questionnaire [8] measuring expectations (pre-survey) and their perceptions of the BL experience (post survey).

Students completed a 22-item questionnaire at the beginning of the semester assessing their expectations (pre-survey) and at the end of the intervention (post survey) on their experience perceptions.

Finally, students' final grades in BL courses during the a.y. 2025–2026 were compared with grades obtained during a.y. 2024/25, in a traditional face-to-face format.

Additional indicators included students' participation rates, final assessment percentage) and course approval/pass rates.

3 Quantitative and qualitative Results

For our analysis, 31 teachers responded to the pre-assessment and 34 to the post-one, 177 students to the pre-survey and 130 to the pos-survey. We obtained administrative data for 32 courses in both 2024/25 and 2025/26.

Teachers' questionnaires revealed no significant changes in teaching approaches or perceptions over the semester.

In contrast, students reported several changes between the beginning and the end of the semester: perceived interaction increased significantly (Mpre = 3.79, Mpost = 4.07, p = .011), while perceived flexibility (Mpre = 3.89, Mpost = 3.65, $p < .001$), motivation (Mpre = 3.57, Mpost = 3.38, p = .002), and support (Mpre = 3.89, Mpost = 3.75, p = .015) decreased. Analysis of academic performance indicators showed no significant differences between BL courses and the same in a face-to-face format. Average grades, enrolment, approval rates and the proportion of students taking the final examination remained stable across academic years (all ps > .56). Approval rates increased slightly from 76% to 82%, although this difference was not statistically significant.

On the qualitative level, findings indicate an overall positive evaluation of the BL by both groups, highlighting greater customization, inclusion and improvements in course design with a shift in mindset toward more flexible teaching models. Some challenges emerged, regarding workload, suggesting that most tensions stem from cultural factors (academic traditions, habits and practices).

4 Theoretical and Educational Significance

By providing a replicable framework that integrates pedagogical and technological dimensions, the project supports flexible, inclusive, and engaging teaching practices while emphasizing the importance of structured faculty development and continuous monitoring to inform future educational policies and research.

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Technology-Enhanced Interventions for Self-Regulated Learning in Secondary Education: A Scoping Review

Marika Lamacchia[1] [0009-0008-9944-9217], Marilena di Padova[2] [0000-0002-2105-7095] and Anna Dipace[2] [0000-0001-9826-073X]

[1] University of Macerata, Italy
[2] Pegaso Telematic University, Naples, Italy
m.lamacchia2@unimc.it

1 Introduction

Self-regulated learning (SRL) refers to learners' ability to actively regulate cognitive, motivational, and behavioral processes in pursuit of academic goals [1,2]. Within the social-cognitive perspective, Zimmerman's cyclical model conceptualizes SRL as a dynamic process involving forethought, performance, and self-reflection phases, through which learners plan, monitor, and evaluate their learning activities [1]. Research has consistently linked SRL to higher academic achievement, learner engagement, and greater autonomy in learning [2]. The growing diffusion of technology-enhanced learning environments has further increased the relevance of SRL. Digital learning contexts often require students to manage their learning more independently while offering opportunities for support through feedback, prompts, interactive tools, and other forms of digital scaffolding [3,4]. As a result, understanding how technologies can foster self-regulatory processes has become an important issue in educational research. Despite growing interest in this field, evidence remains fragmented across technologies, pedagogical approaches, and educational contexts. Intervention-based studies conducted in secondary education have not yet been systematically mapped. To address this gap, the present scoping review aims to identify technology-enhanced interventions designed to foster SRL in secondary education, examining the digital learning environments employed, the pedagogical approaches adopted, and the SRL components targeted.

2 Methods

This study adopted a scoping review methodology following the framework proposed by Arksey and O'Malley [5] and reported in accordance with the PRISMA-ScR guidelines [6]. The review addressed the following research question: Which technology-enhanced interventions support self-regulated learning in secondary education, and which SRL components do they target? A systematic search was conducted in Scopus, Web of Science, and ERIC using keywords related to self-regulated learning, digital learning environments, and educational interventions. The search was limited to peer-reviewed articles published in English between 2015 and 2026. A total of 94 records were identified, resulting in 92 unique records after duplicate removal. Following title,

abstract, and full-text screening, 10 empirical studies met the inclusion criteria. Eligible studies reported technology-enhanced interventions aimed at fostering SRL in secondary education, whereas studies conducted exclusively in higher education or presenting theoretical contributions were excluded. Data extraction focused on the digital learning environments employed, pedagogical approaches adopted, SRL components targeted, and reported outcomes.

3 Preliminary Results

The review included 10 empirical studies and identified three main categories of technology-enhanced interventions supporting self-regulated learning: (1) SRL scaffolding interventions, providing support through prompts, feedback, learning analytics, and guided interactions [7,8]; (2) strategy training interventions, focused on teaching self-regulatory strategies such as note-taking, summarizing, and comprehension monitoring [9,10]; and (3) technology-embedded learning environments, where self-regulation is fostered through autonomous and interactive digital contexts [11–14]. Across these categories, monitoring and strategic regulation emerged as the most frequently targeted SRL processes, whereas planning and goal setting received comparatively less attention. Considerable heterogeneity was observed in both the technologies employed and the assessment methods adopted, ranging from self-report measures to learning analytics and behavioral trace data [8,9]. No studies explicitly reported or examined students with special educational needs, highlighting an important gap in the current literature [7–14].

4 Conclusion

While technology-enhanced learning environments offer valuable opportunities to support self-regulated learning [3,4], the evidence remains fragmented. The predominance of interventions targeting monitoring processes, together with the limited attention to planning and inclusive populations, suggests important gaps in current research. The review proposes a preliminary classification of technology-enhanced SRL interventions and identifies directions for future research on assessment practices, inclusivity, and the pedagogical integration of digital technologies in secondary education.

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Monitoring Inclusive Learning Experiences in Online Higher Education: The CABES Questionnaire as a Data-Informed Tool for Student Support and Educational Improvement

Venusia Covelli[1[0000-0002-5965-2658]], Tania Moretta[1 [0000-0002-4734-1545]], Daniela Maggi[2[0000-0002-6886-8725]], Fabio Lucchini[2 [0000-0002-6092-1907]], Elisa Guidi[1[0000-0003-3038-049X]], Laura Panizza[1], Miriam Trezzi[1], Elisa Zugno[1], Alessandra Marelli[1[0009-0009-7593-1292]]

[1] Department of Theoretical and Applied Sciences, e-Campus University, e-Campus University, Novedrate (Como), Italy
[2] Department of Human and Social Sciences, e-Campus University, e-Campus University, Novedrate (Como), Italy

venusia.covelli@uniecampus.it; tania.moretta@uniecampus.it; daniela.maggi@uniecampus.it; fabio.lucchini@uniecampus.it; elisa.guidi@uniecampus.it; laura.panizza@uniecampus.it; miriam.trezzi@uniecampus.it; elisa.zugno@uniecampus.it; alessandra.marelli@uniecampus.it

1 Introduction and aims

The growing diversification of student populations in higher education has increased the need for systematic approaches to monitoring learning experiences and evaluating the effectiveness of inclusion policies [1-2]. This challenge is particularly relevant in online and distance-learning environments, where ensuring accessibility, participation, academic engagement, and student well-being requires continuous institutional attention [3]. Within this framework, universities are increasingly called upon to adopt evidence-based strategies capable of supporting inclusive educational practices and promoting equitable learning opportunities for all students, particularly those requiring accommodations and support measures [4].

To address these needs, the University Committee for Students with Special Educational Needs (CABES) at eCampus University developed the CABES Questionnaire, an institutional monitoring tool designed to collect data on students' experiences with support services and inclusive measures. The questionnaire investigates perceptions of university services, learning conditions, teaching quality, and support provisions, while also exploring psychological well-being, academic self-efficacy, study motivation, sense of belonging, and perceived institutional support.

Based on previous research [5-6], this study aims to present the development and implementation of the CABES Questionnaire and to provide an overview of the evidence collected through its administration. More specifically, the overall study seeks to examine how students perceive the effectiveness of institutional support measures and to

identify key factors associated with engagement, inclusion, and academic success in an online higher education context.

2 Methods

This study adopted a cross-sectional design. The CABES Questionnaire was administered through an online self-report survey distributed to students receiving accommodations and support measures from CABES. Participation was voluntary and anonymous, and informed consent was obtained prior to questionnaire completion.

The CABES Questionnaire is structured into thematic sections covering: (a) academic progression and study trajectory; (b) use and perceived effectiveness of accommodation measures; (c) accessibility and quality of teaching activities and learning resources; (d) relationships with teaching and administrative staff; (e) emotional well-being and academic experience; (f) motivation, academic self-efficacy, and student engagement; (g) sense of belonging to the university community; (h) experiences with the CABES Support Office; and (i) emerging support needs and qualitative feedback. The questionnaire combines ad hoc monitoring items with validated measures assessing psychological well-being [7], academic self-efficacy [8], motivation in university students [9], and sense of community [10]. Students were also asked to assess their perceived quality of life and health status. Finally, through an open-ended question, participants were invited to share their experiences as university students with learning disabilities, special educational needs, or disabilities.

Data collection is currently ongoing. Preliminary findings from the first participants indicate high levels of satisfaction with the support provided by the CABES service and the accessibility of online learning, together with generally positive levels of academic self-efficacy, motivation, and psychological well-being.

3 Final Remarks

Grounded in the principles of Inclusive Education and Universal Design for Learning (UDL) [11], the CABES Questionnaire was designed to support the systematic monitoring of students receiving accommodations and support measures within an online higher education environment. By integrating indicators related to academic progression, learning experiences, well-being, motivation, self-efficacy, sense of belonging, and perceived institutional support, the instrument provides a multidimensional framework for understanding students' experiences and needs.

Preliminary findings from the first respondents indicate positive perceptions of the accessibility of online learning and the support provided by the CABES service, together with generally favourable levels of academic self-efficacy, motivation, and psychological well-being. These initial results highlight the potential of the CABES Questionnaire as an evidence-informed instrument for guiding institutional decision-making and the continuous improvement of inclusive practices in online higher education.

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Communication and Empathy Skills Training in Pediatric Settings in Undergraduate Medical Education: A Scoping Review

Valeria De Padova[1] [0009-0006-3282-3820], Gianluca Amatori[2] [0000-0002-2477-2422], and Anna Dipace[1] [0000-0001-9826-073X]

[1] Pegaso Telematic University, Naples
[2] European University of Rome, Rome

valeria.depadova@unipegaso.it; gianluca.amatori@unier.it; anna.dipace@unipegaso.it

1 Background and motivation

Effective communication with patients and their families is widely recognised as a core competency in medical education, with documented effects on treatment adherence and patient outcomes [1, 2]. In pediatric settings, this competency takes on a structurally distinct form: the physician must navigate a triadic interaction involving the child, the caregiver, and the specialist, each carrying different needs, expectations, and emotional registers [2]. This is a competency whose institutional recognition is by now well established - enshrined by the World Federation for Medical Education [3] and reflected in major international curricula - yet whose systematic development in undergraduate medical education remains profoundly underdeveloped: most university curricula in fact focus on dyadic communication with adult patients, leaving the specificity of pediatric interaction to unsystematized clinical exposure or deferring it to postgraduate training [4, 5]. The same gap is found, even more markedly, in the emerging field of conversational and artificial intelligence tools for medical education, where the pediatric patient is systematically absent from the mapped interventions, which are designed for communication with adults [4]. Against this backdrop lies a New Digital Humanism, in which artificial intelligence can act as cognitive and relational scaffolding rather than as a substitute for human presence - a perspective that finds in undergraduate medical education a privileged field of application. It is precisely in this context that the contribution of Medical Humanities emerges: not a curricular ornament, but a constitutive dimension of training, capable of cultivating empathy, attentive listening, and relational sensitivity through narrative, aesthetic, and reflective practices [6, 7]. The literature indeed documents that the integration of MH into medical curricula is associated with significant increases in empathy among students [6], while their marginalization often responds to *outcome-based education* logics that risk reducing care to mere technical performance [8]. Holding together these two instances - technological and humanistic - is pedagogy, understood as the discipline that transforms educational experience into an intentional, reflective, and evaluable process [9]. Systematically mapping

existing educational approaches therefore constitutes the necessary first step toward the future design of innovative interventions - including digital and conversational tools - capable of supporting the development of these competencies in a pedagogically grounded way.

2 Objectives

This scoping review aims to systematically map the educational approaches adopted in undergraduate medical education for the development of communication and empathy skills in pediatric settings. The analysis aims to answer the following research question: *What educational approaches are adopted in undergraduate medical education to develop communication and empathy skills oriented toward the pediatric patient and their family?* The analysis covers four dimensions: training approaches (S1); communication structure, including triadic dimension and patient age (S2); competencies developed (S3); dialogue with Medical Humanities (S4).

3 Methods

Following the PRISMA-ScR guidelines [10] and the PCC (Population-Concept-Context) framework, a search was conducted across Scopus, PubMed, EBSCOhost, Google Scholar, and Elicit, completed on 6 May 2026. The search yielded a total of 875 records, after title/abstract screening, 98 records underwent full-text assessment, resulting in 62 included studies. The population is defined as undergraduate medical students; the concept encompasses communication and/or empathy skills in pediatric settings; the context is undergraduate medical education with an identifiable educational intervention. The time window was set from 2003, the year in which the WFME included communication among the core competencies of its global standards for basic medical education [3], marking the moment at which this competency gained international institutional recognition. Inclusion criteria cover primary peer-reviewed studies with experimental, quasi-experimental, or descriptive-evaluative designs, published between 2003 and 2026, in English.

4 Expected contributions

The systematic mapping of the 62 included studies shows a clear predominance of in-person, analogue interventions (82%), compared to still marginal use of digital tools (18% across pure and hybrid digital components); among analogue interventions, a notable subset (6 studies) draws on performative arts techniques (children or trained actors portraying the pediatric patient), offering an alternative, non-technological route to developing the same competencies. Medical Humanities rarely emerge as an explicit theoretical framework (only 4 of 62 studies), even though they are implicitly enacted in nearly half of the corpus (empathy, family narrative, grief management) without ever being named as such. These results provide the empirical basis for designing an AI-based conversational agent dedicated to pediatric communication training: a tool capable of simulating the specialist-child-caregiver triadic dimension, calibrated to the developmental age of the simulated patient, and conceived - consistent with the New Digital Humanism perspective - as relational scaffolding rather than a substitute for real clinical exposure.

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A Participatory Training-Research as a Faculty Development Strategy to Systematize and Disseminate Active and Interactive Teaching Methodologies

Francesco C. Ugolini[1[0000-0002-7887-7983]], Domenico Morreale[1[0000-0002-0435-5269]], Chiara Parretti[1[0000-0003-4490-854X]], Marzia Rossi[1[0000-0001-9059-9931]], Francesca Fallucchi[1[0000-0002-3288-044X]] and Flavia Di Donato[1[0009-0002-3764-0987]]

[1] Università Guglielmo Marconi, Rome, Italy
f.ugolini@unimarconi.it

1 Introduction, State of the Art and Research Questions

With the issuance of Ministerial Decree 1835 of December 6, 2024, Italian online degree courses are required to complete at least 20% of their frontal teaching in synchronous mode. Universities offering this type of course are therefore called upon to implement this constraint in the best possible way, that is, in order to balance sustainability and teaching effectiveness, taking into account disciplinary specificities.

The Teaching and Learning Center (TLC) of the Guglielmo Marconi University (GMU) (whose Board members, from various disciplinary backgrounds, are the authors of this paper) has launched a participatory Training Research project, with the overall aim of identifying the best implementation of the measure. This form of research contextually aims to establish a community of practices [10] within the University's teaching staff, in line with the University's strategy for Faculty Development [1, 2, 6, 8].

With respect to synchronous and asynchronous modes, a recent meta-analysis [11] establishes a slight prevalence, in terms of effectiveness, of the latter (with a "trivial to small" effect). However the research itself suggests that many moderating effects can intervene. In addition to disciplinary specificities, efficacy with respect to the acquisition of high-level skills is particularly relevant. In fact, asynchronous mode appears more suitable for cognitive achievement [5], while synchronous mode is more suitable for skills [4] or social abilities [3, 7, 9] acquisition.

In the European Higher Education Area, learning outcomes follow the so-called Dublin descriptors. What we previously stated therefore suggests that the synchronous component is effective with regard to the second ("Applying knowledge and understanding"), third ("Making judgements") and fourth ("Communication skills") descriptors.

Consequently, the specific research questions are the following:

RQ1: What are the "best" (sustainable, effective for learning, especially in reference to Dublin descriptors 2, 3 and 4) instructional strategies to implement synchronous teaching, taking into account disciplinary diversities?

RQ2: What guidance can be given to teachers and instructional designers to design courses that effectively blend synchronous and asynchronous mode?

2 Methodology

The research adopts a participatory Research-Training approach that aims to involve the entire teaching staff of the GMU. This approach appears to be appropriate as the University has been providing online courses, primarily asynchronously, since 2004, it is staffed by instructional designers who assist teachers in designing and implementing courses and its model systematically integrates synchronous teaching (by virtual classrooms) since 2019. In particular, the research is divided into the following steps:

1. Collection, on a department basis, of active and interactive synchronous teaching practices, which pursue learning objectives consistent with Dublin 2, 3 and 4 descriptors, and their codification in terms of instructional strategies;
2. Methodological consolidation of existing practices and subsequent extension to all teachers through targeted training interventions and sharing of good practices;
3. Verification of overall effectiveness both in terms of building a community of practices and in terms of student learning.

3 Progress and First Results

We report here the results relating to the first step. To collect active and interactive synchronous teaching practices, three synchronous online meetings were organized, one per Department. These meetings saw significant participation from the University's teaching staff: 154 up to 331 teaching staff (46.5%) actively attended the sessions.

During these meetings, a total of 31 teachers shared, on a voluntary basis, their synchronous teaching experiences, which were then codified through an agreement among three researchers, in terms of both teaching strategy and Dublin descriptors involved.

With the exception of two cases, where the intervention focused on feedback, the others appear significant in pursuing learning objectives related to descriptors 2, 3 and 4. In detail: out of 31 interventions, 21 pursue objectives related to the second descriptor, 25 pursue objectives related to both the third and fourth descriptors. At departmental level, the Department of Engineering sees a clear prevalence of strategies relating to the second descriptor (5 out of 7 experiences), typically teacher-guided practice. In the other two Departments, strategies that develop cross-sectional objectives relating to the third and fourth prevail (respectively 14 out of 16 experiences of the Department of Human Sciences and 7 out of 8 experiences of the Department of Legal, Political and Economic Sciences), above all case study and guided discussion. There are also cases of great interest, though less numerous, like peer learning and reciprocal teaching.

Based on what has been noted so far, in the next phase, the TLC will have the task of methodologically consolidating the narrated experiences. Furthermore, it will be appropriate to favor, in the engineering field, more complex and active methodologies, such as Problem-Based Learning, which is currently a minority, over simple exercises, in order to develop transversal skills as well. Furthermore, the more interesting methodological practices will be shared, possibly by the same colleagues who implemented them.

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Digital Teaching Transformation in Higher Education: A Pedagogically Centred Framework and Operational Toolkit Aligned with Education 5.0

Marcelo Maina[1[0000-0002-1889-1097]], Ludovica Fanni[1[0009-0009-9205-7867]], Lourdes Guàrdia[1[0000-0003-3719-9546]], Nati Cabrera[1[0000-0003-1813-9601]] and Ariadna Angulo Brunet[1[0000-0002-0583-1618]]

[1] Universitat Oberta de Catalunya, Rambla Poblenou @22 08018 Barcelona, Spain
mmaina@uoc.edu, lfanni@uoc.edu, lguardia@uoc.edu, ncabrera@uoc.edu, aangulob@uoc.edu.

1. Theoretical Framework

Digital Transformation (DT) in Higher Education (HE) is a strategic, systemic reconfiguration of institutional processes, governance, and culture. Scholarly consensus distinguishes this structural shift from mere digitalisation, which optimizes existing tasks rather than reinventing organizational paradigms through digitally enabled innovation [1], [2], [3]. Despite widespread investment in technological ecosystems, institutional strategies frequently experience fragmentation, prioritizing technological efficiency over pedagogical intent. This challenge is amplified by the emergence of Education 5.0 [4], [5], [6], a human-centred paradigm that demands the ethical, inclusive [7], and sustainable integration of advanced technologies—such as artificial intelligence, learning analytics, and adaptive learning environments—while safeguarding human agency, personalisation, and social responsibility. Existing digital maturity and competency models [8], [9], [10] provide rigorous mechanisms for evaluating infrastructure and strategic capability. However, they primarily foreground organisational and technological dimensions, while the pedagogical dimension of teaching and learning is often treated as a secondary or mediated component rather than a central driver of transformation. As a result, the role of teaching practices in shaping DT outcomes remains partially underdeveloped. To overcome this technology-led fragmentation, there is a need for a holistic model that explicitly positions faculty teaching practices and learning design at the centre of institutional digital maturity.

2. Objectives

This study introduces the Digital Teaching Transformation (DTT) Framework (DTTF) and its accompanying operational Toolkit (T), developed under the DIGITAsia project to assist higher education institutions (HEIs) in systematically embedding digital practices. The primary objective is to articulate a structured model that bridges the gap between high-level institutional governance and granular application. Specifically, the research aims to:

A. Provide HEIs the conceptual basis to frame DT with an actionable mechanism to diagnose current practices, prioritise interventions, and implement measurable DTT initiatives.

B. Establish the structural dimensions of the DTTF that align institutional enablers with teacher competencies.

C. Develop an Excel-based toolkit—comprising a Maturity Model (MM), a Road Map (RM), and an Action Plan (AP)—operationalise these dimensions.

3. Methodology

The development of the DTTF & T was guided by a teaching-centred, four-phase Design-Based Research (DBR) process [11], [12]. In Phase 1, a systematic literature review and comparative analysis of established digital maturity models was conducted alongside the collection of institutional perspectives from project partners The collected material was analysed through a qualitative content analysis approach aimed at identifying recurring themes, conceptual patterns, and key dimensions of digital teaching transformation. Particular attention was given to the relationship between institutional enablers and teacher competencies, ensuring a teaching-centred perspective. In Phase 2, the first version of the framework and toolkit was developed. Through iterative expert discussions and cross-partner validation, the identified dimensions were structured into thematic categories and operational indicators. These were translated into a four-level maturity model grounded in the Capability Maturity Model (CMM) and its e-government applications [13], framing digital teaching development as a progressive trajectory from initial awareness to strategic impact in higher education. The model was operationalised through a colour-coded assessment logic to support visual interpretation of institutional progression and informed the design of a unified Excel-based toolkit integrating diagnostic, planning, and implementation components. In Phase 3, the T underwent an iterative cycle of evaluation, expert feedback, and piloting across partner institutions, where institutional stakeholders tested the practical viability of the tools. In Phase 4, DTTF & T were revised and finalised to consolidate the design decisions emerging from the DBR cycles, ensuring strict structural coherence between the conceptual model and its practical instruments while validating their alignment with the human-centred criteria of the Digital Education 5.0 paradigm.

4. Outcomes and conclusions

The resulting DTTF consists of a conceptual framework structured around two core dimensions—Institutional Enabling and Teacher Dimension—organised through a four-level maturity model that describes progression from initial awareness to strategic impact in digital teaching. The accompanying toolkit operationalises the DTTF and is composed of three integrated components: (i) a Maturity Model (MM) for diagnosing current institutional and teaching maturity across structured indicators and progression stages, (ii) a Road Map (RM) for translating diagnostic results into prioritised strategic objectives, and (iii) an Action Plan (AP) for breaking down these objectives into concrete, assignable, and time-bound implementation tasks. Together, the DTTF & T form an integrated system that connects conceptual modelling with operational execution, supporting structured digital teaching transformation in higher education.

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Exploring Generative AI Use in Teacher Education and Instructional Design

Emmanuele Gatti[0009-0008-0126-0943], Arianna Giuliani[0000-0001-9713-0626], Ilaria Terrenghi[0000-0003-3037-6087] and Serena Triacca[0000-0001-8854-5117]

eCampus University, Novedrate, Italy
{emmanuele.gatti; arianna.giuliani1; ilaria.terrenghi; serena.triacca}@uniecampus.it

1 Introduction

Generative Artificial Intelligence (GenAI) systems are transforming education [1] and are now at the center of scientific, social, and educational discourse. Their growing prevalence has profoundly transformed school, university, and training environments [2], establishing them as a strategic resource for supporting teaching practice. In fact, these tools can facilitate the personalization of teaching, learning, and assessment [3], support inclusive [4] instructional design, provide timely feedback [5], and aid in the analysis of educational processes.

However, alongside these opportunities, ethical, pedagogical, and professional issues are emerging that require the development of critical and reflective skills. Recent European framework for teachers' digital competences, such as DigCompEdu [6], as well as national and international guidelines on the use of AI in education [7-8], align with this approach, emphasizing the importance of a conscious, responsible, and pedagogically grounded use of intelligent technologies [9].

The concept of Artificial Intelligence Literacy (AIL) [10-11] is therefore of particular importance: understanding, critically assessing, and effectively using AI systems is a key dimension of teachers' professional competence and a prerequisite for fostering informed AI literacy among students. The literature highlights, however, that while attitudes towards AI are generally positive and its educational potential is recognized, many teachers report limited knowledge of how these systems work and how to most effectively integrate them into teaching and learning processes [12-13]. This highlights the importance of promoting specific training programs that support the development of teachers' AI literacy through situated, reflective, and collaborative approaches [14].

2 Context, Objectives, and Methodology

This study investigates a teacher professional development experience delivered within the *Qualifying Pathways* developed by eCampus Telematic University (Italy) during the a.y. 2025/26. The exploratory study involved 599 in-service and pre-service teachers attending the *Didattica generale* course (12 hours), which focused on instructional design and the potential role of GenAI in supporting

instructional planning and classroom management. Participants also took part in a workshop on integrating GenAI into instructional design.

The study pursued four main objectives: (1) to investigate participants' prior knowledge, perceptions, and attitudes toward generative AI systems and their possible integration into teaching practice; (2) to examine the AI literacy levels of a large sample of teachers, with the additional aim of identifying emerging formative needs; (3) to explore participants' ability to use AI systems to support instructional design activities by examining their overall approach, prompt design, instructional strategies, and perceived usefulness of AI; and (4) to identify useful elements for the development of future teacher professional development initiatives focused on the relationship between AI and teaching design practices.

The study adopted a mixed-methods approach. On the quantitative side, two mixed questionnaires were used to investigate participants' prior knowledge, perceptions, attitudes, and AI literacy levels. Qualitative data were collected through the trainer's reflective diary, which documented workshop activities and participants' interactions during the online sessions, and through an online form in which participants reflected on their use of the AI tool, the prompts they generated, and the adequacy of the AI-system's responses.

3 Early Findings and Conclusions

The analysis allowed us to identify recurring patterns in participants' approaches to AI-supported instructional planning, as well as emerging challenges, opportunities, and training needs. While a clear majority of teachers expressed a favourable attitude toward the use of artificial intelligence in school settings, only 41.2% reported having used AI for professional purposes, whereas 9% stated that they had never used it at all. At the same time, nearly all respondents report unfamiliarity with any reference framework, and the few who responded affirmatively provided incorrect answers, referencing large language models (LLMs) rather than actual pedagogical frameworks. Concurrently, concerns emerged regarding professional use and student adoption of AI technologies.

As for future expectations, a substantial majority of teachers 73.5% believed that AI could be useful. The most prevalent usage patterns identified are: idea generation (59.1%), speed up internet searches (59.5%), wording and material production (56.7%), and build evaluation tools (32.2%). The qualitative component of the study, conducted through diary-keeping, provided deeper insight into how AI was actually employed in classroom practice, revealing the nuances and contextual factors that quantitative data alone could not capture (e.g. delving deeper into the prompts used, clarifying the prescriptive constraints, trying to understand the specific use made of AI in instructional design). The qualitative findings further highlighted participants' AI-supported instructional design practices, including prompting strategies and pedagogical reasoning. Overall, effective AI integration depends not only on technical familiarity but also on purposeful prompting and pedagogical alignment. These findings call for targeted teacher training across four dimensions of AI use (instrumental, supportive, exploratory, and minimal/uncertain) to foster competent and ethical educational practice.

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Reimagining ePortfolios as Personal Learning Environments for Lifelong Career Development: Insights from the DEVICES Project

Lorella Giannandrea[1] [0000-0002-1169-4795], Chiara Laici[1] [0000-0002-8013-1179] and Francesca Gratani[1] [0000-0003-2974-0101]

[1] Department of Education, Cultural Heritage and Tourism, University of Macerata, Macerata, Italy
lorella.giannandrea@unimc.it; chiara.laici@unimc.it; f.gratani@unimc.it

1 Introduction

Higher education is increasingly challenged to prepare students not only for their first employment but also for lifelong career development in rapidly evolving and digitally mediated labor markets. This shift requires moving beyond knowledge transmission towards educational models that foster learner agency, reflection, adaptability, and Career Management Skills (CMS) [1, 2, 3]. At the same time, digital transformation offers new opportunities to redesign learning environments that support students' personal and professional development throughout their academic journeys.

These challenges are particularly significant in international capacity-building initiatives, where educational innovation must respond to diverse institutional traditions, cultural perspectives, and labor market needs. Despite the rapid expansion of higher education systems in Vietnam and Cambodia, universities continue to face persistent challenges in aligning academic preparation with graduates' employability and labor market expectations [4, 5]. Sustainable innovation in higher education increasingly depends on collaborative and intercultural partnerships that integrate international expertise with local educational priorities through processes of co-design and mutual learning [6, 7].

Within this context, the DEVICES project (*Developing Education in Vietnam and Cambodia Enhancing Employability of Students*; No. 101177347) was launched in November 2024 as a three-year Erasmus+ Capacity Building in Higher Education initiative. Coordinated by the University of Macerata, the consortium brings together nine partner institutions, four European (University of Macerata, Italy, STEPS Research Centre, Italy, University of Alicante, Spain, and WSG University in Bydgoszcz, Poland) and five Asian (Hanoi, Ha Long, and Nha Trang Universities from Vietnam, and CheaSim Kamchaymear and Battambang Universities from Cambodia). The project explores how digital technologies can support CMS, reflective learning, and professional identity development through an intercultural process of pedagogical co-design.

2 The DEVICES Personal Learning Environment

The core contribution of the DEVICES project lies in rethinking the educational role of ePortfolios beyond their traditional function as digital repositories, repositioning them as reflective learning environments that support employability competences and career development [8, 9, 10]. The framework was developed through an iterative co-design process involving academic staff, career service professionals, technical experts, and students from the partner institutions.

The process combined an international benchmark analysis of existing platforms, a needs analysis involving more than 3,000 respondents, collaborative discussions among partners, and the progressive integration of shared pedagogical principles into platform and training requirements. Partner perspectives informed decisions concerning multilingual access, usability, reflective guidance, privacy, competence representation, and the relationship between academic learning and local labor market needs.

Within the resulting framework, the ePortfolio is conceived as a student-owned Personal Learning Environment (PLE) rather than primarily as an institutionally managed platform for documenting learning [11, 12]. Students collect curricular and extracurricular experiences, select evidence of learning, reflect on the competencies developed, receive peer and mentor feedback, and connect their experiences with CMS and future goals. Reflection is therefore conceived as the pedagogical process through which students make sense of their experiences and progressively shape their professional identities and career aspirations.

At the current stage of the project, the pedagogical framework has informed the design of a multilingual Mahara-based platform, and an initial pilot involving students and staff from the Vietnamese and Cambodian partner universities is underway. The pilot examines platform usability, the usefulness of reflective prompts and guidance, and the extent to which the workspace supports students in recognizing, documenting, and communicating their competences.

3 Conclusion

The DEVICES project can be understood not only as an international cooperation initiative but also as a laboratory of intercultural pedagogical innovation. Rather than transferring a predefined educational model across contexts, it adopts an intercultural co-design approach that brings together European, Vietnamese, and Cambodian institutions in the development of a shared pedagogical framework.

Drawing on contemporary debates on the decolonization of higher education [7, 13], epistemologies of the South [14], capacity building, and international cooperation, the project seeks to balance common principles with different educational traditions, institutional conditions, and understandings of employability. Its implementation indeed presents challenges related to digital literacy, language, institutional integration, technical infrastructure, and the different meanings attributed to reflection and career development across contexts. The ongoing pilot will provide evidence for refining both the platform and its pedagogical use.

Overall, the project advances three interconnected dimensions of innovation: pedagogical, by reimagining the ePortfolio as a PLE supporting reflection and lifelong career development; technological, by designing a digital workspace that integrates learning, competence development, and professional identity construction; and intercultural, by co-designing a shared pedagogical framework across diverse educational traditions and context-specific needs.

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Driving the Transformation: A Course Concept Preparing for a Sustainable Future

Sabrina C. Eimler[1[0000−0001−8944−2814]], Uwe Handmann[1[0000−0003−1230−9446]], Nermeen Baker[1[0000−0002−9683−5920]], Julia Maria Barenbrock[1[0009−0006−3758−4136]], Alexandra-Michelle Drechsler[1[0009−0007−8561−2178]], Gian Luca Dossena[1[0009−0006−7959−8202]], Lukas Erle[1[0000−0001−8623−8869]], André Helgert[1[0000−0001−6008−4793]], Ramón-Darius Imort[1[0009−0007−4740−9005]], David Rohrschneider[1[0009−0003−4693−3797]], Jonas Stehr[1[0000−0002−5332−6616]], and Paul Szabó-Müller[1[0000−0002−6626−9390]]

Institute of Computer Science, Ruhr West University of Applied Sciences, Lützowstraße 5, 46236 Bottrop, NRW, Germany sabrina.eimler@hs-ruhrwest.de

1 Introduction

As higher education institutions are expected to foster digital literacy skills, such as critical thinking, collaboration, communication, and more (c.f. 21st century skills [1]) beyond a mere focus on the content of study program-related courses (like technology-related knowledge), there is an urgent need for updated teaching formats. Equipping students with these skills and awareness of the United Nations' Sustainable Development Goals (SDGs) has been a notable trend in Science, Technology, Engineering, and Mathematics (STEM) education [2]. Therefore, we propose a scalable course design that uses blended learning to educate STEM students regarding the impact of modern technologies in achieving the SDGs, as well as fostering future skills. We evaluated the course through three quantitative questionnaires and qualitative interviews, touching upon participants' course enjoyment and knowledge increase.

2 Course Content & Organization

The course "Positive Computing and Diversity in Human Computer Interaction" builds upon prior work and evaluations (c.f. [3]) and is part of the mandatory study program curriculum for "Human Computer Interaction" at the Ruhr West University of Applied Sciences (HRW) in Germany, but also invites students from other disciplines. Instead of relying on classic didactic patterns like lectures, the majority of the course content is offered as self-learning materials (e.g., online resources, annotated research papers, or scientific posters) in the learning management system of HRW, available at any time or place to accommodate various study and life situations. Each week, a new theme is released, accompanied by an online workshop for questions, expert exchange, and additional thematic impulses. Themes include positive computing, gender and diversity, and future technologies that have been identified as particularly relevant

(c.f. [4]), namely: social robotics, extended reality, artificial intelligence. After seven weeks, the course culminates in a two-day ideation hackathon, in which students form groups to develop innovative concepts for addressing one of two societal challenges. The first challenge focuses social robots for public spaces (e.g., city offices, recycling centers) to make circular economy services more accessible and inclusive, while the second challenge is aimed at solutions for public spaces to help people cope with crises and stress, strengthen neighborhood resilience, and support low-threshold services. Groups can get expert feedback during the hackathon and, at the end, present their results as short pitches, enriched by short documentations. Pedagogically, the course combines self-paced learning, expert-supported reflection, and SDG-oriented knowledge application in the hackathon, allowing students to move from conceptual learning to collaborative ideation, thus acting as co-producers of course content.

3 Evaluation

The course was evaluated through three anonymous online questionnaires administered during and after the course, with $N_{Q1} = 34$ responses before the hackathon, $N_{Q2} = 27$ post-hackathon, and $N_{Q3} = 19$ at follow-up. Additionally, we conducted $N_I = 32$ semi-structured interviews with students after the hackathon to enrich statistical data. Quantitative measures include participants' demographic data and general emotional state over the course of the workshop weeks and regarding the hackathon. Additionally, they were asked to indicate their prior knowledge on the course themes and how they would rate their digital literacy skills before and after the hackathon. Furthermore, participants rated how much their interest in and knowledge on different technologies increased throughout the learning activities. Finally, relating to developed concepts, the presumed contribution to and resulting optimism in the different SDGs were measured. As part of the interview guide, participants received questions on the course organization, themes, and hackathon structure. These questions were aimed at gaining a better understanding of which didactic patterns of the course worked better or worse, which themes were especially interesting and well-executed, whether there were materials that were difficult or uncomfortable to work with, whether and how individual skills were addressed and advanced through the course and how collaboration and communication with team members during the hackathon. Results point towards students feeling confident in technology's potential for addressing the SDGs, as well as a heightened awareness of digital literacy skills. The design therefore appears transferable to other higher education contexts.

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Strengthening Pedagogy Through AI-Supported Access to High-Leverage Practices

Meg Kamman[1(0000-0002-9678-561X)] and Erica McCray[2(0000-0001-8140-678X)]

[1] University of Florida, Gainesville, FL 23611
mkamman@coe.ufl.edu
[2] University of Florida, Gainesville FL 32611
edm@coe.ufl.edu

1 AI-Supported Pedagogy and High-Leverage Practices

Current educational contexts have intensified the need for instructional supports that help educators implement evidence-based pedagogical practices across increasingly diverse learning environments. At the same time, artificial intelligence (AI) is rapidly influencing how educators plan instruction, differentiate learning experiences, provide feedback, and support student engagement [1]. Recent discussions in educational technology emphasize that AI should function as a collaborative instructional support rather than a replacement for educator expertise [2,3]. Emerging scholarship further suggests that educators should "remix" existing evidence-based instructional practices with AI-enhanced supports rather than replace established pedagogical frameworks entirely [4].

This paper presents a conceptual framework for strengthening online pedagogy through AI-supported access to High-Leverage Practices (HLPs). HLPs provide an evidence-based instructional framework designed to improve outcomes for all learners, including students with disabilities, across grade levels, content areas, and instructional settings [5]. As online, hybrid, and technology-enhanced learning environments continue to evolve, educators require timely, job-embedded support that helps translate evidence-based practices into authentic instructional decision-making. Positioning AI within the HLP framework provides one approach for ensuring that AI-generated guidance remains grounded in established pedagogical practices rather than generic instructional recommendations.

2 HLP Chatbot Design and Application

To illustrate this framework, the paper describes the development and intended use of an AI-supported HLP chatbot designed to provide teacher candidates and practicing educators with on-demand pedagogical guidance. Users interact with the chatbot by entering instructional challenges, lesson-planning questions, or classroom scenarios using natural language without needing prior knowledge of specific HLPs. The chatbot analyzes the educator's request, identifies the High-Leverage Practices most relevant to the instructional scenario, and generates evidence-informed suggestions, reflective

questions, instructional considerations, and implementation strategies aligned with those practices.

For example, an educator planning a synchronous online lesson for learners requiring varying levels of support may request strategies to increase engagement, facilitate discussion, or differentiate instruction in a virtual environment. Rather than simply generating lesson ideas, the chatbot explicitly connects its recommendations to relevant HLPs while encouraging educators to reflect on instructional decisions and adapt recommendations to their own classroom contexts.

The chatbot is intended to function as a pedagogical scaffold that supports lesson planning, reflection, instructional coaching, and professional learning rather than automating instructional decision-making. Educators remain responsible for evaluating AI-generated recommendations for accuracy, accessibility, contextual appropriateness, and alignment with individual learner needs. This human-centered approach reflects emerging guidance emphasizing AI as a tool that augments educator expertise while maintaining human judgment, ethical decision-making, and instructional responsibility [2,4,6,7].

3 Conclusion and Implications

This paper is conceptual and implementation-focused and does not report empirical effectiveness data. Instead, it describes the design rationale, intended functionality, and potential applications of an AI-supported HLP chatbot as one example of integrating generative AI into educator preparation and professional learning. By grounding AI-supported instructional guidance within an evidence-based pedagogical framework, this work demonstrates one approach for strengthening online pedagogy while maintaining a clear emphasis on human expertise, reflective instructional decision-making, and inclusive teaching practices. Implications for educator preparation, faculty development, instructional coaching, and scalable professional learning systems are discussed.

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The experimental learning cycle in university education for the healthcare professions in a four-year training and research initiative within a course on Didactics and Experimental Pedagogy

Susanna Piacenza[1][0009-0005-4045-3869] Maria Luisa Boninelli[2] [0009-0000-0329-1358] Paola Cortiana[1][0009-0001-1330-4367] Leonardo Menegola[1] [0000-0003-4712-4740] Norma Lamberti [3] [0009-0008-2373-2825]

[1] Università Telematica eCampus, Novedrate (Co), Italy
[2] Università degli Studi di Catania, Catania, Italy
[3] Università di Torino, Torino, Italy

susanna.piacenza@uniecampus.it; marialuisa.boninelli@unict.it; paola.cortiana@uniecampus.it; leonardo.menegola@uniecampus.it; norma.lamberti@unito.it

1 Introduction

This paper presents a four-year training-research initiative carried out within the Experimental Didactics and Pedagogy course of the Master's Degree Program in Diagnostic Technical Health Professions at the University of Turin. The initiative explores the potential of the experimental learning cycle (CAE) as a cross-disciplinary teaching tool in health science programmes and investigates how it can support reflective, competency-based learning in students training for diagnostic and clinical practice.
The theorical framework adopts the CAE model, which conceptualizes learning as a circular process [1] beginning with an authentic problem and progressing through experience, communication, analysis, generalization and application.

This framework guides the design of teaching activities is integrated with the revised Bloom taxonomy by Anderson and Krathwohl [2], focusing on cognitive processes and with the R-I-Z-A model [3], which describes competent action as the integrated mobilization of resources, interpretive structures, action and self-regulation.
The CAE strategy combines with the application of R-I-Z-A model aligned with the European framework [4] of key competences for lifelong learning, with specific emphasis on "learning to learn", draws on Feuerstein's perspectives on structural cognitive modifiability [5] highlighting the role of educational mediation in transforming students' cognitive structures [6].

2. Methods

Within the master's course "Training 2 (Teaching and Experimental Pedagogy)", students design, implement, and reflect on training activities applying CAE and R-I-Z-A to professional contexts. Across five cohorts, they select an open-ended professional

scenario and complete a structured assignment targeting specific learning objectives and cognitive processes. During the simulation, one student assumes the role of trainer, guiding peers in selecting and organizing stimuli, supporting the articulation of thoughts and verbalization of processes, and connecting past experiences to new situations, in line with established criteria [7]. This role is enacted through peer-assisted learning and teaching [8], with rotation in the guide position, emphasizing the educational value to peer resources in promoting participation, mutual support and inclusion [9-10] within a heterogenous group of health-profession students. In this higher-education context, "peer resources" refer to the competences, experiences and perspectives that students bring to the group and that are activated to sustain each other's learning [11-12]. The staged problem situations cover the phases of the CAE and are filmed at key moments, from the initial experience and communication of developed situations to guided analysis and shared generalization. Each group then produces a short video that summarises the planning process and central phases of the cycle, including problem presentation, collaborative development of solutions, and formulation of procedures or "best practice" rules for future professional situations. The video is addressed to a real audience, the following year's students, and its production is conceived as a generative activity that fosters metacognitive reflection [13-14]. In this way, the digital artefact extends the workshop-based, face to face dimension of the simulation and contributed to a hybrid learning environment in which video functions both as a representation of practice and as a resource for subsequent cohorts [14].

This paper examines the implementation of a hybrid pedagogical approach integrating the CAE framework, simulation-based activities, and student-generated videos. It investigates students' perceptions of the CAE and its perceived contribution to competence development, reflexivity, and professional growth within a university pedagogy module in a medical-scientific curriculum. [15].

The empirical study is currently at the instrument development and initial implementation stage. The main instrument, which is a self-report questionnaire on students' experience with the CAE and the associated video production, is being finalised and piloted with the most recent cohort. The items refer explicitly to:1) the phase of the cycle (from initial problem to application); 2) the revised taxonomy's descriptors of cognitive processes; and 3) the R-I-Z-A- model's descriptors of interpretation, action and self-regulation. Specific scales address the perceived utility of the CAE for professional practice, the perceived activation of cognitive processes (e.g. analysis, synthesis, evaluation) and the perceived support for self-regulation [3-6, 8].

Particular attention is devoted to the concept of mediation. Items explore students' perceptions of the intentionality and meaning of the proposed experience, as well as their perceived competence. This is in line with Feuerstein's view of cognitive modifiability.

Additional items investigate the perceived transferability of the CAE to the professional context to Technical Professional Science students, considering the integration of pedagogical content into a predominantly medical scientific programme.

3. Conclusions

This exploratory study investigates students' perceptions of the CAE, mediation, and video production by triangulating questionnaire data with simulations, student-generated videos, and written reflections. Preliminary findings suggest that the approach helps students reinterpret real clinical situations through a pedagogical lens. The study highlights implications for designing mediated, competence-oriented learning environments and fostering reflective professional development in health professions education.

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E-Tutoring, Digital Readiness and Learning Agency in Online Higher Education: A Case Study at IUL, an Italian Online University

Massimiliano Naldini[1][0000-0002-7892-8111]

[1] National Institute for Documentation, Innovation and Educational Research (INDIRE), Italy
m.naldini@indire.it

1 Context

The rapid expansion of online higher education has highlighted the strategic role of e-tutoring in supporting student engagement, persistence and academic success. Within digital learning environments, students are required not only to manage technological tools, but also to develop self-regulation, autonomy and metacognitive strategies. Although the literature on online learning emphasizes the importance of interaction and social presence, less attention has been devoted to how students perceive the pedagogical role of e-tutors in fostering digital readiness — students' self-efficacy and self-directedness in online contexts [1] — and learning agency — their capacity to exercise active control over the learning process [2] — within fully online university contexts. This study addresses this gap through a case study conducted at the Università Telematica degli Studi IUL, an Italian online university whose educational model is grounded in the Community of Inquiry (CoI) [3] framework and collaborative online learning practices [4][5]. The study provides evidence from an Italian online university context, still underexplored in international research on e-tutoring.

2 Aim

The research aims to explore students' perceptions and expectations regarding the role, competencies and practices of the e-tutor in online higher education. In particular, the study investigates which tutoring strategies are perceived as most effective in supporting motivation, self-regulated learning, participation and the development of a collaborative online learning community. Furthermore, the study seeks to understand how tutoring contributes to students' digital and metacognitive readiness [6] [7].

3 Method

The study adopts an exploratory sequential Mixed Methods design. The qualitative phase involved semi-structured interviews with graduates from IUL University, aimed at identifying tutoring practices perceived as significant for academic success and continuity in online learning. Findings from the interviews informed the construction of a quantitative questionnaire administered to 149 first-year students enrolled in an online degree program. The questionnaire explored expectations related to tutoring

functions, communication practices, motivational support, self-regulation and collaborative learning tools. The integration of qualitative and quantitative data allowed the triangulation of students' past experiences and incoming expectations. The research is therefore configured as an exploratory case study focused on the tutoring model adopted within the educational ecosystem of Università Telematica degli Studi IUL.

4 Results

Findings show that students perceive e-tutoring not merely as technical or disciplinary support, but as a multidimensional pedagogical practice integrating instructional, relational and emotional dimensions [8] [9]. Qualitative data highlight the importance of timely feedback, clarity of explanations, tutor availability and empathic communication in reducing feelings of isolation and sustaining participation in online learning environments. A particularly relevant finding concerns students' digital and metacognitive readiness: many adult learners initially experience difficulties in organizing autonomous study processes, managing time and navigating online platforms. In this context, the e-tutor emerges as a key mediating figure supporting the development of self-regulation, study strategies and learning awareness. Quantitative findings confirm these patterns, revealing high expectations toward tutoring in relation to motivation, academic performance, continuity of study and autonomy. Students also associate effective tutoring with a stronger sense of belonging and participation in the online academic community.

5 Implications

The study suggests that e-tutoring in online higher education should be conceptualized not only as instructional support, but as a strategic pedagogical device fostering self-regulation, digital readiness and learning agency. The findings reinforce the relevance of the Community of Inquiry framework for designing collaborative online learning environments and underline the need for universities to invest in specialized tutoring practices capable of integrating cognitive, social and motivational support. More broadly, the research contributes to the international debate on the pedagogical sustainability of online higher education and on the evolving professional identity of the e-tutor in digital universities.

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Bridging Higher Education and Socio-Educational Practice: A Human-Centred AI Literacy Framework for Professional Learning

Marco Rondonotti[1[0000-0003-1579-6737]], Federica Emanuel[1[0000-0002-7922-719X]] and Paolo Raviolo[1[0000-0002-2876-514X]]

[1] eCampus University, Italy
marco.rondonotti@uniecampus.it; federica.emanuel@uniecampus.it; paolo.raviolo@uniecampus.it

1 Introduction

The rapid diffusion of Generative Artificial Intelligence is transforming educational, social and care practices. In socio-educational contexts, AI tools are increasingly used to support communication, documentation, planning, access to information, decision-making and personalised interventions [1, 2]. These developments require professionals to acquire not only operational skills, but also the ability to understand AI systems, critically assess their outputs, recognise bias and misinformation, protect vulnerable users and preserve human agency in educational and care relationships.

Higher Education institutions can play a key role in this process by connecting theoretical knowledge, professional preparation and the responsible adoption of AI in practice. This is particularly relevant for the socio-educational field, where digital transformation affects both initial education and continuing professional development [3]. From this perspective, AI literacy needs to be translated into training models that are ethically grounded, professionally relevant and practice-oriented.

The proposal is grounded in research on AI literacy, digital competence, trustworthy AI and reflective professional learning. AI literacy is understood as a multidimensional competence that enables individuals to understand, use, evaluate and critically engage with AI systems. This perspective is supported by exploratory evidence on university students' perceptions of AI skills [4] and by recent studies on AI use and professional profiles in educational and socio-educational contexts [5]. The framework builds on DigCompEdu, AI competence models, and European principles for trustworthy AI, emphasising human agency, ethics, transparency, privacy and accountability in socio-educational contexts.

2 Aim

This contribution proposes a competence-based, training-oriented framework for developing AI literacy at the interface between Higher Education and socio-educational practice. It identifies key competence areas and translates them into learning outcomes, assessment criteria and modular training activities, supporting theoretically grounded, ethically aware and practice-oriented professional development. The proposal also explores how digital learning environments, micro-credentials and open badges can

enable scalable and recognisable training pathways. It builds on previous studies on AI literacy, co-design and AI integration in educational and socio-educational settings, particularly within the TEACH-AI projects [5, 6, 7, 8].

3 Proposed Framework and Methodological Design

The framework comprises five interconnected competence areas: conceptual and technical understanding of AI; ethical and legal awareness; pedagogical and professional use; critical evaluation of AI outputs; and reflective and participatory governance. Together, they address AI functioning and limitations, privacy, transparency, bias and accountability, professional applications, and the preservation of human agency and professional judgement. As interdependent dimensions of AI literacy, they connect informed use, critical evaluation, ethical responsibility and reflective practice.

Methodologically, the framework bridges academic knowledge and professional practice through a design process that combines theoretical grounding, analysis of professional needs, participatory development and validation in modular training pathways. This approach allows Higher Education institutions to translate competence areas into learning outcomes, assessment activities and recognisable certification formats.

The training model is based on practice-oriented digital resources and reflective activities, aligned with specific learning outcomes and potentially connected to micro-credentials or open badges. In this way, it supports flexible and recognisable opportunities for lifelong learning and professional development.

4 Conclusion

The proposal contributes to the debate on AI in Higher Education by moving beyond tool adoption and focusing on universities' responsibility in preparing socio-educational professionals for responsible AI use. It connects AI literacy with ethical, relational and contextual dimensions of practice, while positioning micro-credentials as a bridge between academic training, lifelong learning and professional recognition.

By framing AI literacy as an integrated professional competence, the framework supports the design of training pathways that are technologically informed, pedagogically meaningful and socially responsible. It also offers professionals shared criteria for evaluating, adapting and governing AI tools in their contexts of practice [9].

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General Track 2

Learning technologies, data analytics and educational big data mining as well as their applications

Teaching Graduate Students to Design Learning Analytics Tools in the Age of Machine Learning and Generative AI

Martin Drlik[0000-0002-5958-7147] and Janka Pecuchova[0000-0002-9225-7449]

Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, Nitra, Slovakia
mdrlik@ukf.sk, jpecuchova@ukf.sk

1 Introduction

Learning analytics (LA) is commonly taught as a methodological field concerned with collecting, processing, and analysing educational data. This may lead students to see it mainly as applying algorithms to existing datasets. However, in authentic educational contexts, meaningful analytics begins earlier with designing learning activities, digital tools, and data traces that provide interpretable evidence about learning.

This paper reflects on a graduate-level Learning Analytics course in which IT students design educational tools that intentionally generate data for later analytics. The course positions LA not only as technical practice, but also as pedagogical design. The course has evolved over three years. Its main novelty compared with dataset-first instruction is a reversed design sequence, in which students begin with a self-defined educational problem, not a predefined dataset or analytical method. Using participatory design methods and the Machine Learning (ML) Canvas, they identify learning needs, design an educational tool, and define expected learning processes [1]. They then specify what data should be collected and how this data could be analysed. This approach emphasises that LA depends not only on algorithms, but also on educationally meaningful data and valid interpretations. By framing LA as a bridge between educational design and data science, the paper offers a practical approach to developing AI-related competencies in pedagogically meaningful, technically informed, and ethically responsible ways [2].

2 Course Design and Analytical Approach

The course is organised around project-based learning. Student teams design an educational tool addressing a learning challenge such as self-regulated learning, adaptive practice, programming education, or automated assessment. Projects specify target learners, educational context, learning problem, pedagogical rationale, resulting data traces, and suitable analytics methods. The outcome is a design proposal or prototype, not necessarily an implemented application.

A key pedagogical principle is to treat data as evidence, not merely as system output. Initial students' ideas often rely on easily collected indicators such as clicks, time spent, completed tasks, or quiz scores. Through lectures, peer discussion, and instructor

feedback, students consider what these traces indicate, possible alternative interpretations, and the contextual information needed to avoid misleading conclusions.
The reflective analysis in this paper draws on three years of student project proposals, peer-feedback activities, and instructor observations. It examines recurring difficulties in connecting educational problems and learning processes with data traces, analytical methods, and interventions. It identifies recurring patterns rather than evaluating individual performance or learning gains. The analysis also reflects that Generative artificial intelligence (GAI) has changed student projects. As a result, students increasingly propose tools that automate feedback, support AI-assisted writing, generate questions, and provide recommendations. These projects enable discussion of advanced analytical methods [3] and issues including transparency, bias, privacy, academic integrity, and validation of AI-generated feedback.

3 Results

Analysis of course artefacts and teaching reflections revealed the following recurring patterns:

- Technology-first framing: Initial students' ideas frequently started with an LLM tutor, predictive model, automated feedback, or dashboard, with the educational problem articulated afterwards. Iterative design and critique required teams to clarify target learners, learning needs, and pedagogical purposes, shifting attention toward what learning process should be supported or made visible.
- Overinterpretation of behavioural traces: Students commonly treated clicks, time spent, task completion, or scores as sufficient indicators of constructs such as engagement, confusion, or self-regulation. Discussions exposed ambiguity because similar traces may have different interpretations depending on context. More developed proposals therefore qualified conclusions, combined indicators, or identified additional contextual information.
- Disconnect between analytics and pedagogical action: Students could propose prediction, classification, clustering, recommendation, or visualisation methods, but did not always specify who should use the results, when an intervention should occur, or how it would address the educational problem. As a result, refinement focused on connecting analytical outputs with actions by stakeholders or educational systems and environments.
- The educational validity of GAI outputs: Students often proposed LLM-generated solutions, frequently with limited consideration of validation. Therefore, the critique addressed reliability, hallucinations, bias, teacher oversight, learner autonomy, and evaluation of AI-generated feedback.

4 Discussion and Conclusions

The identified patterns suggest that educational tool design can move students beyond a technology-first understanding of LA. Starting with their own educational problem and intended learning process, rather than an existing dataset, encourages students to

consider the relationship between what can technically be measured and what can meaningfully serve as evidence of learning.

The findings support a design logic linking educational problems, analytics, and pedagogical interventions. Analytical methods should follow decisions about the learning problem, relevant processes, and evidence needed to make them visible. LA education should therefore include not only data analysis but also critical design of the environments and tools that generate educational data. LA curricula should introduce problem formulation and data design before advanced analytics, preparing students to evaluate what data represents and connect evidence to meaningful interventions [4]. AI-supported tool ideation can integrate pedagogy, technology, data, and ethics [5], while ML and GAI encourage critical examination of evidence, its validation and interpretation, and analytics' role in supporting rather than replacing educational judgement.

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SEE-ITACA Framework: Integrating Learning Analytics, Competency Modelling and Virtual Reality for Instructional Design

Mariangela Mirra [1] Immacolata Stizzo[2] and Stefano Di Tore[3]

[1] University of Macerata and University of Salerno
[2]Itaca Education, Pontecagnano (SA) 84098
[3]University of Salerno, 84084 Fisciano (SA), Italy

mirra2@unimc.it; istizzo@fmtsgroup.it;sditore@unisa.it

1 Introduction

1.1 Conceptual and Technological Context

The increasing adoption of learning analytics and competency-based education has transformed the ways in which educational data are collected and utilised to support teaching and learning processes. Although learning analytics is an established field for educational decision support, its integration into instructional design remains only partially formalised and operationalised [1]. Current approaches tend to address competency representation, learning analytics and instructional design as separate processes, limiting continuity between data interpretation and pedagogical action [2]. Consequently, competency evidence is not always effectively translated into instructional decisions. Competency frameworks such as ESCO provide standardised representations of skills across educational and labour-market domains, supporting interoperability between different contexts [3]. However, their translation into operational instructional models remains limited. European skills intelligence initiatives promote alignment and comparability, yet interoperability between competency frameworks, learning analytics and educational systems remains a challenge [4,5]. Virtual reality (VR) has shown significant potential for immersive learning by sup-porting engagement, contextualised skill acquisition and learning effectiveness through cognitive and motivational factors [6]. Interaction design and perceptual coherence represent relevant determinants of learning effectiveness in immersive environments [7]. Recent developments in NPC-based virtual environments further highlight the potential of adaptive and data-driven immersive systems [8]. However, VR applications remain largely disconnected from competency frameworks and learning analytics, limiting pedagogical traceability and evidence-based instructional design [9]. To address this gap, this paper proposes the SEE–ITACA framework, which integrates competency modelling, organisational analysis and immersive instructional design. SEE provides the analytical component for competency modelling, organisational analysis and learning analytics interpretation.

2 SEE-ITACA Framework

The SEE–ITACA framework connects competency modelling, learning analytics and instructional design through a workflow that translates competency evidence into immersive learning environments. As illustrated in Figure 1, the framework is composed of two interconnected components: SEE, which performs the analytical activities, and ITACA, which operationalises the results through instructional design and VR scenario development. SEE is organised into three analytical layers. Competencies are identified and mapped through the ESCO classification system and refined through the INAPP framework [3,4]. Organisational analysis and competency assessment support the identification of competency gaps and training priorities [5]. These outputs are then translated by ITACA into learning objectives, instructional strategies and VR-based learning scenarios. Within this architecture, VR is not considered as an isolated technological solution but as the final outcome of a competency-driven and data-informed instructional design process [6].

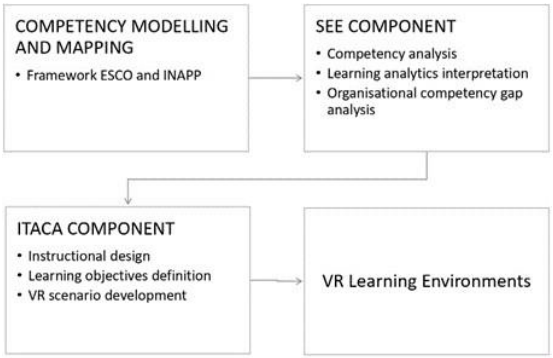

Figure 1. SEE–ITACA framework workflow

3 Conclusion

This paper presented the SEE–ITACA framework, a conceptual model integrating competency modelling, learning analytics and immersive learning design. By connecting competency analysis, analytics interpretation and instructional design, the framework supports the translation of competency evidence into VR-based learning environments. The integration of ESCO and INAPP frameworks with organisational analysis enhances traceability and evidence-based instructional decisions. Immersive VR learning environments have shown potential to support engagement and contextualisation [10]. Further empirical studies are needed to evaluate the framework's feasibility and effectiveness in educational and organisational contexts.

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Beyond Communities of Practice: An Emerging Framework for Institutional Support Communities in Pre-Service Teacher Education

Simona Ferrari[1][0000-0003-3736-1320] and Federica Pelizzari[2][0000-0003-2223-7212]

1 Catholic University of the Sacred Heart, Milan, Italy
2 Catholic University of the Sacred Heart, Milan, Italy
simona.ferrari@unicatt.it federica.pelizzari@unicatt.it

1 Introduction

Online learning communities in higher education have been organised around four dominant theoretical lenses: course-based Communities of Inquiry [1]; Wenger's Communities of Practice (CoPs) and legitimate peripheral participation [2, 3]; MOOC-specific frameworks [4]; and Connectivism with Personal Learning Networks [5]. Yet a fifth class of spaces, empirically widespread across European universities, escapes systematic treatment: institutionally-managed environments that accompany in-presence pathways with information, coordination, and operational materials.

Such spaces—programme-level communities, institutional information hubs, practicum-support platforms—are neither knowledge-production courses, MOOCs, user-initiated networks, nor discipline-based CoPs; evaluated through CoP metrics they appear defective, yet may be functioning instances of a structurally different category. We propose Institutional Support Communities (ISCs) as an emerging fifth category.

2 The Institutional Support Communities Framework

We define ISCs as institutionally-managed environments that support an in-presence curricular pathway by providing information, coordination, and operational materials to a bounded student population. ISCs are distinguished by five operationalised constitutive dimensions (D1–D5), summarised in Table 1 together with their operational criteria and the values observed in our case. Governance (D5) is bipolar (institution ↔ members), without the third-party actors that generate a professional third space [6].

The framework complements existing lenses: it inherits legitimate peripheral participation from CoP theory [3], reframing long-tail asymmetry as legitimate rather than failed; the vocabulary of presences from CoI [1], reading low cognitive presence as structural for service-oriented spaces; and trajectory-analysis methods from MOOC research [4]. It also dialogues with recent work on program-level communities beyond the single-course lifecycle [7], and with syntheses [8] cautioning that log-only inference under-represents brief consultative interactions, which motivates triangulation with self-report data.

Table 1. The five constitutive dimensions of ISCs, their operational criteria, and the values observed in the case study.

Dim	Construct	Operational criterion	Threshold	Case
D1	Stellar information centrality	Louvain modularity (co-access network)	< 0.30	0.115
D2	Long-tail asymmetry	Access Gini (low no-show rate)	0.40–0.60	0.482 (no-show 0.1%)
D3	Heteronomous rhythm	Change-points on academic calendar	qualitative	4 CPs at milestones
D4	Monologic interaction	Forum-active / membership	< 5%	2.5%
D5	Bipolar governance	Third-party actors (mentor teachers)	absent	none traceable

3 Case, Data, and Methods

The case is a Blackboard community supporting the Italian degree in Scienze della Formazione Primaria (Primary Education Sciences) in Milan; logs span 178 days (16 Nov 2025 – 13 May 2026). After excluding 161 non-student users (2.4% of events), the dataset comprises 49,655 events from 1,169 active students across 148 content items. Ten Learning Analytics analyses were conducted in Python; most relevant here are participation inequality (Gini), Louvain community detection on the co-access network, Binary-Segmentation change-point detection, K-means clustering, and Kaplan–Meier survival analysis.

In parallel, a self-report questionnaire integrates six validated scales — Online Student Engagement [9], Classroom Community [10], Teacher Role Identity [11], plus three custom scales (perceived utility, informal channels, peer tutoring) — hash-linked to logs (SHA-256) for triangulation between observed and self-reported engagement; it will be reported in a journal extension.

4 Evidence for the Five Dimensions and Membership Types

As Table 1 shows, the case satisfies all five dimensions: activity decays 78% across four calendar-aligned change-points, and forum traffic is negligible against lesson access (124 vs 9,684 hits).

K-means clustering ($k = 4$; silhouette = 0.386) identifies four membership types: Early Dropouts (9.8%), Highly Engaged (12.2%), Casual Majority (66.6%), Late Joiners (11.5%). Their survival trajectories differ markedly (log-rank $\chi^2(3) = 1993.7$, $p < .001$): Early Dropouts show a median active survival of one day and a 100% disengagement rate, Highly Engaged a 0.7% rate.

5 Discussion and Replication Agenda

Recognising ISCs as a distinct category enriches the typology of online academic communities and reframes long-tail asymmetry as legitimate rather than defective participation. It also implies three finding-grounded design principles. Information-first design follows from stellar centrality (D1) and monologic interaction (D4): design for rapid information access rather than dialogue. Year-differentiated onboarding follows from the Late Joiners (11.5%) and change-points (D3): stagger it by year and anchor it

to milestones. Cluster-calibrated early warning follows from the Early Dropouts (median survival one day): the intervention window lies in the first days. Derived from a single Italian case, the framework is proposed as emerging and invites replication across institutional contexts.

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Augmented Reality, Engagement, and Inclusive Learning in Students with Mild Visual Impairment

Luna Lembo[1[0009-0003-2976-4514]] Stefania Morsanuto[1[0000-0002-9323-1005]]

Margot Zanetti[1[0000-0002-9702-9840]] Francesco Peluso Cassese[1[0000-0002-6798-3668]]

luna.lembo@unipegaso.it; stefania.morsanuto@unipegaso.it;

margot.zanetti@unipegaso.it; francesco.pelusocassese@unipegaso.it

[1] Pegaso Telematic University, Naples, Italy

1 Introduction

This study investigates whether accessible Augmented Reality (AR) can support learning outcomes and engagement among students with mild visual impairment. Building on evidence of AR's educational benefits [1, 2] and addressing accessibility barriers that may affect learning and participation [3], the study examines AR-based multisensory environments in line with Universal Design for Learning principles [4], extending previous research in mainstream educational settings [5, 6, 7].

2 Research Project

A within-subject cross-over experimental design was adopted, in which each participant experienced both a traditional instructional condition and an AR-based instructional condition, thus serving as their own control. The sample consisted of 87 young adults (18–30 years old) with a certified diagnosis of mild visual impairment (visual acuity ranging from 3/10 to 5/10). Participants were recruited from school, university, and vocational training contexts. These educational contexts were combined because the study focused on the effects of the instructional condition rather than on differences between educational settings. Learning outcomes were assessed using the Learning Test (PA) from the AMOS battery, based on a text concerning the Protohistory of Africa and aimed at measuring conceptual understanding and sequential memory. In both conditions, participants were asked to read, study, and memorize the AMOS text concerning the Protohistory of Africa and subsequently answer the comprehension and sequential memory questions related to the text. Engagement levels were assessed through the User Engagement Scale [8], which investigates dimensions such as focused attention, perceived usability, aesthetic appeal, and reward factor. In the AR condition, students interacted with accessible three-dimensional models developed in

HTML/JavaScript (A-Frame, AR.js), including zoom, rotation, lighting control, and integrated audio support.

The results revealed statistically significant improvements in both academic performance and subjective engagement during the AR condition. In particular, scores related to conceptual understanding (Tab.1) were significantly higher in the AR condition compared to the traditional condition ($M = 28.1$ vs. 26.4, $p < .001$, Cohen's $d = 0.59$), as were scores related to sequential memory (Tab. 2) ($M = 12.1$ vs. 10.7, $p < .001$, Cohen's $d = 0.53$).

Tab. 1. Descriptive Statistics for Conceptual Understanding Scores in the Control and Augmented Reality Conditions.

GROUP	N	M	SD	MIN	MAX
CONTROL	87	26.4	3.8	19	34
EXPERIMENTAL	87	28.1	3.6	21	36

Tab. 2. Descriptive Statistics for Sequential Memory Scores in the Control and Augmented Reality Conditions.

GROUP	N	M	SD	MIN	MAX
CONTROL	87	10.7	2.5	6	15
EXPERIMENTAL	87	12.1	2.3	8	16

Similarly, all engagement dimensions measured through the UES showed significant increases (Tab. 3), with particularly strong effects in the "Aesthetic Appeal" and "Reward Factor" dimensions, suggesting a possible association between engagement and AR-supported learning processes [9].

Tab. 3. Paired-samples t-test results for User Engagement Scale (UES) dimensions across the Traditional and Augmented Reality conditions.

ITEM	t(86)	**p-value**
FOCUSED ATTENTION	9.84	< .001
PERCEIVED USABILITY	6.52	< .001
AESTHETIC APPEAL	15.76	< .001
REWARD FACTOR	12.42	< .001

3 Discussion and Conclusion

The findings suggest that AR may support learning and engagement by improving accessibility, although aesthetic appeal and technological novelty may also influence motivation. Overall, AR shows potential as an inclusive educational resource consistent with UDL principles, while further longitudinal studies are needed to distinguish accessibility effects from novelty-related motivational effects.

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DigCompEdu and training future teachers: assessing digital skills through SELFIE for Teachers

Alessandra Natalini[1][0000-0001-6585-3176] and Maria Rosaria Re[2][0000-0002-0429-8954]

[1]Link Campus University, 00165 Rome, Italy
[2] Link Campus University, 00165 Rome, Italy
a.natalini@unilink.it, m.re@unilink.it

1 Theoretical framework

DigComp 3.0 [1] is the fifth edition of the European Digital Competence Framework and defines the knowledge, skills, and attitudes needed to use digital technologies safely, critically, and responsibly in everyday life, work, learning, and social participation. Compared to previous versions, it systematically integrates Artificial Intelligence (AI)-related skills and focuses on five priorities: AI, cybersecurity, digital rights and responsibilities, digital well-being, and combating disinformation. The framework is based on the principles of the European Declaration on Digital Rights and Principles, promoting inclusion, democratic participation, security, and sustainability. DigComp 3.0 identifies five competence areas and twenty-one competencies, organised into four proficiency levels (basic, intermediate, advanced, and highly advanced), and includes 522 learning outcomes supporting training, assessment, and certification. A key innovation is the cross-curricular integration of AI across all competence areas. In education, the specific framework for teachers is DigCompEdu [2], which defines the digital competences teachers need to integrate technologies effectively into teaching. Structured into six areas and 22 competences, it includes six progression levels (A1–C2) and serves as a reference for self-assessment, professional development, and the promotion of innovative and inclusive teaching.

2 The research

SELFIE for Teachers [3] is a free self-assessment tool developed within the DigCompEdu framework to support teachers in reflecting on the integration of digital technologies into teaching. Validated in Estonia, Italy, Lithuania, and Portugal, it consists of 32 items covering the 22 DigCompEdu competences. The questionnaire takes about 25 minutes to complete and generates an individual report with feedback, suggestions for improvement, and the possibility of monitoring progress over time. A recent "Group Self-Assessment" function allows participants to complete the questionnaire individually while generating an anonymised collective report that supports collaborative reflection and the planning of professional development activities. This study administered SELFIE for Teachers to 111 second- and third-year students enrolled in the Primary Teacher Education programme at Link Campus University during the 2025–2026 academic year. The aim was to assess their self-perceived digital

competence and to identify training needs related to integrating digital technologies into teaching and learning. Results showed an overall B1 – Integrator level (38%). The highest scores were recorded in Professional Engagement (42%) and Digital Resources (40%), while Teaching and Learning (38%), Assessment (36%), and Empowering Learners (39%) also reached the B1 level. The lowest score concerned Facilitating Learners' Digital Competence (32%), corresponding to the A2 – Explorer level, indicating lower confidence in supporting pupils' digital competence. The originality of this study lies in the application of the SELFIE for Teachers questionnaire to a sample of pre-service teachers. In contrast, previous research has predominantly employed the instrument with in-service teachers. The study therefore provides valuable insights into self-perceived digital competence before entry into the teaching profession, offering evidence on the training needs of future primary school teachers. From a practical perspective, the findings highlight the need for initial teacher education programmes to strengthen not only students' technical digital skills but, more importantly, their ability to design learning experiences that effectively foster pupils' digital competence and integrate digital technologies into teaching, learning, and assessment through sound pedagogical approaches. In this respect, self-reflection tools such as SELFIE for Teachers may represent valuable resources for monitoring and supporting the development of digital competence throughout initial teacher education.

3 Conclusions

In line with studies conducted so far in the Italian context [4], the research results have allowed us to map the digital skills of the participants and to obtain useful information for the design of targeted training interventions, aimed at promoting professional development consistent with the needs of contemporary schools and with European guidelines on digital education.

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From Technopanic to a Pedagogy of Attention: An Umbrella-Oriented Review of Digital Media, Well-Being and Learning

Monica Di Domenico[1][0009-0004-3595-0345], Giovanna Amendola[2][0009-0001-6731-7147] and Pio Alfredo Di Tore[2][0000-0003-4335-7635]

[1] University of Salerno, Salerno, Italy
[2] University of Cassino and Southern Lazio, Cassino, Italy
modidomenico@unisa.it

1 Introduction

Public and educational debates often frame youth discomfort, attentional fragility and educational difficulty through technopanic, rapidly attributing them to screens, smartphones, social media or digital platforms. Evidence describes more differentiated, context-dependent associations. Since Orben and Przybylski [1] found that digital technology use explained only a very small proportion of variation in adolescent well-being, subsequent syntheses have shown marked heterogeneity and sensitivity to measurement choices. The issue is relevant to higher education through teacher and educator education, where evidence on young people's digital experiences informs professional frameworks, classroom practices and guidance for schools and families.

This paper presents the protocol and preliminary conceptual mapping of an umbrella-oriented review of systematic reviews, meta-analyses and umbrella reviews on digital media use, well-being and learning outcomes. The term umbrella-oriented indicates a study in progress: a protocol for a full review of reviews is combined with an initial mapping used to refine the search strategy and analytical framework. Drawing on ecological understandings of attention [2], the proposed pedagogy of attention examines how digital environments organise visibility, comparison, feedback, self-regulation and meaning-making, and which attentional habits they foster within platform-based experience.

The review addresses three questions: RQ1, evidence on digital media use, well-being and learning outcomes; RQ2, how syntheses conceptualise digital risk through screen time, problematic use, addiction, social comparison, attentional disruption, platform design or contextual vulnerability; and RQ3, the implications of a pedagogy of attention for digital and teacher education.

2 Methodology

The protocol specifies systematic searches in Scopus, Web of Science, ERIC, PsycINFO and PubMed for peer-reviewed systematic reviews, meta-analyses and umbrella reviews published between January 2019 and July 2026. Eligible syntheses

examine digital media use among children, adolescents or young adults and report outcomes related to well-being, mental health, attention or learning. The completed review will be reported in accordance with PRISMA 2020 [3]. Screening will follow predefined eligibility criteria; the methodological quality of included reviews and potential overlap among their primary studies will be examined during synthesis. At this stage, the preliminary mapping has identified seven evidence syntheses that inform the refinement of the search strategy and analytical categories.

3 Preliminary Findings and Conclusions

The preliminary mapping suggests that relationships between digital media use, well-being and learning are neither negligible nor straightforward. Reported effects tend to be small to moderate, heterogeneous and dependent on the form of use, outcome, age group, context and methodological choices [4, 5]. Evidence becomes more informative when syntheses distinguish aggregate screen time from specific practices such as passive scrolling, social comparison, problematic smartphone use, sleep displacement, educational co-use and creative production [4-10]. Aggregate exposure measures frequently yield weak or inconsistent conclusions. Recent syntheses also foreground interactional and contextual variables: the social meaning of online activity, feedback quality, peer comparison, pre-existing vulnerabilities, family and school mediation, and platform design. The distinction between use, problematic use and dependency is therefore central.

Taken together, the findings related to RQ1 and RQ2 explain the proposed pedagogical shift. When outcomes vary according to forms of use, individual vulnerabilities, social contexts and platform design, exposure time alone cannot provide an adequate educational interpretation. Attention becomes the process through which these dimensions interact and acquire educational significance. A pedagogy of attention therefore examines how attention is solicited, distributed, sustained and regulated within digital environments, while making the architectures that organise notification, recognition, comparison and participation visible.

For teacher and educator education, this framework supports four connected capacities: interpreting evidence without causal overstatement; distinguishing duration from forms and contexts of use; analysing the attentional architectures of platforms; and designing mediated practices that foster self-regulation, sustained attention, meaningful participation and collaborative learning. The preliminary mapping thus positions higher education as the setting in which evidence concerning adolescents can be translated into professional judgement and educational design. A pedagogy of attention offers an evidence-oriented framework for addressing digital media as formative environments that shape how learners attend, compare, respond and make sense of experience.

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Quality Assurance Index (QAI) for Higher Education: A Dynamic LMS-Based Composite Model Validated Through PLS-SEM

Artina Kamberi [0000-0002-6625-5036], Agon Memeti[0000-0002-6824-3856], Ibrahim Neziri[0000-0001-5061-4199], Kushtrim Ahmeti [0009-0006-0904-2102], Vullnet Ameti [0000-0003-3733-2618]

University of Tetova, Tetova, North Macedonia
{artina.kamberi, agon.memeti, ibrahim.neziri, kushtrim.ahmeti, vullnet.ameti}@unite.edu.mk

1 Introduction and Objective

Quality assurance is essential for accountability, accreditation, transparency, and improvement in higher education [1]. However, it is still implemented mainly through retrospective artifacts such as self-evaluation reports, annual statistics, and accreditation files. This creates a time lag between the emergence of operational risks and their formal detection. LMS platforms can reduce this gap because institutional processes leave continuous, time-stamped digital traces.

Learning analytics generally focuses on learner engagement, performance, and prediction [2, 3], rather than institution-level quality assurance. Composite-indicator methodology provides an aggregation framework [4], and PLS-SEM is appropriate for formative constructs composed of distinct institutional processes [5-7]. The objective is to operationalize LMS evidence as a higher-order QAI construct and test its measurement validity, structural effect, predictive relevance, and robustness. The study contributes an ARTP interpretation rule, a six-dimensional formative architecture, and a complete empirical validation sequence.

2 QAI Model and Methodology

2.1 Construct and Hypotheses

QAI measures an institution's capacity to generate continuous quality assurance evidence from digital processes. The ARTP unit identifies the account, institutional role, time period, and process associated with each LMS event, preventing the index from becoming a context-free activity count. Six first-order dimensions form QAI: Learning Continuity, Assessment Reliability, Student Progression, Administrative Responsiveness, Data Completeness and Traceability, and Quality Assurance Readiness. H1 proposes that LMS indicators significantly form these dimensions; H2

that the dimensions significantly form QAI; H3 that QAI positively affects institutional quality outcomes; and H4 that QAI predicts future outcomes.

2.2 Data and Estimation

The design-oriented quantitative study uses the University of Tetova LMS population of 17,909 students, 1,164 academic staff, and 181 administrative staff. The analytical unit is the study program-semester. The matrix contains 156 observations, 18 indicators, six first-order dimensions, one second-order construct, and four institutional outcomes; indicators are normalized to 0-1, with higher scores indicating stronger quality conditions. Stage one estimates the first-order dimensions, and stage two uses their scores as formative components of QAI. Validation evaluates VIF, bootstrapped weights, path coefficients, R^2, f^2, SRMR, NFI, Q^2, PLSpredict diagnostics, and alternative weighting schemes.

3 Results

The highest dimension mean is Data Completeness and Traceability (81.05), followed by Assessment Reliability (77.19), Learning Continuity (76.28), and Student Progression (76.15); Administrative Responsiveness (68.38) and Quality Assurance Readiness (70.73) are lower, demonstrating the index's diagnostic differentiation.

H1 is supported: all first-order formative weights are significant ($p < 0.001$), and maximum VIF values range from 2.979 to 4.899. H2 is also supported: every dimension significantly contributes to QAI, with weights of 0.311 for Assessment Reliability, 0.311 for Student Progression, 0.286 for Learning Continuity, 0.251 for Quality Assurance Readiness, 0.210 for Administrative Responsiveness, and 0.122 for Data Completeness and Traceability (all $p < 0.001$).

H3 is confirmed by the positive path from QAI to Institutional Quality Outcomes ($\beta = 0.659$, $t = 10.89$, $p < 0.001$; $R^2 = 0.435$).

H4 is supported by predictive relevance ($Q^2 = 0.385$), while early-semester QAI explains 37.0% of end-semester outcome variance. PLSpredict also shows lower prediction error than the naive benchmark (RMSE = 0.041 vs. 0.076), with sensitivity analysis confirming robustness across alternative weighting schemes.

4 Discussion and Conclusion

The findings show that LMS data can be transformed into continuous institution-level quality assurance evidence, complementing rather than replacing accreditation and self-evaluation. QAI provides a diagnostic framework for identifying quality limitations across learning, assessment, progression, administration, data traceability, and QA readiness. Although validated at a single institution, the framework can be adapted to other higher education contexts through institution-specific indicator calibration; future research should therefore focus on longitudinal and multi-institutional validation.

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Beyond the Improvement Curve: Uncertainty-Aware Knowledge Tracing and the Problem of the Lucky Correct Answer

Artem Boyarchuk[1[0000-0001-7349-1371]], Daria Shteinbrekher[2[0000-0003-2584-3437]], and Antonio Maffei [3[0000-0002-0723-1712]]

[1] Tallinn University of Technology, Tallinn, 19086, Estonia
artem.boyarchuk@taltech.ee
[2] National Aerospace University, Kharkiv, 61070, Ukraine
d.shteinbrekher@gmail.com
[3] KTH Royal Institute of Technology, Stockholm, Sweden
maffei@kth.se

1 Introduction

The Erasmus+ SMART-PL project was carried out by six Ukrainian universities between 2022 and 2025, under wartime conditions, with the aim of widening access to higher education for displaced students, students with disabilities and war veterans. One of its outputs was an information-diagnostic online platform built on an open-source Moodle stack [1]. Through the spring 2025 semester the platform ran a simple cycle (for 800 students): a student sat a test, received feedback tailored to the result, and sat the test again.

From this data the SMART-PL consortium computed a straightforward statistic. Second and subsequent attempts tended to score higher than first ones, with a median gain of about 17 per cent. Plotted across attempts, this rise formed what the project called an "improvement curve", and the consortium read it as evidence that tailored feedback was successfully supporting learning [1, 2].

The improvement curve is a solid and defensible result, but it is an aggregate, and aggregates conceal as much as they show. The curve is assembled from answers sorted into two bins, correct read as mastery and incorrect read as a knowledge gap. Research on knowledge tracing, the family of methods that infer learning from a student's history of answers, has shown repeatedly that this binary reading has low specificity: a model that scores a lucky guess or a half-understood answer as mastery lets real misconceptions through, and on a feedback platform a misconception that goes unnoticed is one the student is never asked to revisit [3]. This contribution asks what the same data look like when the analytics are allowed to express doubt, and it argues that the doubt is the more useful signal for the teacher and for the student.

2 From Mastery Scores to Uncertainty Estimates

The SMART-PL platform already records everything the method needs: the answer chosen, the number and order of attempts, the time between them, and which

instructor's feedback a student saw before retesting. We propose adding a data-analytics layer that applies a deep knowledge-tracing model to these logs and returns, for each concept, both a predicted mastery state and a confidence in that prediction. Following recent work, that confidence can be estimated with Monte Carlo dropout, a procedure in which the same model is run many times with parts of it switched off at random; the spread of its answers across those runs shows where the model is settled and where it is effectively guessing [3, 4].

The point of the estimate is to reverse the platform's current logic. At present a correct answer clears a concept. Under the proposed layer, a correct answer that the model holds with low confidence is not cleared but sent back for a brief re-probe, so that a lucky choice is separated from real mastery before the student is told they have understood. This sits on top of the current retest loop of the platform; what it changes is which students are asked to retest, and on which concepts.

Because the platform was built to widen access for non-standard learners, the analytics layer carries a known risk in that setting. Models trained mainly on the common answer patterns tend to be least reliable on the learners they have seen least often, so a tool adopted to help these students could end up disadvantaging them [5]. The confidence estimate speaks to this directly. High uncertainty marks the cases where a platform’s automated judgement should defer to a teacher, so the signal that catches lucky correct answers is the same one that concentrates human review.

3 Findings and Conclusions

The pilot provides the empirical ground: a diverse student population, studying under wartime conditions, generated enough repeated attempts to make per-concept tracing feasible. The contribution is a re-reading of that data. Treating mastery as a value with a confidence attached brings to the surface a class of errors the improvement curve hides, the luckily correct answers that should not have counted, and it gives teachers a reason to look again at students the score sheet had already cleared.

Two conclusions follow. First, the improvement curve and an uncertainty layer are complementary: the curve shows that feedback moves scores, and the uncertainty layer shows where a moved score can be trusted. Second, in a project driven by inclusion, the most valuable output of an analytics layer may not be a higher accuracy figure but an honest account of its own doubt, used to route the hardest cases to people rather than to the model. The planned next step is a retrospective study on one or two SMART-PL pilot disciplines, comparing the concepts cleared by score alone with those that would clear under a confidence threshold, in order to estimate how many of the masteries behind the original curve were in fact uncertain.

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Chatbots as a Component of the Digital Learning Environment to Support STEM Education

Olha Hulai[0000-0002-1120-6165], Vitalii Kabak[0000-0001-9823-825X], Vasylyna Shemet[0000-0001-8952-5097] and Iryna Moroz[0000-0001-9167-4876]

Lutsk National Technical University, Lvivska, 75, Lutsk, Ukraine
o.hulai@lntu.edu.ua, v.kabak@lutsk-ntu.com.ua,
v.shemet@lntu.edu.ua, i.moroz@lntu.edu.ua

1 Introduction

The development of the industry's intellectual human capital during wartime and in the post-war reconstruction period requires consideration of global trends. In the context of Industry 4.0, digital skills and educational and professional qualifications in STEM fields are in particularly high demand [1–2]. STEM specialists play a key role for Ukraine during wartime, contributing to the development of innovations in military technology, medicine and healthcare, stimulating scientific research and ensuring the strengthening of national resilience [3–4]. The Second World War marked the starting point for the emergence of STEM. At that time, scientists and the military joined forces to develop innovative technologies that helped defeat the enemy [5], However, STEM was not introduced into education until much later, at the end of the 20th century [6].

An analysis of recent research indicates that chatbots and artificial intelligence technologies are playing an increasingly significant role in the educational process [7]. It has been confirmed that the integration of artificial intelligence tools, in particular ChatGPT, into STEM education contributes to the development of cognitive skills, critical thinking, the ability to analyse information and make informed decisions, which are important components of modern professional training [8-9]. At the same time, chatbots can perform not only an educational but also a socio-psychological function, providing immediate support to students in conditions of heightened stress and uncertainty, particularly during a state of emergency [10].

The aim of this study is to demonstrate the benefits of using a chatbot as part of a digital learning environment to support STEM education and career guidance for students, as well as to develop and test the STEM_lntu_bot chatbot.

2 Methods and results

The first stage involved a study of how students at Lutsk National Technical University understand the concept of STEM. The target group comprised first- to third-year students (76 respondents) specialising in Vocational Education (Digital Technologies) and Secondary Education (Computer Science) at the Faculty of Digital, Educational and Social Technologies, as these fields are directly linked to the development of technology and education. Students on these courses need to understand the basics of mathematics, algorithms and programming, as well as the engineering principles

underpinning the creation of technology. In the future, they will either teach others or create innovative solutions. Without a knowledge of STEM, they will find it difficult to prepare competitive graduates or create technological products. The survey results confirmed the value of developing a chatbot to support STEM education and career guidance for students. Although 36.8% of respondents are well acquainted with the concept of STEM, almost two-thirds of those surveyed either have only a partial understanding of this field (28.9%) or do not understand its essence at all, even though they have heard of it (28.9%). The results indicate an information gap between the popularity of the STEM concept and the level of awareness among students.

The survey also revealed that students predominantly associate STEM solely with specific disciplines, primarily mathematics, physics and computer science, whilst the interdisciplinary nature of this approach is not sufficiently recognised. This points to a need for an accessible tool that would provide structured information about STEM fields, their components, opportunities for professional development and employment prospects.

Today's young people are used to gadgets and technology, so learning via a bot feels natural and comfortable to them. That is why the next step in our project was to develop the 'STEM_lntu_bot' information chatbot. The SendPulse platform and the Telegram BotFather service were used to create the chatbot. In the first stage, a new Telegram bot was created and a unique API token was obtained to connect it to the SendPulse platform. The bot was then integrated with the chatbot management system and its main operating parameters were configured. Next, the chatbot's structure was developed, including a start menu, thematic sections and user interaction scenarios. For each section, information messages were prepared, navigation buttons were configured, along with transitions between blocks and links to additional resources. Functions were also implemented to automatically provide information on STEM education, STEM careers and the university's educational opportunities.

Once development was complete, the chatbot was tested to ensure that all scenarios, navigation elements and transitions between sections were functioning correctly. Following the test results, identified shortcomings were rectified and the structure of user interaction was optimised. The developed chatbot was implemented as part of a digital educational environment to provide information, support STEM education and offer career guidance to students.

3 Conclusion

Thus, the creation of the STEM_lntu_bot chatbot was a response to the identified need for a prompt and convenient source of information on STEM education. The chatbot is designed to raise awareness among students, provide access to up-to-date information on STEM disciplines and professions, and promote career self-determination and the popularisation of STEM fields among young people.

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Chatbot-Supported Rubric Design: Perceived Usefulness, Critical Reflection, and Metacognitive Awareness

Federica Emanuel[1[0000-0002-7922-719X]], Marco Rondonotti[1[0000-0003-1579-6737]], Angelo Basta[1[0009-0008-3954-997X]], Silvia Dell'Anna[1[0000-0001-7201-918X]] and Paolo Raviolo[1[0000-0002-2876-514X]]

[1] eCampus University (Italy)
federica.emanuel@uniecampus.it; marco.rondonotti@uniecampus.it; angelo.basta@uniecampus.it; silvia.dellanna@uniecampus.it; paolo.raviolo@uniecampus.it

1 Introduction

The growing use of Artificial Intelligence in education is transforming assessment practices and teacher professional development. However, integrating AI-based tools into assessment is not merely a matter of technical efficiency. It requires teachers to develop assessment literacy, AI literacy, and the ability to critically interpret automated feedback within pedagogically grounded evaluation processes.

In this context, RubricaBot [1] is presented as a chatbot supporting rubric-based assessment and formative feedback in teacher training. The tool is not intended to replace the teacher, but to act as a pedagogical mediator that fosters reflection on criteria, descriptors, feedback quality, and differentiated assessment.

In this study, the Use of Technology [2] and Technology Acceptance Models [3] provide interpretive dimensions for examining perceived usefulness, ease of use, and acceptance of the tool, rather than being tested as complete explanatory models. Finally, research on formative and rubric-based assessment stresses the role of feedback, criteria, and descriptors in supporting learning regulation, transparency, and student agency [4, 5]. From this perspective, a chatbot for rubric-based assessment can support professional reflection on the relationship between learning objectives, assessment criteria, feedback, and inclusive practices.

2 Aim of the study

This study investigates the perceived usefulness of RubricaBot [1] and involved 956 teachers enrolled in a postgraduate training programme. It examined whether chatbot-supported work could improve rubric design, foster critical reflection, and strengthen professionals' awareness of their competences in assessment. The training activity was organised in two phases. First, participants independently developed an assessment rubric based on learning objectives, criteria, descriptors, and performance levels. Second, they used RubricaBot to review and refine their work. At the end of the activity, a self-report questionnaire collected data on both phases and on the perceived educational and metacognitive value of the experience.

3 Main results

Descriptive results show that autonomous rubric construction was perceived as moderately demanding, with relatively low scores for confidence, ease of defining criteria and levels, and rapidity of the process (M = 2.78–2.92, 1-5 scale). These findings suggest that, although rubric-based assessment is considered pedagogically relevant, its practical design remains challenging for many teachers.

The chatbot-supported phase received more positive evaluations. Participants considered RubricaBot easy to use, clear in interaction, and useful for rubric construction (M = 4.07–4.09). They also reported that the tool helped them identify overlooked elements, clarify assessment criteria, improve rubric structure, and reflect more critically on their assessment decisions. Future intention to use the tool (M = 4.04) and willingness to recommend it to colleagues (M = 4.03) were similarly high.

At the same time, participants expressed moderate concerns about the reliability of chatbot-generated content and its ability to capture the specific features of the teaching context (M = 3.10–3.13). These results underline the need to integrate RubricaBot within supervised, critically mediated teacher training practices.

Reflective items confirmed the metacognitive value of the activity, with positive scores for critical revision, explicitness of criteria, deeper reflection, and acquisition of new strategies (M = 3.75–3.98). They also actively compared their own rubric with the chatbot-supported version (M = 3.89), improved their rubric design competence (M = 3.85), and acquired new ideas or strategies (M = 3.88). Overall, the chatbot-supported experience was perceived as formative (M = 3.98).

4 Conclusion

These findings suggest that RubricaBot can support teacher training not as a substitute for professional judgement, but as a reflective device for developing assessment literacy and AI literacy. Its pedagogical value lies in fostering comparison, revision, and critical dialogue with AI-generated suggestions. The results also highlight the need to embed such tools in guided training settings, where professionals can critically validate, adapt, and contextualise chatbot outputs while retaining responsibility for final assessment decisions. From a training perspective, RubricaBot appears useful for moving from intuitive or generic assessment practices toward more explicit, criteria-based, and formative designs [6]. Its contribution to clearer criteria, improved rubric quality, time efficiency, and metacognitive reflection makes it suitable for professional development focused on rubric construction, formative feedback, and inclusive assessment. However, the findings are based on self-reported perceptions and do not provide objective evidence of changes in rubric quality or assessment competence. Future research should therefore include objective and longitudinal measures of these outcomes.

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Special Track 1

Active Online Assessment in Higher Education: Pedagogical Models, Digital Practices and Evidence-Based Approaches

Organizers:
Anna Dipace, Pegaso University, Italy
Paolo Raviolo, eCampus University, Italy
Teresa Savoia, Pegaso University, Italy
Ilaria Fiore, Pegaso University, Italy

Formative Assessment in Higher Education: the design and experimental Implementation of the AcOnHE Framework for Online Assessment

Matteo Adamoli [0000-0001-9149-3944], Federica Emanuel [0000-0002-79-719X], Marco Rondonotti [0000-0003-1579-6737], Paolo Raviolo [0000-0002-2876-514X]

eCampus University (Italy).

matteo.adamoli@uniecampus.it;federica.emanuel@uniecampus.it; marco.rondonotti@uniecampus.it; paolo.raviolo@uniecampus.it

1 Introduction

The emergence of Generative Artificial Intelligence (GenAI) is reshaping teaching and learning processes in higher education, with significant epistemological, ethical and pedagogical implications for assessment practices [1]. While online teaching has often reproduced summative and monitoring-oriented models through intrusive and technically complex proctoring systems, the PRIN project Active Online Assessment in Higher Education (AcOnHE), led by eCampus University in collaboration with the Universities of Florence, Pegaso and Padua, proposes a sustainable and pedagogically grounded alternative based on formative, authentic and portfolio-based assessment [2, 3]. The AcOnHE framework combines authentic assessment [4] with the principle of 'co-assessment', in which AI algorithms support, but do not replace, human professional judgement or teachers' decision-making authority. Grounded in a competency-based approach and active learning principles [5-6], the framework uses formative e-tivities, learning portfolios, and learning analytics to document students' mastery levels, engagement, and learning outcomes, while supporting both formative and summative assessment [7-9]. The central hypothesis is that authentic, portfolio-based and data-supported assessment models can offer a more sustainable and pedagogically meaningful alternative to online exams based mainly on proctoring. Such models may foster deep learning, autonomy, self-regulation and motivation [10-12]. At the same time, it examines the validity conditions, privacy requirements and disciplinary contexts in which data-driven assessment can be effectively and ethically implemented [13-14].

2 AcOnHE Framework Design and Experimental phase

The aim of the experiment is to design an automated system, based on Generative Artificial Intelligence, for the assessment of e-tivities and the generation of personalised and timely feedback. The initial phase involved creating a reference knowledge base for training the AI system, by selecting student exercises assessed by lecturers as excellent and used as representative models in accordance with the theoretical contexts, the answers provided and the required assessment criteria. At the same time, assessment

criteria and levels were defined, organised into separate rubrics for each of the six types of exercises envisaged: a concise written assignment linked to theoretical content; a slide-based summary of theoretical concepts; short-answer questions; a slide-based summary of in-depth scientific articles; the creation of concept maps; and a mock exam with open-ended questions [15, 16]. The second phase involved the development of a computerised interface for the systematic analysis and assessment of the exercises, designed using an API (Application Programming Interface) to enable rapid and efficient processing of responses. From a technological perspective, the application overcomes the structural, maintenance and economic limitations of traditional RAG (Retrieval-Augmented Generation) systems by harnessing the potential of recent expanded-context models. The adoption of a strategy based on comprehensive prompts for each individual request ensures superior deterministic control over the process, transparent auditing of inputs and outputs, and the non-persistence of sensitive data in memory. The software architecture, utilising a Flutter web interface and AWS (Amazon Web Service) Lambda functions to extract and process texts (PDF/Docx) entirely in-memory, ensuring maximum compliance with privacy regulations. The multimodal prompts generated in this way incorporate theoretical context, assessment criteria, marking schemes and the student's output, enabling the system to accurately assess even complex graphical artefacts such as concept maps. The framework was empirically validated within the Docimology course of the LM-85 master's degree programme. The study analysed 397 student assignments. The validation process relied on a double-blind comparative analysis between assessments generated by multimodal AI models and those provided manually by course lecturers, using the same overall and analytical assessment rubrics [3]. The results show an overall agreement of 85%, indicating that the system is sufficiently reliable for training and preliminary screening, particularly for written exercises, although limitations emerged in the assessment of non-linear, multimodal and creative outputs, where the AI tended to produce polarised judgements and showed limited sensitivity to divergent thinking; further analyses are therefore examining agreement between human raters and different GenAI models (ChatGPT, Nova Pro, Nova Lite, Nova Micro and Claude Sonnet 3.5) to assess inter-rater reliability and framework consistency.

3 Conclusion

The study suggests that GenAI can support the regulation of learning in Higher Education when algorithm-mediated assessment is embedded within a robust pedagogical framework designed and supervised by lecturers. In this model, the machine supports assessment processes, while the human assessor retains final responsibility for judgement, interpretation and feedback [9]. Future developments include the integration of synchronous guided practice sessions to strengthen students' self-assessment, the standardisation of e-tivity formats to optimise model input, and the extension of the AcOnHE framework to courses in related disciplinary areas. These steps will make it possible to further examine the transferability, validity and sustainability of the framework within broader higher education assessment ecosystems [10].

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The ReflectUp E-Portfolio as a Self-reflective Device: Reflections of participants in the PRIN AcOnHE Project

Anna Dipace[1[0000-0001-9826-073X]], Teresa Savoia[1[0000-0003-0363-7077]], Ilaria Fiore[1[0009-0000-1989-2908]]

[1] Pegaso Digital University, Centro direzionale, Isola F2 - 80143 Naples, Italy
anna.dipace@unipegaso.it; teresa.savoia@unipegaso.it; ilaria.fiore@unipegaso.it

1 Introduction

Self-assessment is central to fostering educational development and authentic learning [6], and when embedded in structured tools like portfolios, it widely promotes metacognitive reflection [2]. However, achieving self-regulation in learning requires structured conditions and ongoing support [7]. Within this framework, the 2022 AcOnHE (Active Online Assessment in Higher Education) PRIN project developed an instructional design and assessment model based on e-tivities, with strong emphasis on self-assessment. E-tivities, framework for enhancing active and participative online learning by individuals or groups" [5], involve interaction and reflective dialogue between students and teachers in technology-mediated environments. This model integrates self-assessment practices through reflective tools such as portfolios and e-portfolios [3].

The e-portfolio specifically collects textual, graphic, audio, and video materials to encourage reflection on learning processes and support formative assessment [1]. As Raviolo et al. [4] note, it plays a strategic role in developing transversal competences, supporting reflective and autonomous learning, and prompting critical analysis of both learning processes and the technological skills used to present experiences and achievements. This leads to the research question: What obstacles emerge from self-assessment practices in the use of the ReflectUp e-portfolio?

2 Methodology and Strategy Research

The AcOnHE project developed and tested an online formative assessment framework based on e-tivities, e-portfolios, and e-moderators. The experimentation, conducted in 2025 with 30 participants at Pegaso University, followed Salmon's [6] five-stage model through synchronous and asynchronous moments, with a twofold objective: to verify the transferability of the model and to collect data on participants' perceptions through pre- and post-questionnaires and the ReflectUp e-portfolio, structured around four competence dimensions (disciplinary-design, collaborative, digital, and self-assessment and reflective) self-assessed across four levels (Starting, Developing, Autonomous, Expert).

The ReflectUp data show medium-high levels of perceived competence across all dimensions, with the self-assessment and reflective dimension being the most consolidated (61.7% Autonomous) and the digital dimension being the most variable (16.3% Starting), attributable to the heterogeneity of the sample in terms of familiarity with technological tools. From this descriptive analysis emerged the need to further investigate the obstacles self-reported by participants in their competence development. An exploratory thematic analysis of the open-ended responses collected through ReflectUp was therefore conducted Coding combined quantitative categorisation of the disciplinary-design responses with qualitative thematic reading of the more elaborated responses for the other three dimensions; counts were tallied manually with AI support and then verified, and representative excerpts were selected to illustrate recurring themes.

3 Conclusion

The analysis reveals that the self-reported obstacles are not primarily conceptual, but rather structural and contextual. Across all dimensions, a common pattern emerges: students show awareness of what is lacking but locate the obstacle in the absence of conditions — time, practice opportunities, structured moments — rather than in a lack of understanding. The most significant finding concerns the self-assessment and reflective dimension: although it shows the highest perceived levels, it reveals the most sophisticated obstacles, suggesting a latent but not yet activated reflective competence in practice. These results indicate that ReflectUp functions as a device that activates metacognitive awareness, but that this awareness needs to be sustained by structured follow-up within the education pathway.

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Does Thinking with Artificial Intelligence Make Us More Creative? Evidence from a Quasi-Experimental Study on Comprehension, Critical Thinking, and Creative Production

Eugenia Treglia[1] [0000-0002-1228-8959], Anna Maria Mariani[1] [0000-0001-8952-0886], Francesco Peluso Cassese[1] [0000-0002-6798-3668]

[1] Pegaso Digital University, Naples, Italy
Corresponding author: eugenia.treglia@unipegaso.it

1 Introduction

Generative artificial intelligence (AI) is reshaping higher education by supporting information retrieval, synthesis, and academic writing [1, 2]. Its educational value, however, depends on AI literacy, effective prompting, and learners' capacity to monitor and critically evaluate generated outputs [3-5]. This issue is especially relevant for higher-order thinking and creativity, with recent evidence suggesting positive effects of generative AI on students' higher-order thinking [6]. Creativity entails producing ideas that are both original and appropriate [7], but the extent to which AI-assisted cognitive work translates into genuinely creative performance remains unclear [8, 9]. Drawing on Bloom's revised taxonomy [10] and theories of metacognition and self-regulated learning [4, 11], including recent work on metacognitive engagement in textual activities with generative AI [12], this study examines whether generative AI supports university students' text comprehension and critical analysis, and whether such support is associated with stronger creative production. It also investigates the relationships among perceived AI competencies, metacognition, and creativity.

2 Method

The study adopted a quasi-experimental between-groups design. Participants were 187 university students recruited by convenience sampling at the University of Cassino and Southern Lazio and the University of Brescia. The sample was predominantly female (79.1%), with a mean age of 21.97 years (SD = 5.45); 71.7% were enrolled in Educational Sciences. Students were assigned to an experimental group (AI) or a control group (No AI) according to the initial letter of their surname.

After completing a socio-demographic questionnaire and a ten-item DIGCOMP-based scale of perceived AI competencies (0-4), participants read an expository text and answered ten multiple-choice comprehension items based on Bloom's revised taxonomy. The experimental group could use generative AI during this phase, whereas the control group worked without technological support. All participants then completed, without AI, an authentic creative task: producing a social-media post

offering an original and critical reinterpretation of the text. Two independent raters assessed the products with an analytic rubric covering comprehension, originality, critical reflection, communicative effectiveness, and title/slogan quality (0-20). Participants also completed an on-task metacognitive scale assessing planning, monitoring, and self-regulation; AI users answered additional questions on prompting, verification, and critical reflection. Independent-samples t-tests (Welch correction where required), Cohen's d, and Pearson correlations were calculated ($p < .05$).

3 Results

Generative AI significantly improved text comprehension. The AI group obtained a higher overall score ($M = 9.05$, $SD = 1.89$) than the No AI group ($M = 7.51$, $SD = 2.06$), $t(152.28) = 5.20$, $p < .001$, $d = 0.79$, with the clearest advantages on items requiring analysis, interpretation, and critical evaluation. Perceived AI competencies were low to moderate ($M = 1.59$, $SD = 0.54$): students felt more confident searching for and evaluating AI-generated information than addressing ethics, privacy, copyright, and AI-based content creation. Metacognitive scores were relatively high ($M = 3.35$, SD approximately 0.71) and did not differ significantly between groups. AI users generally reported targeted prompting, information verification, and critical consideration of AI suggestions.

Creative product quality was high overall ($M = 16.42$, $SD = 4.52$), but did not differ significantly between the AI and No AI groups, $t(139.92) = 1.49$, $p = .140$, $d = 0.23$. Female students obtained higher creativity scores than male students, $t = 2.36$, $p = .023$, $d = 0.54$. Metacognition correlated positively with creative product quality ($r = .353$, $p < .001$), whereas perceived AI competencies did not ($r = -.039$, $p = .599$). AI competencies were positively associated with metacognition ($r = .269$, $p < .001$).

4 Conclusion

Generative AI can effectively scaffold comprehension and critical analysis, particularly when tasks require interpretation and evaluation. Nevertheless, this cognitive advantage did not automatically yield more creative products. Creative performance was instead associated with planning, monitoring, and self-regulation, underscoring metacognition as a central mechanism in productive engagement with AI. These findings support educational approaches that integrate generative AI with explicit instruction in prompting, source verification, ethical awareness, and metacognitive reflection. In higher education, AI appears most valuable when it augments learners' cognitive and self-regulatory processes while leaving them responsible for interpretation, judgment, and creative knowledge construction.

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From Needs Assessment to Adaptive Design: AI Tool Taxonomy for Heterogeneous LSP Cohorts in Online Higher Education

Teresa Savoia[1[0000-0003-0363-7077]], Raffaele Di Fuccio[1[0000-0001-8886-3967]], Oleksandra Zagorulko[1[0009-0004-0746-7719]], and Valeria Formisano[2[0009-0005-8682-0353]]

[1] Pegaso Digital University, Centro direzionale, Isola F2 - 80143 Naples, Italy
[2] SMARTED srl, Riviera di Chiaia str., 256, 80121, Naples, Italy
teresa.savoia@unipegaso.it; raffaele.difuccio@unipegaso.it; oleksandra.zagorulko@unipegaso.it; valeria.formisano@smarted.it

1 Introduction

The rapid advancement of Artificial Intelligence (AI) is fundamentally transforming pedagogical paradigms, particularly within Language Education and Education Management. At the core of this transformation is a profound paradigm shift in how knowledge is constructed, delivered, and assessed. Traditional didactic models, often reliant on standardized instruction and uniform pacing, are increasingly being augmented by intelligent systems capable of unprecedented personalization. In the context of language acquisition, and specifically Language for Specific Purposes (LSP), the affordances of AI are particularly transformative. Language learning is an inherently individualized process in which learners exhibit distinct interlanguage patterns, professional goals, and cognitive styles. Generative AI tools, such as advanced Large Language Models, empower educators to move away from rigid, "one-size-fits-all" textbooks. Instead, teachers can dynamically adapt their teaching strategies, generating highly customized reading corpora, realistic professional dialogues, and targeted vocabulary exercises that resonate directly with the specific academic or professional needs of their learners, adjusting difficulty and focus in real-time [1, 2].

This contribution argues that valid and pedagogically coherent AI-assisted language instruction methodologies cannot be developed without a prior, systematic needs analysis that maps learner profiles, target communicative demands, and institutional constraints. Drawing on the AILEM Erasmus+ project (AI-Infused Language Education: Empowering Teachers through Multilingual MOOC Training, KA220-HED-D6888EC3), this contribution presents a methodological framework for LSP needs assessment in online LSP instruction, developed and delivered through a multilingual MOOC for higher education language teachers, and provides a review of existing AI tools categorized according to the heterogeneity dimensions identified by the framework, to support course adaptivity and flexibility.

2 Method

The contribution adopts a design-based methodology. Within the AILEM MOOC, a structured needs assessment module was developed for language teachers in higher education, instructing them in the systematic diagnosis of learner needs as a precondition for course design and adaptation for possible cohort heterogeneity. The theoretical grounding of the proposed Needs Assessment framework draws on foundational LSP needs assessment models: Hutchinson and Waters [3], Dudley-Evans and St. John [4], and Long's task-based approach [5], which are integrated with Stefaniak's [6] iterative five-stage needs assessment process. This framework is extended to accommodate the specific conditions of online higher education: heterogeneous learner cohorts, asynchronous delivery, and the affordances and risks of AI-supported pedagogical design.

The module covers three analytical layers: contextual analysis (institutional parameters, course format, target communicative tasks); learner profiling (professional background, current proficiency, metacognitive awareness, learning preferences, and goal orientation), operationalized through a five-block structured questionnaire instrument; and stakeholder triangulation, combining literature-based baselines, faculty input, and learner-generated data.

The AI tools reviewed are organized according to the five diagnostic blocks of the AILEM needs assessment framework, so that each heterogeneity dimension identified through needs analysis corresponds to a distinct category of adaptation tool:

- Professional background block covers content differentiation tools that help generate discipline-specific corpora and tasks for cohorts spanning multiple fields.
- Proficiency block is connected to level and pacing tools, adjusting lexical/syntactic complexity and CEFR-aligned task difficulty across learners.
- Engagement preferences cover task-format tools, varying delivery mode and activity type (e.g., branching structures) to match stated preferences.
- Awareness and Goal Setting block, in turn, corresponds to reflective and self-regulatory tools, supporting AI-assisted e-portfolio feedback and goal-tracking rather than content adaptation.

3 Implications and Conclusions

As teachers master these AI competencies, AI tools function as adaptation instruments rather than diagnostic ones, with human pedagogical judgement governing which adaptation suits which identified need. Thus, the proposed paper makes two connected contributions: (1) it establishes needs analysis as a non-negotiable precondition for identifying the heterogeneity dimensions that course adaptation must address; (2) it provides a replicable, MOOC-delivered instructional model through which higher education LSP teachers can develop both the methodological and AI literacy competences required to thoughtfully implement valid AI-tools in their teaching practice to promote flexibility and adaptivity of instruction activities.

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The Teacher as Augmented Assessor: Docimological Literacy, Assessment Posture and Professional Development in a Digital University

Maria Concetta Carruba[1[0000-0001-9316-6509]], Elisabetta Lucia De Marco[1[0000-0002-5875-5313]], Anna Dipace[1[0000-0001-9826-073X]] and Pierpaolo Limone[1[0000-0003-3852-4005]]

[1] CETAL, Università Telematica Pegaso, Naples, Italy
{mariaconcetta.carruba, elisabettalucia.demarco, anna.dipace, pierpaolo.limone}@unipegaso.it

1 Introduction and Research Context

The growing emphasis on competency-based learning in higher education has placed new demands on assessment design and, consequently, on the professional role of university teachers. In digitally mediated learning environments, assessment can no longer be conceived as a terminal, summative event; rather, it must function as an ongoing, formative, and participatory process [1]. Within Italian telematic universities, the adoption of Ministerial Decree 1835/2024 has accelerated this shift, requiring institutions to rethink their assessment architectures in terms of multi-component, distributed evaluation systems.

This paper reports on the experience of Università Telematica Pegaso, where the Centre for Technology-Enhanced Learning and Assessment (CETAL) has coordinated a professional development programme designed to support teachers in transitioning towards active, competency-aligned assessment practices. The programme is grounded in the conceptualisation of assessment as an active, reflective, and student-centred process that fosters self-regulation and critical thinking [2].

2 The Augmented Assessor: Theoretical Framework

The concept of the “augmented assessor” draws on augmentation theory in educational technology [3], reframing teacher development not as an additive process of skill acquisition but as a transformative reconstitution of professional identity. In the context of active online assessment, this implies a shift in the teacher's posture: from evaluator of products to co-designer of learning processes; from administrator of tests to facilitator of authentic assessment experiences [4].

Docimological literacy — understood as a teachers' capacity to design, implement, and critically reflect on assessment practices — emerges as a key competency in this framework. It encompasses not only technical knowledge of assessment instruments but also awareness of the epistemological and ethical dimensions of evaluation in higher education [5].

3 The CETAL Professional Development Programme

The assessment model implemented at Pegaso distributes evaluation across three integrated components: intermediate online tasks aligned with learning outcomes; certification of synchronous participation in live sessions; and in-person oral examinations conducted by multidisciplinary boards using professionally-oriented scenario prompts. Each component requires teachers to adopt a specific assessment posture and to command a shared evaluative language.

The CETAL programme addressed these requirements through a structured sequence of collaborative activities: (a) analysis and co-design of professional scenarios used as oral examination prompts; (b) collaborative construction of competency-based rubrics; and (c) development of a shared docimological glossary. These artefacts served both as learning tools and as evidence of the collective reconceptualisation of the assessor role.

4 Findings and Discussion

Analysis of the collaborative outputs and facilitated sessions reveals three emergent assessment postures among participating teachers: a reflective-adaptive posture, characterised by openness to reconceptualising prior evaluation habits; a procedural-compliance posture, oriented primarily towards fulfilling institutional requirements; and a resistant-traditional posture, marked by adherence to summative, product-focused models [6].

Recurring resistances centred on terminological ambiguity, workload concerns, and uncertainty about the validity of distributed assessment. These resistances underscore the need for sustained institutional support structures and for professional development models that combine conceptual depth with practical collaborative experience.

5 Conclusions

This paper contributes to the evidence base on active online assessment by framing teacher professional development as a core component of sustainable assessment reform in digital higher education. The “augmented assessor” model offers a productive lens for designing faculty development initiatives that go beyond tool adoption, addressing the identity, language, and relational dimensions of the evaluator role.

Future research will investigate the longitudinal impact of the programme on students' learning outcomes and self-regulated learning capacities. The findings suggest that sustainable assessment reform requires not only new procedures and tools, but also intentional investments in teachers' professional identity, shared evaluative language, and collective assessment culture.

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From Retrospective E-Portfolio to Dialogic Reflection: Generative AI as a Scaffold for Active Online Assessment in Teacher Education

Maria Ermelinda De Carlo[1[0000-0002-0586-2692]] and Lia Daniela Sasanelli[1[0000-0003-3822-8855]]

[1]Pegaso University, Italy
mariaermelinda.decarlo@unipegaso.it
liadaniela.sasanelli@unipegaso.it

1. Introduction and Theoretical Framework

The Italian teacher qualification pathways established by the D.P.C.M. 4 August 2023 position the e-portfolio as a central artifact for assessing teacher candidates' professional development. Completion alone, however, does not generate reflective learning: quality depends on task structure, guidance and theory-experience connections [1-3]. This literature is not univocal, and its disagreements are adopted here as an analytical stance. E-portfolios support self-directed learning only where scaffolding, feedback and assessment purpose are aligned [4]; reflection itself is operationalised with heterogeneous and often unstated purposes, so that instruments claiming to capture it may instead record compliance with a prescribed format [5]. If reflective quality is a property of design rather than of the medium, the object of study is not whether candidates reflect, but which features of the artifact make reflection visible [3].

Three commitments translate this stance into the coding matrix, so that theory informs the design rather than merely preceding it. Schön's reflection-in- and reflection-on-action [6] and Moon's levels of reflection [7] define reflective depth as a graded, evidence-anchored construct. Clarke and Hollingsworth's model of professional growth [8] requires that narratives be read for their connection to teaching practice. Assessment as learning [9] and online formative assessment [10] frame the e-portfolio as an instrument of self-regulation, motivating the professional awareness and critical thinking dimensions; openness to digital technologies was added because critical technology use is now constitutive of teacher professionalism. The study asks which dimensions are made visible under ordinary conditions, and which design requirements the limitations generate.

2. Method

A mixed-methods institutional case study analysed a naturalistic corpus of 29 e-portfolios produced by teacher candidates in qualification pathways at Pegaso University in 2025/2026, covering different subject areas and 30-, 36- and 60-ECTS pathways and including all submissions. The mandatory e-portfolio combined initial and final self-assessment grids aligned with the national competence framework with narrative sections on practicum episodes. It was compiled exclusively within the

pathway: prior employment was never separately documented, and earlier experience entered only as interpretive material inside a practicum narrative. Development was not free-form, since the template prescribed guiding prompts mapped onto the competence areas; the artifact is therefore template-driven and high-stakes, treated here as an explanatory variable.

Thematic analysis [11] examined the corpus through a theory-informed matrix of five dimensions: professional awareness, critical thinking, reflective depth, connection to teaching practice, and openness to digital technologies. Each was rated on an ordinal scale of increasing reflective complexity adapted from Moon [7], with descriptors fixed in the codebook before coding; the coding unit was the thematic segment addressing a single practicum episode or judgement. Approximately 20% of the corpus was independently double-coded (Cohen's $\kappa = .74$) and disagreements were resolved by discussion. Self-assessment scores were compared descriptively and integrated with the coded profiles in a case-ordered matrix, keeping convergent and divergent cases visible. Portfolios were processed anonymously.

3. Findings

Three findings emerged, each with its warrant. First, reflective depth was greatest when narratives were grounded in concrete teaching episodes: those anchored in a situated, datable episode reached higher levels on the depth scale, whereas those reproducing the template prompts did not, irrespective of length. Second, self-assessment gains did not systematically coincide with more complex narratives: score trajectories and changes in coded complexity diverged across the corpus, and it is this divergence, rather than any aggregate gain, that constitutes the finding. Third, openness to digital technologies was coded in every portfolio, while generative AI appeared in none of the 29. Fine-grained quantification of these patterns is currently being finalised.

The absence of generative-AI references is not proof of non-use but may indicate a misalignment between what the artifact elicits and emerging practice, whether through limited adoption or insufficient language for discussing AI critically [12].

4. Towards AI-Supported Dialogic Reflection

Each design requirement answers an observed limitation rather than a technological opportunity. (i) Depth co-occurs with episode-anchored narration, which identifies the elicitation prompt, not the platform, as the operative variable and yields the requirement to begin from concrete episodes. (ii) A single retrospective submission cannot distinguish professional growth from improved self-presentation, yielding the requirement to make reflection visible over time. (iii) A dimension present in the framework but absent from the corpus is one the artifact does not elicit, yielding the requirement to prompt explicitly for the critical disclosure of technology use. The second phase therefore introduces a generative AI agent as a dialogic scaffold for weekly reflection-on-action cycles. The justification is functional rather than technological: AI sustains such prompting at scale in a distance-learning cohort,

confined to the role of interlocutor, with grading remaining with human assessors [9, 10].

Acknowledged limits remain: a census of 29 cases in one institution supports analytical, not statistical, generalisation, and the risk that an AI interlocutor standardises rather than deepens reflective language is itself among the hypotheses the planned quasi-experimental comparison will test. The study thus turns first-phase limitations into testable design hypotheses for dialogic, evidence-based online assessment.

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Towards a Living Cybersecurity Curriculum for Smart Manufacturing: A Challenge-Based Learning Framework for Adapting to Emerging Threats

Antonio Maffei[1[0000−0002−0723−1712]], Andrea de Giorgio[1,2[0000−0001−6064−5634]], Magnus Wiktorsson[1[0000−0001−7935−8811]], Roberto Guanciale[1[0000−0002−8069−6495]], and David Romero[3[0000−0003−3610−0751]]

[1] KTH Royal Institute of Technology, Stockholm, Sweden
[2] Artificial Engineering, Naples, Italy
[3] Tecnológico de Monterrey, Mexico City, Mexico
maffei@kth.se, andrea@degiorgio.info, magwik@kth.se, robertog@kth.se, david.romero.diaz@gmail.com

1 Introduction

The digital transformation of manufacturing has accelerated the adoption of Industry 4.0 technologies such as the Industrial Internet of Things (IIoT), cyber-physical production systems, digital twins, and artificial intelligence. These technologies create opportunities for productivity and innovation, but they also expose manufacturing systems to a growing number of cybersecurity threats [1,2]. Recent reports from IBM, Verizon, ENISA, and the World Economic Forum consistently identify manufacturing among the sectors most affected by cyber incidents [3,4,5,6].

Production engineers, who design and manage connected environments of industrial control systems, manufacturing execution systems (MES), industrial networks and data-driven decision support, must therefore understand risks such as ransomware, compromised PLCs, manipulated sensor data, supply-chain attacks and vulnerabilities of digital twins and IIoT infrastructures [7,1]. However, the rapid evolution of cyber threats makes it difficult for educational offerings to remain relevant over time: a topic list fixed at programme approval is already dated when the first cohort graduates. This paper proposes a Living Cybersecurity Curriculum framework for production engineering education, combining systematic topic identification, industrial intelligence and Challenge-Based Learning (CBL) to translate emerging threats and solutions into authentic learning challenges, so that cybersecurity education evolves with the needs of smart manufacturing.

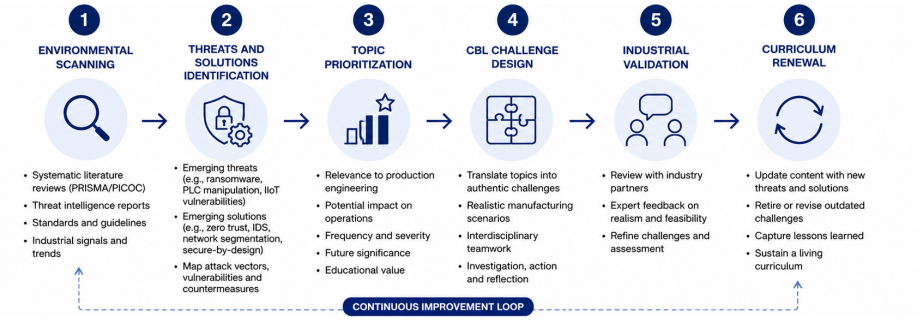

Fig. 1. Framework for a Living Cybersecurity Curriculum in production engineering education.

2 A Living Cybersecurity Curriculum Framework

CBL anchors the framework: it is suitable for cybersecurity education because it engages students with authentic, open-ended, and multidisciplinary problems requiring investigation, collaboration, action, and reflection [8,9].

As shown in Fig. 1, the framework consists of six phases: (1) environmental scanning of academic, industrial, and educational sources; (2) identification of emerging threats and solutions; (3) topic prioritization; (4) translation into CBL challenges; (5) industrial validation with experts and companies; and (6) curriculum renewal. The framework is sustained by systematic reviews, threat intelligence reports [3,4,5,6], cybersecurity standards (NIST CSF [10], IEC 62443, ISO/IEC 27001), industrial engagement and educational feedback.

The loop itself is deliberately conventional; what is proposed here is not the loop but the machinery placed inside it, which is what makes a curriculum *living* rather than merely periodically revised [11]. Three properties carry the contribution. The curriculum is *dual-speed*: intended learning outcomes are anchored to a stable competence reference [12] and change on the programme cycle, whereas the challenge layer is re-authored every course round, so content can track threats without curriculum re-approval. The update cadence is set by the release rhythm of threat intelligence rather than by the academic calendar. And prioritization (phase 3) is an explicit scoring function over manufacturing relevance, observed frequency and impact, and tractability in an available testbed, applied in both directions: challenges scoring below threshold are retired, so the curriculum sheds content as well as adding it.

Phase 4 is governed by a fixed translation template that turns a prioritized threat into an authentic challenge with a target asset, a learner role, an essential question, evidence of competence, and a safety envelope. For example, the rise of ransomware on OT networks becomes *keep the line running*: given a segmented MES/PLC testbed and a compromised engineering workstation, teams must sustain production without paying, and defend a segmentation and recovery plan before an industrial panel.

3 Conclusions and Future Work

This paper proposed a Living Cybersecurity Curriculum framework combining systematic topic identification, industrial intelligence, challenge-based learning, and continuous renewal, with its novelty in the dual-speed architecture, the intelligence-driven cadence and the explicit prioritization and translation rules inside an otherwise conventional loop. Future work will instantiate the scoring function on a full year of threat-intelligence releases, co-design challenges with industrial partners, and evaluate the first cycle in a production engineering course.

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Making Learning Visible Through E-tivities: A Mixed-Methods Study of Constructive Alignment, Cognitive Demand and Student Participation in Blended Higher Education

Alessandro Roveda[0009-0003-6959-9728], Stefano D'Ambrosio[0000-0003-0248-6289], Ornella Sannazzaro[0009-0000-7223-7742] and Fabio Sacchi[0000-0002-0388-824X]

University of Bergamo, Bergamo, Italy
alessandro.roveda@unibg.it; stefano.dambrosio@unibg.it; ornella.sannazzaro@unibg.it; fabio.sacchi@unibg.it

1 Introduction and Objectives

The progressive integration of online and blended modalities in higher education raises a crucial pedagogical question: to what extent are the e-tivities proposed to students designed in a manner that is coherent with the expected learning outcomes, and what level of cognitive demand and participation do they actually elicit?

As Cronje [1] observes, a definition of blended learning centred predominantly on technologies or delivery modes risks overlooking the pedagogical problem of learning. Within the EduNext (Digital Education Hub funded through PNRR resources) context, this study analyses e-tivities as instructional devices through which the relationship between design intentionality, expected learning outcomes, and the knowledge-elaboration processes they elicit can be made observable [2, 3].

The study adopts the principle of constructive alignment [4, 5] as its overarching framework, integrating it with two complementary operational tools: the revised Bloom's taxonomy [6] to classify the cognitive demand of learning tasks, and Salmon's model [7, 8] to describe the participatory and collaborative progression of online activities. The product expected from the student is treated as observable evidence of the coherence between learning outcomes, activities and assessment, while formative feedback is regarded as an internal component of the learning process rather than a mere concluding moment of response on the quality of completed work [9, 10]. A cross-cutting dimension concerns the accessibility of tasks according to UDL (Universal Design for Learning) principles [11, 12], which call for offering multiple, flexible means of representation, expression and engagement so that learning opportunities are accessible to diverse functioning profiles and learning styles.

2 Methods

The study adopts a mixed-methods design motivated by the complementarity of its quantitative and qualitative components. The quantitative analysis examines 48 e-tivities collected from 16 modules belonging to four EduNext Clusters of the Master's

Degree Programme in *Design of Accessible and Inclusive Living Environments* at the Universities of Bergamo and Salento. A structured coding grid is used to analyse the e-tivities according to cognitive demand, participatory scaffolding, constructive alignment and accessibility criteria, enabling the description of their distribution across the cognitive and social dimensions of Bloom's revised taxonomy and Salmon's model. This analysis is integrated with learning analytics data related to students' participation traces, including access logs, activity completion and platform interactions. The qualitative component explores the instructional rationale underlying the tasks and the conditions for participation through semi-structured interviews with the module designer-teachers, providing a deeper understanding of the internal coherence of the e-tivities. For both analytical components, coding is conducted using a shared grid, refined through inter-researcher comparison and subsequently verified through inter-rater agreement [13]. Findings from the three data sources are then integrated through triangulation to support a comprehensive interpretation of the relationship between task design and student participation.

3 Results and Conclusion

Preliminary findings suggest a concentration of e-tivities at the intermediate cognitive levels of Bloom's taxonomy (application and analysis), with limited presence of activities oriented towards evaluation and creation. A recurring gap also emerges between the cognitive level stated in the learning outcomes and that actually implicit in the formulation of the tasks. With regard to constructive alignment, an initial analysis indicates that coherence between learning objectives, activities and assessment criteria is met in approximately half of the e-tivities examined, while in the remainder critical issues are found in the definition of the expected product or in the integration of formative feedback as part of the learning process. A representative case of full alignment is an e-tivity asking students to draft an ICF-based functioning profile from a choice of six case descriptions: the stated objective (applying ICF categories to a specific case), the expected product (a completed profile with a short rationale) and the formative feedback are explicitly and coherently linked. Qualitative analysis of the tasks and interviews with the designer-teachers suggests that the most favourable conditions for participation are associated with e-tivities designed to support forms of participation corresponding to stages 3–4 of Salmon's model, in which scaffolding is made explicit within the task itself, while activities at the initial levels display greater variability in the clarity of instructions and the accessibility of the proposed formats. Learning analytics data are being analysed to examine whether e-tivities characterised by more structured tasks, explicit feedback and appropriate levels of participatory scaffolding are associated with higher levels of student participation.

The contribution offers operational criteria for a more conscious and participatory design of e-tivities in blended contexts, with particular attention to the accessibility of tasks and to formative alignment. The recurring patterns and critical issues identified provide the basis for practical recommendations addressed to teachers and curriculum designers engaged in the innovation of university teaching.

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AI-Mediated Formative Feedback and Metalinguistic Awareness in Higher Education: A Case Study on Complex Grammatical Structures in Arabic-Speaking Learners of Italian

Valentina Isceri[0009-0000-0280-844X]
Università Telematica Pegaso, Naples, Italy
valentina.isceri@unipegaso.it

This contribution investigates AI-mediated formative assessment practices in higher education and their role in fostering metalinguistic awareness and self-regulated learning, taking as a case study the acquisition of clitic pronouns by Tunisian university learners of Italian as a Foreign Language. The study is positioned within the debate on active online assessment, understood – in Sadler's [1] terms – as a participatory practice that shifts the locus of evaluation from summative judgment to the ongoing, learner-centred regulation of learning. AI-based digital tools are examined as possible scaffolds for formative feedback, capable of sustaining the internal feedback loops that Nicol and Macfarlane-Dick [2] place at the basis of self-regulation.

It is in distance and blended higher education that the question becomes most pressing: digitally mediated assessment must compensate for reduced opportunities for synchronous feedback. The quality of feedback – timing, specificity, capacity to activate learner agency – becomes, with Hattie and Timperley [3], the factor that discriminates between support for genuine learning and the automation of surface-level correction. Domains of high morphosyntactic complexity offer a privileged testing ground: in Italian clitic pronouns, errors tend to stabilise into fossilised patterns – Selinker's [4] interlanguage, Han's [5] fossilisation, documented for Tunisian learners by Rahal and Smaoui [6] – and formative intervention must reach beyond error flagging, so as to engage learners in explicit rule articulation and self-correction.

Twenty-one undergraduate and graduate students from six Tunisian institutions (Université de la Manouba, de Sfax, de Monastir, de Gabès; Institut Supérieur des Langues de Tunis; Institut Supérieur des Langues Appliquées de Moknine) took part in a quasi-experimental one-group pre-test/post-test design articulated in four phases. The pre-test combined seven completion items targeting accusative, dative and combined clitics with grammaticality judgments and ten distractor items, so that target structures emerged incidentally. An AI-based automated correction tool (LanguageTool) was employed as a support for formative assessment: for each of five non-target-like sentences, students received immediate feedback and were invited to identify the rule violated, to propose a correction and to verbalise the underlying rule.

A parallel post-test with minimally varied items distinguished genuine internalisation from rote recall, while a concluding image-based narrative task, designed around the radial agent–recipient–theme structure proposed by Pona [7], created pragmatic pressure for spontaneous clitic use within a communicative frame.

The integrated battery of instruments captured assessment as a multidimensional construct, triangulating spontaneous, induced and reflective data. Results show an overall reduction in error rates between pre- and post-test, with the most substantial gains in clitic omission (from 52% to 31%) and misplacement with infinitives and modal verbs (from 48% to 26%), alongside a marked increase in students' capacity to autonomously detect and reformulate their own errors (mean accuracy 77.8%, peaking at 95.2% for placement errors). About 70% of learners maintained accurate performance under minimal item variation, an indication of incipient internalisation; when uncertain, twelve learners out of twenty-one reported deliberately retrieving the relevant grammatical rule, a strategic, metacognitively driven behaviour that Sato [8] places at the centre of data-driven learning, and around three quarters judged the technological support helpful to their understanding. More complex structures, such as combined clitics (glielo, gliela), showed comparatively limited improvement, a pattern consistent with Sorace's [9] interface hypothesis.

The formative value of AI-based feedback, however, proved to be anything but automatic. Learners who engaged the tool through active metacognitive strategies – articulating explicit rules, comparing near-identical pre/post items, monitoring their own reasoning – achieved more durable restructuring of their interlanguage, consistent with Schmidt's [10] noticing hypothesis and with the evidence from Sadler [1] and Nicol and Macfarlane-Dick [2] on the gap between current and desired performance. Learners who treated the tool as a simple corrector obtained, instead, superficial and non-transferable gains, in line with what Koltovskaia [11] observes regarding student engagement with automated written corrective feedback: their performance proved inconsistent on the near-identical post-test items designed to disentangle internalisation from rote memorisation.

One indication for active online assessment in higher education follows from this: AI-based tools can be reframed in terms of scaffolding within a formative, learner-centred design, provided that their use remains embedded in reflective pedagogical mediation, along the lines of the ICALL perspective of Heift and Schulze [12]. The exploratory scope of the study entails clear limitations – the small, self-selected sample, the absence of a control group, the short intervention and the partial coverage of complex clitic clusters by the tool – which caution against causal generalisation and call for replication with larger cohorts and delayed post-tests. What emerges is a socio-digi-constructivist model in which AI triggers metalinguistic reflection within an ecology of self-regulated learning, where the quality of digital assessment rests on the pedagogical architecture surrounding the tool far more than on the algorithm.

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Gamification apps for museum assessment. A scoping review.

Delio De Martino[1[0000-0003-3107-1816]], Maria Clara Dicataldo[1[0000-0001-6999-4128]], Ilaria Fiore[1[0009-0000-1989-2908]], Alessia Scarinci[2[0000-0002-3174-7137]], Anna Dipace[1[0000-0001-9826-073X]]

[1] Telematic University Pegaso, Naples, Italy; [2] University of Salento, Lecce, Italy
delio.demartino@unipegaso.it;mariaclara.dicataldo@unipegaso.it; ilaria.fiore@unipegaso.it; alessia.scarinci@unisalento.it; anna.dipace@unipegaso.it

1. Introduction

The new museology has profoundly changed the museum conception, switching the focus from the musealization of the cultural heritage in direction of the relation with the visitor [1]. The new museum is a physical and digital space indeed as a dialogic texture where experience, engagement, participation, and knowledge are co-built [2].

The participatory museum, as defined by Nina Simon [3], is a cultural space where the participation of the visitors is enhanced at all levels, also through a deep and authentic assessment. In this framework also the gamification is a crucial methodology to engage the visitor in the assessment, transforming him into a sort of "coauthor" of the cultural innovation [4].

Gamification apps, such as Kahoot and similar, are based on Multiple choice test [5] and can be used just for these typologies of active museum assessment practices. Mostly used in educational context, these gamification apps can be useful for a continuous enhancement and redesign of the museum in a logic of continuous improvement. At the same time the data provided by the analytics are useful themselves to promote a higher and deeper relation with the visitor and the society. The integration with Ai could make these apps more and more effective as assessment tools.

This scoping review is aimed to explore the literature about the use of gamification apps as assessment tools in the museum. Indeed, while the literature about Kahoot and similar educational tools in school and university [6] is consistent, it could be interesting to verify if and how the academia has studied the gamification apps for the specific purpose of the museal assessment and the related practices.

2. Methodology & strategy research

This study adopted a scoping review methodology to map and to synthesise the literature on the use of gamification applications for learning assessment in museums and cultural heritage contexts. The review was conducted following the methodological framework proposed by Arksey and O'Malley [7], further developed by Levac et al. [8], and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).

The review was guided by the following research questions:

RQ1. How are gamification applications used for learning assessment in museums and cultural heritage contexts?

RQ2. Which theoretical and design models underpin the use of gamification applications in museum assessment practices?

The literature search was conducted in Scopus and ERIC. These databases were selected because of their broad coverage of educational technology, museum studies, cultural heritage research, and digital learning.

The search strategy was designed to identify studies addressing the use of gamification applications and game-based digital tools in museum and cultural heritage settings, with particular attention to learning assessment, visitor evaluation, engagement, and participation.

The preliminary search conducted in Scopus and ERIC identified a substantial number of records potentially relevant to the topic. At this stage, the review is still in progress and the screening process has not yet been completed. Therefore, the data reported should be considered preliminary and are intended to provide an overview of the scope of the literature retrieved through the search strategy. Probably an abundance of literature on student formative evaluation (with a focus on engagement, participation and gamification etc.) but scarcity of articles on Kahoot as a museum evaluation.

Preliminary results of this scoping review demonstrate that gamified learning assessment applications, particularly Kahoot!, are widely used in schools and universities [9], while they appear to be less widespread in museums for the valorization of cultural heritage. This appears to be consistent with previous studies [10], which highlight the lack of methods and tools for assessing learning outcomes in museums. From a methodological perspective, the data presented should be considered preliminary. Further analysis, supported by empirical data, will clarify the extent and nature of this gap.

3. Conclusion

During a new digital revolution of the museum, the literature scarcity about the use of gamification apps as assessment tools is surprising. The emergence of new functionalities and tools recently integrated in these apps could change the game and revive the interest also toward the museal assessment practices.

The scoping review underlines a gap that could be filled in the near future due to emerging new features able to enrich the gamified museum assessment experience.

Specifically, the integration of Ai and the launch of narrativisation tools, such as Kahootopia (a new virtual reality environment with the form of an island, that narrativize the Multiple choice test structure) or Escape room by Genially could stimulate the spreading of new assessment practices also in the museum and, consequently, push a new wave of academic publishing interest toward digital gamification assessment models.

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Special Track 2

Rethink Education: The Opportunities and Challenges of Artificial Intelligence

Organizers:
Gabriella Casalino, University of Bari Aldo Moro, Bari, Italy
Alessio Ferrato, Roma Tre University, Rome, Italy
Carla Limongelli, Roma Tre University, Rome, Italy
Daniele Schicchi, Independent Researcher, Italy
Davide Taibi, National Research Council of Italy, Institute for Educational Technology, Italy

A Co-Designed Learning Agreement Framework for Transparent AI Disclosure in Higher Education

Patricia Santos[1][0000-0002-7337-2388], Cansu Koyuturk[2][0009-0005-7562-7400], Andrea Martineghi[2] [0009-0003-3398-232X], Davide Taibi[3][0000-0002-0785-6771]

[1] Department of Engineering, Universitat Pompeu Fabra, Barcelona, Spain
[2] University of Milano-Bicocca, Milan, Italy
[3] National Research Council of Italy, Institute for Educational Technology, Palermo, Italy
patricia.santos@upf.edu, cansu.koyuturk@unimib.it, a.martinenghi1@campus.unimib.it, davide.taibi@cnr.it

1 Introduction

The rapid diffusion of Generative AI (GenAI) tools in higher education has created an urgent governance gap. Students and educators routinely use large language models for tasks ranging from drafting and summarisation to code generation and research synthesis. Although institutions increasingly provide guidance on GenAI use, policies and transparency requirements remain uneven and context-dependent [1, 2]. Such inconsistency can undermine academic integrity, assessment validity, and trust in authentic learning relationships. Transparency is also a bilateral issue. Much of the existing literature focuses on student disclosure, whether students report their use of AI in submitted work, while the parallel obligation of educators to inform about their own AI-assisted practices (in course design, feedback generation, or assessment) has received comparatively little attention. Yet if instructors use AI without disclosure, they model precisely the opacity they seek to prevent. This paper presents a framework developed within the AILA project to address this gap. AILA is a European project involving universities across Italy, Serbia, Turkey, and Spain, with the aim of fostering the responsible use of AI in higher education. The AILA Learning Agreement (LeA) is a co-designed document that makes AI use policies explicit, negotiated, and transparent for all parties.

2 The AILA Framework

The AILA pedagogical framework is based on three interconnected pillars. The first maps the opportunities and threats of GenAI in higher education, from personalised learning support and AI literacy development, to cognitive dependency, misinformation, academic dishonesty, and environmental impact, with explicit recognition that the same tool can support or undermine learning depending on context, discipline, and use [3, 4]. The second pillar articulates the ethical foundations of responsible AI use: transparency, accountability, fairness, autonomy, and human-centred design [5]. The third aligns the framework with the four horizontal priorities of the Erasmus+ programme such as Climate Action, Digital Transformation, Civic Responsibility, and

Inclusion & Diversity. A key design principle of the framework is that AI governance in higher education should not be imposed top-down [6]. Overly restrictive or coercive institutional approaches can undermine genuine engagement and, paradoxically, encourage performative compliance or dishonest behaviour [7]. The AILA framework instead provides the structure for contextualised, collaborative decision-making at the course level, with students as active agents rather than passive recipients of rules.

3 The Learning Agreement

The AILA Learning Agreement (LeA) is grounded in Self-Determination Theory [8], which identifies three basic psychological needs: autonomy, competence, and relatedness. The satisfaction of these needs is essential for intrinsic motivation and genuine engagement and co-designing the LeA aims to support all three. Students actively co-design the agreement rather than merely comply with it (autonomy); the LeA provides explicit scaffolding that reduces AI-related uncertainty (competence); and the collaborative process creates a shared classroom norm (relatedness).

Structurally, the LeA adopts a four-level classification of AI use for each course activity: Encouraged (AI actively enhances the learning experience), Allowed (permitted without restriction beyond ethical guidelines), Restricted (permitted but likely to reduce learning value; requires reflection), and Prohibited (constitutes a violation of academic integrity). For example, AI use might be classified as Encouraged for brainstorming or language polishing in essay writing, Restricted for debugging support in coding assignments, and Prohibited during closed-book exam preparation. This graduated structure preserves student autonomy, in fact students may use AI even in restricted contexts, provided they disclose and justify, while giving instructors pedagogical nuance across different task types within the same course [9]. The LeA is produced through a structured collaborative session in the first or second week of the course. The instructor prepares a preliminary draft, students discuss the AI-related concerns most relevant to their discipline, and the class negotiates the level assigned to each major activity type. The instructor finalises the agreement incorporating student input and documenting how feedback was considered. The LeA is treated as a living document, revisable at a mid-course review and at any point through a transparent revision process.

4 Conclusion

The AILA Learning Agreement offers a principled, participatory approach to one of higher education's most pressing governance challenges: how to make AI use visible, responsible, negotiated, and ethically grounded for all members of a course community. By framing disclosure as a bilateral agreement, and by embedding it in a collaboratively designed document rather than a unilateral institutional policy, the framework positions transparency not as a compliance burden but as a shared academic value. Future work will assess the framework's impact through empirical data collected across partner institutions during the 2026–27 academic year, including the facilitation mechanisms used to mediate disagreement during the negotiation phase.

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Reframing Learning Design for the Age of GenAI: The LLMed Framework

Lourdes Guàrdia[1[0000-0003-3719-9546]], Ludovica Fanni[1[0009-0009-9205-7867]], Marcelo Maina[1[0000-0002-1889-1097]] and Nati Cabrera[1[0000-0003-1813-9601]]

[1] Universitat Oberta de Catalunya, Rambla Poblenou @22 08018 Barcelona, Spain
lguardia@uoc.edu, lfanni@uoc.edu,mmaina@uoc.edu, ncabrera@uoc.edu.

1. Theoretical Framework and objectives

Higher Education (HE) is increasingly confronted with the need to redefine how teaching is designed in environments where Generative (Gen) Artificial Intelligence (AI) tools are becoming embedded in everyday academic practice [1]. While Large Language Models (LLMs) are already being used by educators and students for a wide range of instructional and learning activities, their role within pedagogical design processes remains insufficiently articulated. Current discussions on GenAI in education have largely focused on digital competences, ethical concerns, or AI literacy, offering limited guidance on how educators can intentionally incorporate LLMs into Learning Design (LD) processes [2], [3].

This paper presents the development of the LLM-ed Framework for LD [4], created within the European-funded ADMIT project on GenAI and LLMs. The Framework conceptualises LLMs as emerging pedagogical "assistants" that can participate in LD under human pedagogical oversight. The purpose is to support teachers and instructional designers in structuring teacher–AI collaboration across diverse educational contexts while maintaining pedagogical coherence, inclusivity, and ethical accountability [5].

The study investigates how LLMs can be integrated into LD processes in ways that remain educationally meaningful and institutionally adaptable. The Framework builds on LD traditions that position educators as reflective designers responsible for aligning learning outcomes, activities, assessment, and learner engagement. It also incorporates principles derived from constructivist pedagogy and Universal Design for Learning (UDL) [6] to address accessibility and learner variability from the early stages of course design. It is also informed by research and policy on AI and digital education, including UNESCO's AI Competency Framework for Teachers [7] and European digital education strategies [8], which view AI as a support for teaching practice rather than a replacement for pedagogical judgment.

2. Methodology

The study adopts a Design-Based Research (DBR) methodology [9], [10], appropriate for investigating complex educational innovations involving emerging ICTs through iterative, theory-informed, and practice-embedded cycles. DBR enables the

codevelopment of theory and practice through successive phases of analysis, design, testing, and reflection in authentic educational contexts.

The research was structured into four DBR phases.

I. A systematic literature review and comparative analysis of established LD models (ABC LD, Carpe Diem, enABLe, Iceberg, and ELDeR) was conducted in collaboration with project partners. The aim was to identify shared pedagogical structures, design activities, and decision points relevant to integrating LLMs in HE, as well as associated affordances and constraints.

II. Based on Phase 1, the LLM-ed Framework for LD was developed by mapping LLM affordances onto core LD activities. The design incorporated principles from UDL and relevant AI ethics and policy guidelines, resulting in an artefact that clarifies the roles of teachers and LLMs across design processes.

III. The Framework was iteratively refined through participatory workshops, institutional design sessions, and focus groups involving academic staff, instructional designers, and support professionals across partner institutions. Qualitative data (transcripts, artefacts, field notes) were thematically analysed to improve clarity, usability, and pedagogical coherence across successive cycles.

IV. The final phase consolidated findings into transferable design principles, emphasising embedded AI integration within LD, preservation of teacher agency, and the integration of ethical and inclusive considerations. This phase resulted in the final version of the Framework.

3. Conclusions

This study resulted in the LLM-ed Framework for LD, a DBR-informed artefact designed to support the pedagogical integration of LLMs in HE. Developed and refined through iterative design and validation cycles, the framework clarifies the complementary roles of teachers and AI across LD processes. Beyond the framework itself, the study generates broader design principles for GenAI integration, highlighting the importance of embedding AI within established LD practices, positioning AI as a collaborative assistant that supports teachers' professional judgment, and addressing ethical, inclusivity, and accessibility considerations throughout the design process. From a research perspective, the study contributes to ICT in Education and Training by connecting the development of a concrete design artefact with emerging theoretical understandings of GenAI integration. The LLM-ed Framework therefore serves both as a practical tool and a theory-informed model, demonstrating how DBR can support the co-evolution of educational theory and professional practice. Ongoing implementations within the ADMIT project will provide further evidence to refine the framework and advance research on design-oriented approaches to AI integration in HE.

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Artificial Intelligence as a Partner in Formative Assessment for Introductory Programming

Enrichetta Gentile[1[0000-0002-4502-030X]], Alessandro Pagano[1[0000-0002-7465-9778]], Paola Plantamura[1[0000-0001-6172-9557]], Veronica Rossano[1[0000-0002-4079-9641]], Sara Maria Cosima Tondo[1[0009-0007-5236-3814]]

[1] Department of Computer Science, University of Bari, Italy
enrichetta.gentile@uniba.it,alessandro.pagano@uniba.it,
paola.plantamura@uniba.it,veronica.rossano@uniba.it,
s.tondo4@phd.uniba.it

1 Introduction

In recent years, AI has increasingly influenced educational practices, particularly in relation to teaching, learning support, and assessment. This development is commonly framed within AI in Education (AIED), an interdisciplinary field that investigates how AI methods and tools can support and enhance learning, teaching, and assessment. In this context, AI can support both teachers and students by providing feedback on learners' strengths, weaknesses, and possible areas for improvement [1]. The ability to provide continuous feedback and monitor progress is a key aspect of formative assessment. This type of assessment is effective when the feedback encourages the student to adopt a reflective approach to their learning, enabling them to answer the following questions: Where am I going? Where am I now? What strategies can I use to achieve my learning objectives? [2]. The effectiveness of formative assessment is particularly significant in the context of learning to code, which poses a considerable challenge for many students and requires continuous support throughout the learning process [3]. The variety of answers and problem-solving strategies students use to complete programming tasks [4] means teachers must carefully analyze each assignment, evaluating not only its syntactic correctness, but also the underlying logic and efficiency of the solution and reasoning process [5]. However, with a large number of students, it is difficult for teachers to provide customized support and timely feedback. Despite over two decades of research on automated assessment and feedback generation for programming assignments [5,3], the pedagogical quality of AI-generated feedback remains an open issue [3]. The key question is not only whether AI can produce feedback, but whether such feedback is relevant, understandable, motivating, and able to promote students' reflection.

2 Materials and Methods

Considering the role of formative feedback in supporting programming learning, the aim of this study was to investigate how teachers perceive the pedagogical quality of

AI-generated feedback for introductory programming assignments. To this end, we tested an AI-based plug-in designed to support teachers in evaluating students' coding assignments. The plug-in, integrated into the Moodle platform, automatically compares the student's code with a reference solution provided by the teacher and generates an assessment evaluating: syntactic accuracy, code structure, and the logic. Alongside a quantitative score, the system provides descriptive feedback to highlight strengths and weaknesses and suggests strategies for improvement, with the aim of supporting formative assessment practices. The research involved 20 teachers enrolled in a university-based teacher training programme in Computer Science and Technology. They were asked to evaluate a randomly selected programming assignment produced by students attending the "Programming Laboratory" course and previously assessed by the plug-in. The teachers used the same assessment criteria adopted by the system: solution logic, code structure, and syntactic accuracy. They were then asked to compare their own feedback with the feedback generated by the AI plug-in and to evaluate its pedagogical quality. The pedagogical quality of the feedback was assessed through a four-dimensional rubric adapted from Watts et al. [6]. The rubric considered: relevance to the task, communicative clarity, ability to engage and motivate the student, and promotion of reflective thinking. Originally developed to assess feedback on scientific reasoning, the rubric was adapted to the programming context. In particular, the relevance dimension was operationalised by assessing whether the feedback accurately distinguished among syntax, logic, and program-structure issues, supported students in completing the task, and provided technically accurate information..

3 Results and Conclusion

The results showed that AI-generated feedback was rated positively, particularly in terms of communicative clarity, while its ability to foster engagement and motivation emerged as its weakest aspect. Task relevance and the promotion of reflective thinking received moderately positive evaluations. No significant differences emerged in terms of teachers' teaching experience or knowledge of the C programming language. Qualitative comments confirmed that AI-generated feedback was often perceived as coherent with teachers' assessments, but they also revealed limitations related to technical accuracy, completeness, and motivational aspects. The findings suggest that the plug-in can support formative assessment by providing teachers with an initial, structured interpretation of students' programming assignments. However, its contribution appears stronger in making feedback explicit and readable than in producing fully pedagogically complete feedback. The study therefore identifies a specific role for AI in introductory programming assessment: offering a preliminary layer of feedback that teachers can validate, refine, and contextualise. This is particularly important when feedback must address not only syntax and code structure, but also the reasoning process underlying the proposed solution. Accordingly, AI-supported assessment tools should be designed not only for technical correctness, but also for pedagogical mediation, including motivational tone, completeness, and support for reflection.

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Teaching and ai: examples of good practices in the field

Giuseppe Filippo Dettori - https://orcid.org/0000-0003-3493-5237
and
Barbara Letteri - https://orcid.org/0000-0001-9153-2712

Università di Sassari, Dipartimento di Storia, Scienze Umane e dell'Educazione, Sassari, Italia
gfdettori@uniss.it; bletteri@uniss.it

1 Introduction

Generative artificial intelligence has rapidly entered university and school teaching, often faster than the regulatory frameworks and professional competences needed to govern it responsibly. This raises concrete questions for educators: which tools comply with the data-protection requirements of the GDPR [9] and the European AI Act [10]? How can student data be protected? How can AI use move from a spontaneous practice to an intentional pedagogical project?

This contribution presents a set of best practices for integrating generative AI into teaching, grounded in an action-research process conducted in a.s. 2024/2025 within various lower and upper secondary schools in Sardinia, involved in the training and experimentation for the PNRR projects. In each context, AI was introduced not as a neutral efficiency tool, but as an object of critical inquiry and a support for instructional design. The four practices presented in Section 2 were not defined a priori: they emerged iteratively from the experimentation itself and were refined across successive classroom cycles structured around three recurring phases — guided use, critical analysis, and collective evaluation. This cyclical model, consistent with what Hobbs [3] terms algorithmic media literacy, allowed each use of an AI tool to become an occasion for reflective learning, and let the authors distinguish which recommendations held up across contexts from those that required revision.

2 Best Practices from Field Experimentation

2.1 Choice of Tools

Not all AI systems are compatible with institutional use: services that retain prompts, transfer data outside the EU, or require students' personal accounts expose institutions to unmanageable regulatory risks. Tools such as Gemini for Education or Copilot for Education — configured within institutional environments and covered by GDPR-compliant contracts — allow safe operation while preserving institutional control over data; free consumer-grade chatbots are, by contrast, problematic under the current regulatory framework [2, 9].

2.2 Data Management

The principle of data minimisation (GDPR, Art. 5(1)(c)) was adopted not only as a legal constraint but as a pedagogical criterion: activities were designed so that students never entered personal data into AI tools, relying instead on fictitious examples and purpose-built case studies. Where analysis of authentic student work was necessary, pseudonymisation (GDPR, Art. 4(5)) preserved its evaluative value while removing identifying elements [4].

2.3 Modal Transformation of Content

AI was used to reformulate texts across registers, complexity levels, and communicative formats, drawing on Kress's social semiotics [6] and the principles of Universal Design for Learning [1]. This supported the creation of differentiated materials and diversified study strategies. AI acted as an assisted co-designer, with the teacher retaining critical supervision: every output was checked, corrected, and integrated before classroom use, limiting the risk of hallucinations and conceptual distortions [5].

2.4 Digital Citizenship

Structured activities — including critical tool analysis, recognition of risk points in data sharing, and simulation of governance choices — enabled students to develop the competences described in Areas 4 (Safety) and 5 (Problem Solving) of DigComp 2.2 [12], learning not only to use AI but to question and evaluate it.

3 Institutional Governance and Conclusion

These practices cannot be left to individual teachers' initiative. They require institutional governance that defines shared use policies, trains staff in the safe and pedagogically grounded use of AI, and establishes periodic risk-assessment processes, as required by the AI Act for high-risk systems [8, 10]. As Luckin [7] observes, a teacher who does not understand how a system works cannot meaningfully oversee it, making continuous professional development a necessary rather than optional condition.

The experimentation points to three enabling conditions for responsible adoption: informed tool selection grounded in the regulatory framework; continuous rather than episodic teacher training; and institutional governance treated as a systemic condition rather than a bureaucratic constraint. In line with UNESCO's recommendation [11], the goal is not to adopt AI because it is available, but to integrate it — transparently and in a controlled manner — because it serves clearly defined educational purposes.

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AccuGrade: Human-in-the-Loop Document Intelligence for Active and Auditable Assessment in Higher Education

Marco Cremaschi[1,2], Riccardo Pecori[3,4], Pietro Squeri[4,5], and Davide Ditolve[6]

[1] Department of Informatics, Systems and Communication - DISCo, University of Milano-Bicocca, Milan, Italy
marco.cremaschi@unimib.it
[2] Whattadata S.r.l., Milan, Italy
[3] DiSTA, eCampus University, Novedrate (CO), Italy
riccardo.pecori@uniecampus.it
[4] CNR-IMEM, Parma, Italy
[5] CHIMOMO Dept., University of Modena and Reggio Emilia, Modena, Italy
383901@studenti.unimore.it
[6] Noovle S.p.A. (TIM Group), Milan, Italy
davide.ditolve@noovle.com

Handwritten open-ended examinations remain only partially digitized within higher education assessment. Even where universities rely on online learning environments, the interpretation, review, transcription, and archival of handwritten scripts often remain manual. This produces delays in feedback, uneven review workload, limited traceability for appeals and quality assurance, and a weak connection between assessment evidence and data-informed educational governance. Prior research on marking reliability, rubrics, reviewer workload, automatic assessment, and handwritten mathematical artefacts suggests caution: mixed handwritten submissions including prose, formulae, diagrams, corrections, and marginal notes are not situations when automated evaluation should be treated as granted [1–5]. The work by Gao et al. [6] synthesized 93 studies of text-based response assessment while explicitly excluding handwritten responses. Recent studies have investigated feedback on textual answers, writing proficiency, LLM-based scoring, collaborative grading, graphical responses, fairness, scalability, and score validity [7–10], but they do not establish a comprehensive end-to-end solution for mixed handwritten university scripts. In this scenario, we present **AccuGrade**, a human-in-the-loop intelligent document understanding platform for active and auditable assessment workflows in higher education. Its agentic system is designed as a reviewer support rather than an automated grading tool with the objective to transform handwritten submissions into structured, inspectable drafts that can be validated, corrected, and exported for main usage by instructors. Its architecture combines deterministic pre-processing, multimodal layout routing, specialist extraction paths for text, mathematical notation and graph-like content, structured validation, and a reviewer dashboard exposing ambiguous regions and validation failures. Rather than producing a single opaque score, **AccuGrade** generates typed artefacts with provenance, rendering checks, schema checks, and review-priority signals.

This design draws on OCR-free and multimodal document-understanding research while preserving the accountability of the human assessor [11, 12].

Operationally, the workflow starts from secure ingestion and page-level preprocessing, including rendering, de-skewing, de-noising, and contrast normalisation. The orchestration layer separates heterogeneous regions according to the evidence they contain: prose, labels, mathematical derivations, tables, diagrams, and graph-like content. Specialist paths then generate draft transcriptions, mathematical representations, or structured graph descriptions, which are recomposed into a page-level object containing provenance and validation metadata. This decomposition avoids treating a complete script as a single undifferentiated prediction: a problematic mathematical block can be escalated while other parts remain usable and ready for reviewer validation. The reviewer interface is conceived as an active assessment surface rather than a passive display of model output. It places the original handwritten evidence beside the structured draft, highlights ambiguous regions, and records edits required before approval. When instructors provide rubrics, solution keys, exemplars, or course-specific instructions, the system can adapt extraction priorities and optionally generate provisional scoring suggestions. These suggestions are not institutionally valid grades: they remain reviewer-facing hypotheses, subject to explicit confirmation on the part of instructors. This boundary is consistent with rubric-mediated assessment and with the need for careful oversight when Large Language Models (LLMs) are used in educational contexts [1, 13].

The work particularly examines how Gemma4, as LLM, and Ollama, as engine, can extend digitally mediated assessment beyond conventional online quizzes and text-based submissions. The proposed workflow supports formative and summative practices in courses where open-ended handwritten work remains pedagogically important, such as mathematics, engineering, and data-intensive disciplines. It also addresses institutional requirements often overlooked in AI assessment narratives: audit trails, reviewer edit histories, export to learning-management or administrative systems, data governance, and conservative escalation boundaries. The evaluation framing separates public evidence from unsupported performance claims. It defines a protocol for comparing unaided manual review with **AccuGrade**-assisted review in terms of reviewer time, edit burden, escalation frequency, structured-validation pass rate, export success, and error classes. This framing follows the need for careful oversight in educational uses of LLMs [13]. The validation model is deliberately conservative. Review priority can be raised by schema failures, invalid mathematical rendering, malformed graph output, disagreement across extraction passes, missing mandatory fields, or high reviewer edit burden. These signals do not replace pedagogical judgement but help reviewers to put attention where the pipeline is less stable and create a traceable record of what was extracted, what was uncertain, and what was corrected before export [14].

By positioning AI as a supervised document-intelligence layer, **AccuGrade** supports transparent, scalable, and accountable assessment while keeping final academic judgement with educators.

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Studying with AI, from Shortcuts to Critical Use: A University-Wide Hackathon Fostering Critical AI Literacy in Higher Education

Maria Ranieri[1[0000-0002-8080-5436]], Gabriele Biagini[1[0000-0002-6203-122X]], and Francesca Pezzati[1]

[1] University of Florence, Florence, Italy
maria.ranieri@unifi.it; gabriele.biagini@unifi.it
francesca.pezzati@unifi.it

1 Introduction

The rapid diffusion of generative AI (GenAI) is changing how university students search for information, draft texts, and prepare academic work, opening real opportunities alongside well-documented challenges for assessment, integrity and learning [1, 2]. A central concern is cognitive offloading: when learners systematically delegate reasoning to external tools, they risk eroding the very processes that learning should develop, and metacognitive misjudgments may foster suboptimal reliance [3]. Fostering *critical AI literacy* - the competences to evaluate, use and collaborate with AI critically and responsibly - has thus become a priority for higher education [4, 5, 6]. Many initiatives are instructional and top-down; this work instead explores a participatory, student-as-producer format in which students create an awareness campaign for their peers.

2 Designing the Hackathon

The hackathon was part of the UNIFI final event of the Alma-DEH project (Advanced Learning Multimedia Alliance for Inclusive Academic Innovation, Digital Education Hub), a national initiative funded by the European Union–NextGenerationEU under the Italian PNRR that unites thirteen Italian universities and an AFAM arts academy. Held in Florence in May 2026 with over 400 students, it was framed by the theme *"Studying with AI: from shortcuts to critical use."* Hackathons are increasingly recognised as a form of experiential, challenge-based learning [7], well-suited to active engagement with the topic.

Teams of six to seven students produced a coherent system of at least two digital communication artefacts - for example, a video spot, a social campaign, a landing page, a podcast or an interactive quiz - addressed to their peers and developed with GenAI support through the institutional Google Workspace for Education (e.g., Gemini, NotebookLM). The design rested on four ethical principles: (i) AI as transparent support, not an invisible shortcut; (ii) the centrality of authorship, with intentionality and critical selection left to the team; (iii) equal dignity for non-AI and hybrid practices; and (iv)

coherence between theme and process. Crucially, each team completed a structured process-documentation form that recorded the tools and prompts used, the human–AI division of labour, the outputs they revised or discarded, and what they chose not to delegate - thereby turning reflexivity into an explicit, assessed object. The day ran in three phases - research (1 h), ideation and development (~5 h), and a final selection pairing a public exhibition with an elevator pitch - which was evaluated by an expert jury (60%) and a peer vote (40%).

3 Method

Reception was assessed through a voluntary post-event online questionnaire under informed consent; 182 responses were collected, and 181 consenting responses were retained. The instrument used five-point Likert blocks (1 = strongly disagree, 5 = strongly agree) on self-assessed critical-use competences (eight items, S1–S8), team process and ethical reflection (six items, P1–P6) and event organisation (five items, H1–H5), plus an overall satisfaction item, multiple-choice questions on tools and phases of AI use, and open-ended questions. We report descriptive statistics and a thematic reading of the open responses. The design is exploratory, and some item blocks show partial missingness.

4 Results

GenAI was widely adopted: the most frequently used tools were Gemini (n = 157), ChatGPT (120), and Canva (94), used primarily for image generation (112), copywriting (68), graphic design (67), and information gathering (60). Overall satisfaction was high (M = 3.96, SD = 0.98; 74% rated 4–5). Students judged their team's use of AI as critical and conscious (M = 4.15; 87% ≥ 4), and felt the product represented their own viewpoint (M = 4.08; 81% ≥ 4). Self-assessed specific competences were more moderate (S1–S8 mean ≈ 3.28), with the lowest scores for avoiding the use of sensitive data in unauthorised tools and for knowing when to disclose AI use. Team process and ethical reflection (P1–P6) and event organisation (H1–H5) were rated moderately positive (block means ≈ 3.34 and 3.54; adequate spaces and tools, H4 M = 3.97). Among the day's phases, hands-on product work (46 mentions) and ethical reflection on AI use (38) were most often named as most useful for learning. The open responses traced a coherent arc: the most frequently intended change was to verify AI outputs against reliable sources; the most frequently cited critical aspects were over-delegation, source reliability, and hallucinations; and what teams most often kept from AI was the core idea and creative direction.

5 Discussion and Conclusion

The design appears to have surfaced the intended reflection. Ethical reflection ranked among the most useful phases, while students' commitments to verify outputs, disclose

AI use, and avoid over-delegation align with the shift "from shortcuts to critical use." A gap emerged between high self-perceived critical use ($M \approx 4.1$) and more moderate competences ($M \approx 3.3$), especially for data protection and disclosure. This confidence-skill gap echoes metacognitive misjudgments linked to cognitive offloading [3] and argues for sustained AI-literacy provision beyond one-shot events. The single-institution, self-report design without matched pre/post measures limits claims to perceived learning. Even so, the hackathon offers a replicable student-as-producer model, which the full paper will examine further through team artefacts and process documentation.

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The Role of Personal Knowledge and Institutional Context in the Development of AI Literacy. The TEACH-AI Research Contextualises International Frameworks

Michele Marangi[1] [0000-0003-2013-5079] and Matteo Adamoli[1] [0000-0001-9149-3944]

[1]eCampus University, Novedrate, Italy
michele.marangi@uniecampus.it matteo.adamoli@uniecampus.it

1 Introduction

The proliferation of Gen AI is reconfiguring socio-educational and professional practices, requiring practitioners not only to use AI effectively, but to understand its mechanisms, critically evaluate its outputs, and preserve human agency within care and educational relationships [1-2]. The PAIR questionnaire (Participatory AI for Inclusive Relationships), developed within the TEACH-AI project (Transformative Educational Approaches for Civic and Human-centered AI), measure AI readiness among socio-educational practitioners across three dimensions: Affordance-in-Practice, Capability, Sentiment [3-4]. These dimensions, however, leave partially unaddressed two areas identified as central by international frameworks: declarative knowledge (KNW) and institutional positioning (Context). This contribution examines the robustness of the framework with respect to these two parameters, in productive dialogue with DigComp 3.0, UNESCO 2024, and the Council of Europe 2026 Recommendation on AI literacy.

2 Theoretical Background

AI literacy is a multidimensional competence encompassing operational skills, ethical awareness, critical interpretation, contextual judgement [5-6]. The ARISE framework (AI Responsive Integrated Socio-Education) operationalises it through the concept of enacted affordance [7-8], Capability Approach [9-10], and models of emotional valence [11]. Leading international frameworks converge on the need to include declarative knowledge as a foundational layer: DigComp 3.0 [12] addresses literacy and content production; UNESCO frameworks [13-14] introduce a human-centred mindset and applied ethics; the Council of Europe Recommendation [15] proposes a Human, Technological and Practical tripartition directly mappable onto the PAIR dimensions. Institutional context is a well-established moderator in technology adoption [16] and is increasingly foregrounded in AI governance frameworks [17-18].

3 Research Objectives and Questions

This contribution pursues three objectives: to analyse the composition of the KNW and Context parameters in the PAIR questionnaire in relation to international standards; to examine how these parameters interact with the three foundational

dimensions to produce a more comprehensive picture of professional readiness; and to propose an expanded theoretical model that explicitly situates PAIR within the international landscape of AI literacy [19]. Three research questions guide the analysis: which items capture declarative knowledge and what gaps remain with respect to international benchmarks; which items reflect institutional context and how they may be structured as an Organizational Readiness Score (ORS); and how the interplay between KNW, Context, and the three foundational dimensions enriches our understanding of AI readiness among socio-educational practitioners.

4 Item Analysis

Regarding AI knowledge, PAIR includes five multiple-choice items—covering Gen AI's definition, prompting, an applied example, hallucination causes, and algorithmic bias—coded into a declarative literacy score, plus an operational literacy proxy from the share of known AI tools used. Against DigComp 3.0 and UNESCO 2024, the battery shows gaps in effective prompting, ethical implications, AI typology, and hallucination understanding, pointing to additional PAIR dimensions, including an ethical literacy sub-scale aligned with the Council of Europe's Human pillar [15]. The study asks whether KNW is necessary but insufficient: high declarative knowledge without enacted use or agency yields a fragile profile, while high use with low KNW may signal unreflective adoption or uncritical dependency.

5 Towards an Organizational Readiness Score

PAIR does not include a dedicated section on context, but two sources capture it implicitly: the Policy item; and the section on current AI use within the organisation. These items may constitute a parallel contextual index, not a component of the individual measure, since context is external to the subject. The research hypothesis examines four diagnostic profiles: capable practitioners in enabling contexts; capable practitioners in blocking contexts; fragile practitioners in high-expectation contexts; and fragile practitioners in blocking contexts. This matrix shifts the analytical focus from individual deficit to the organisational structure, with implications for AI governance in the Third Sector [3-4; 17] and in alignment with the provisions of the AI Act [18] on organisational accountability.

6 Conclusions and Perspectives

This contribution enriches the debate on measuring AI literacy in education. Anchoring KNW and Context completes the theoretical architecture grounded in Affordance-in-Practice, Capability, and Sentiment, capturing enacted practice, agency, affective disposition, declarative knowledge, and institutional environment. This points to a composite readiness measure that is theoretically richer, empirically robust, and applicable to training design and AI governance in socio-educational services [20]. Articulated as a weighted index and an Organizational Readiness Score, this architecture offers a scalable, internationally comparable tool for monitoring AI integration in the Third Sector.

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Human guidance or artificial guidance? Generative inference underpins the process of representing educational reality

Angelo Cappello[1]

[1] University of Messina, Messina, Italy
angcappello@unime.it

1 Artificial inferences and algorithmic knowledge for a conscious representation of the world

The relentless development of generative systems, based on statistical inferential relational models, has led to a profound redefinition of the ways in which knowledge appears to us, reinvents itself, and is represented by interpreting it within educational contexts. This work seeks to explore the extent of human nature and the epistemic tension between human and automated guidance, investigating the threshold or limit that influences the development of decisions perceptible in the environment and the conscious analysis of the very perception of the learning experience.
In light of the most recent perspectives on the on-life experience [1], the distributed and situated nature of cognition [2, 3], and the dynamics of fragmentation and recomposition of the real world in contemporary times [4], this study aims to highlight how generative inference not only supports traditional educational action, developed on canons of co-evolutionary representation, but also introduces new forms of cognitive orientation, interpretive automation, and co-production of educational reality.
The issue, therefore, revolves around a redefinition that is no longer exclusively technical, understood in the sense of systemic and algorithmic relationships, but profoundly epistemological and pedagogical. UNESCO [5] in its document "Generative AI and the Future of Education" highlights how the speed with which generative AI is spreading in educational governance processes far outstrips the capacity of institutions to regulate it, raising questions about the risk of a differentiated delegation of the educational function to potential ecosystems that are neither controllable nor understood.
This very educational vision, implicit in its forms, must guide us in constructing meaningful knowledge born from purely human processes, supported by social responsibility and shared associations, which do not replace human intellectual capacities but reconfigure them according to structured and potentially more accurate modalities. If this perspective succeeds in showing us a further way to anchor educational subsistence, it will do so precisely thanks to the great flexibility with which it will be able to incorporate innovative relationships, systems, and procedures, which are the basis for an open society that is consciously alert to the changes taking place.

In these respects, the paper proposes a structured and interpretive model that integrates the epistemological theory of representation, the computational theory of knowledge, and reasoning on digital influence, highlighting risks and opportunities, from cognitive delegation to the redefinition of pedagogical authority, and then arriving

at the need to develop skills to govern the interaction between human agents and digital inferential systems by developing forms of critical thinking [6]. The aim is to contribute to the debate on the nature of educational guidance in the era of generative intelligence, questioning the increasingly porous and evolving boundary between human mediation and algorithmic and systemic mediation.

2 Factorial implications and technological dynamics

What is represented constitutes the epicenter of a deeper and more complex structure of human experience. If we consider this merely as a mental articulation or the internal image that allows us to faithfully reproduce inferences from the outside world, we could fall into errors of judgment and interpretation. It must be considered a process, a primary cognitive function, which allows humans to organize, select, and interpret, giving specific weight to the experiential process. The way we create representations of the world allows us to dissipate this by constructing a possible learning scenario, through memory, predictive activity, and communication. The ways we collaborate are structures that substantiate the basis of this activity. Without representation, much of our internal processing would not lead to any form of knowledge, much less lay the foundation for a process of sharing the world as consistent as possible with society's expectations.

Technologies don't focus exclusively on continuous mediation; in fact, they recompose, transform, and automate it. The algorithmic form opens the way to the process of instrumental decoding, achieved by generating representations of what is observed, influencing perception, memory, and decision-making [7]. If we think about it carefully, many of us often mistakenly identify human inferential representation as an internal, almost exclusive and uncommon process, organized and managed through impulses and internal elaborations, as if it were a private show.

The emergence of new, advanced forms of technological tools and intelligent systems has ushered in a new epistemic thinking supported and grounded in digital inferences and algorithmic knowledge, revolutionizing the way reality is represented, learned, and interpreted. The shift taking place is not merely technological, but deeply rooted in cognitive, cultural, and pedagogical aspects; it redefines the very nature of knowledge, its emanation, its movement, and its legitimacy. Artificially constructed inferences, the beating heart of contemporary Artificial Intelligence systems, do not constitute and shape simple statistical calculations, but modeling processes of real-world inferences emerging from complex computational architectures, such as deep neural networks, self-regressive generative systems, and cutting-edge multimodal models [8].

The growing complexity of foundation models has allowed the introduction of new forms of emergent self-generalization, in which unpredictable or artificially programmed forms of representation of reality can spontaneously manifest during training and the inferential process [9]. This phenomenon builds underlying and hidden inferential planes, identifiable as emergent abilities, redefining the very concept of inference and introducing a level of epistemic unpredictability that reorganizes and models itself with traditional theories of knowledge.

The resulting algorithmic knowledge presents itself as a form of operational, performative, and implemental knowledge, capable not only of describing reality, but also of transforming it and of predicting and anticipating it. It is based on inferential pipelines

that include data pre-processing phases, multimodal embedding, propagation, and dissemination through parametric models, post-processing, and feedback loops that reinforce observed patterns, making specific representations of the world more stable [10]. Its functional approach stems from the ability to operate on a massive scale, interacting in a coordinated manner by integrating text, images, videos, and audio in hypermedia contexts that personify the information experience, thanks to recommendation systems based on predictive models [11].

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Integrating Generative AI in teaching and learning in Higher Education: a framework for university teachers

Elisabetta Nicchia[1[0009-0009-8196-4808]], Myrna Pario[1[0009-0004-0375-530X]] and Davide Parmigiani[1[0000-0003-0985-3862]]

[1] University of Genoa

elisabetta.nicchia@edu.unige.it
myrna.pario@edu.unige.it
davide.parmigiani@unige.it

1 Introduction

The quick diffusion of Generative Artificial Intelligence (GAI) tools is reshaping teaching and learning at higher education level, offering both valuable and critical educational opportunities that need a deep reflection [1], [2], [3]. As highlighted by the European Commission, the adoption of AI in education entails implications related to transparency, fairness, data governance, and the preservation of human agency; dimensions that call for awareness rather than mere technical familiarity[4]. International institutions have accordingly issued guidelines for a deliberate, competence-based integration of AI, with particular attention to teacher preparation[5], [6]. It is within this still-evolving landscape that the present study situates itself, offering a contribution to the ongoing conversation about how university teachers might be supported in developing a pedagogically grounded approach to GAI.

2 The framework

This study adopts a theoretical-conceptual methodology. Drawing on the literature on GAI in education, relevant international policy documents, and research on faculty development in higher education, the authors developed a conceptual framework mapping the educational functions of GAI within university teaching and learning processes. The framework was constructed through a multidimensional analysis of how GAI tools operate and the pedagogical purposes they may serve, and deliberately incorporates a dual perspective, accounting both for the standpoint of the student (as a learner interacting with GAI-enhanced environments) and the standpoint of the teacher (as a designer and facilitator of learning experiences). As shown in Figure 1, the proposed framework configures GAI as an interconnected ecosystem of educational affordances articulated around three fundamental points represented by the vertices of the triangle. *GAI for study* includes functions that mediate cognitive processes directly tied to learning, with GAI acting as a cognitive mediator that facilitates access to information and supports content elaboration [7]. *GAI for personalization* addresses the capacity of AI-driven

systems to adapt learning pathways to individual students' needs, prior knowledge, and linguistic competences[8], [9]. *GAI for assessment* covers tools oriented towards the monitoring and regulation of learning, including systems that support self-regulation and provide timely feedback to both students and teachers[10], [11].

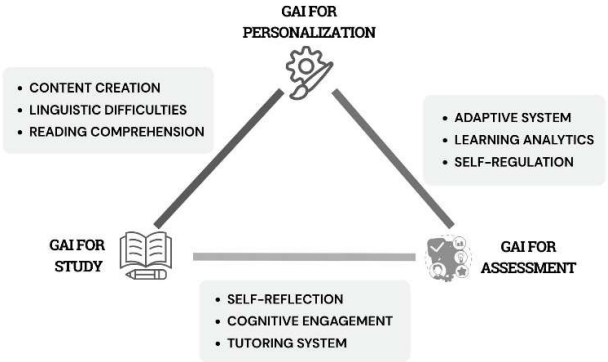

Fig. 1. A framework for university teacher: integration of GAI in teaching and learning in HE

A distinctive feature of the framework is represented by the intersections among the vertices, which capture inherently hybrid functions: content creation and comprehension scaffolding (between Study and Personalization); Intelligent Tutoring Systems and engagement (between Study and Assessment); and adaptive systems and learning analytics (between Personalization and Assessment). To support its practical application, nine classroom activities have been designed, each mapped onto a specific pole and following a shared four-phase structure of preparation, generation, interaction, and discussion.

3 Future Directions

This study proposes a conceptual framework for the integration of GAI in higher education, with a specific focus on teacher training. By mapping the educational functions of GAI across three interconnected dimensions, the framework offers teachers a conceptual tool for making deliberate, pedagogically informed decisions about if, when, and how to incorporate GAI into their teaching practice. The dual perspective embedded in the model, which considers both student and teacher agency, positions it as a resource not only for individual instructional design but also for institutional faculty development programmes. To validate the proposed framework empirically, a complementary pre-test/intervention/post-test design is being developed for the 2027-2028 a.y., involving university teachers across different disciplinary areas at the University of Genova. Data will be collected through a combination of quantitative and qualitative tools administered to both teachers and students. The intervention will take place in four phases (plenary training, discipline-specific design sessions, individual coaching, and classroom implementation) to measure effects on both teaching practice and student learning outcomes.

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AI Assisted Learning in Higher Education: A Thematic Analysis of User Experiences with generative AI tools

Mouna Mazzi[1], Mohammed Hassainate[2] and Mohammed Elmeski[2]

[1] Ibn Tofail University, Kenitra, Morocco
[2] Mohammed V University, Rabat, Morocco
mazzi.mouna@gmail.com, hassainate@gmail.com,
elmeskimohammed@gmail.com

1 Theoretical Background

While prior research has tried to explain the technology use using the Technology Acceptance Model (TAM) [1,2], this latter often overlooks some critical dimensions that should be taken into consideration when trying to comprehend the human-AI interaction such as academic integrity and cognitive impact resulting from the use of AI and trust in AI tools.

Trust is a concept that is intertwined with human-computer interaction. It was found that it has an effect on intention to use technology [3-5]. In this specific context that lacks the typical human interaction, trust becomes a crucial factor explaining the use or the adoption of a certain technology [6]. Furthermore, academic integrity is integrated into this research in order to assess the responsible use of AI tools among students. As Holmes et al. [7] and Mustofa et al. [8] stated, there are increasing ethical concerns in relation to transparency and accountability when it comes to the use of AI in education. The concept of academic integrity is often related to plagiarism and academic dishonesty [9] or any academic misconduct, such as contract cheating or digital misconduct facilitated by AI tools [10].

Another key concept is the perception of the cognitive impact. This latter refers to how generative AI affects how humans think, learn and make decisions. Many authors are questioning the impact of generative AI tools on critical thinking [11, 12, 13], yet the findings remain divergent. If it is used to bypass thinking, then it might lead to reduced thinking. Nevertheless, some authors [13] argued it might still benefit students' critical thinking, provided that the students engage with it in a specific way.

In alignment with recent growing body of literature, this research contributes to the conversation and takes a complementary approach by adopting an inductive-deductive approach, to address the limited application of hybrid qualitative analysis.

2 Methodology

The topics explored in the interviews were selected following a comprehensive literature review, according to the methodology presented in [14]. The data was collected via focus groups and semi-structured interviews with higher education students of two

universities (Mohammed V University and Ibn Tofail University). The authors have opted for both methods for comparison purposes: individual versus group perceptions. The sample size approach adopted aligns with recommendations in qualitative research literature [15]. A total thirty-two semi-structured interviews were conducted with students from two Moroccan public universities. Data saturation was reached at approximately the 25th interview. Additional interviews were conducted to confirm the stability of the identified themes. The data were analyzed using deductive-inductive thematic analysis to describe reported themes and to generate new interpretations and themes beyond those identified during the comprehensive literature phase. The thematic analysis was conducted systematically, based on iterative coding, grouping data into themes and interpreting patterns.

3 Findings and contribution

This study resulted in findings that not only corroborate themes reported in the existing literature [3,5-9,11,13] but also uncover additional perspectives that were not captured by theory alone. The analysis identified six main themes that shape the student's perception and use of generative AI tools, namely perceived usefulness, perceived ease of use, intention to use AI tools, trust in AI, academic integrity, cognitive impact (medium and long term impact on learning) with eight associated sub-themes including user experience and accessibility, peer influence and external pressure, sources of trust (experience based or technology based trust) and levels of trust, academic fairness and ethics and the morality.

In addition, the thematic analysis has shed light on the interactions that influence students' decisions as well as the nature of their interactions with AI. Indeed, the analysis revealed four recurring relationships that help explain patterns of AI tools among students, namely the time-effort relationship, the relationship between level of trust and user experience, the relationship between level of trust in AI tools and technological optimism, and the relationship between academic pressure and level of trust.

Furthermore, other dimensions emerged from the analysis, such as the perception of plagiarism in the AI context, fear of technological obsolescence, digital portability (access across any device, because it is web-based or lightweight), and the sense of unfairness toward evaluators who do not know how or cannot distinguish between students who have used AI and those who have used their own ideas and knowledge.

The study is situated within one region of Morocco which may limit the generalisability of the findings across the country's twelve regions. Nevertheless, it provides valuabe insight into the students' perception and use of AI tools, which could be useful for further research in other regional contexts.

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Developing Critical and Strategic AI Competencies: A Framework for Teacher Competence in GenAI-Integrated Education

Francesco Facciorusso[1[0009-0003-7563-5182]], Marilena di Padova[2[0000-0002-2105-7095]] and Anna Dipace[2[0000-0001-9826-073X]]

[1] Department of Education, Cultural Heritage and Tourism, University of Macerata, Italy
[2] Faculty of Humanities, Education and Sports, Pegaso Telematic University, Naples, Italy
f.facciorusso@unimc.it

1 A New Role for Teachers

Teacher professional competence in the era of Generative AI (GenAI) requires a substantial reconceptualization. Recent literature suggests that the central educational challenge is especially preparing teachers to decide when, why, and how AI should, or should not be integrated into teaching and learning processes [1, 2]. This shift reflects a broader transformation in the role of the teacher, who is increasingly called upon to exercise critical judgment, mediation, and pedagogical orchestration in technology-rich environments [3]. Starting from a critical review of existing AI literacy frameworks [4, 5], this paper investigates the competences that enable teachers to act as informed pedagogical decision-makers in AI-mediated educational contexts. This position is consistent with the UNESCO AI Competency Framework for Teachers [2], which identifies AI Pedagogy, Human-Centred Mindset, and Human Agency as foundational dimensions of teacher professionalism, and reinforces the teacher's role as the primary decision-maker in interactions between students, teachers and AI.

2 A Step Toward Critical Literacy in Educational AI

The analysis highlights a significant gap in current conceptualisations, rooted in a tension that the literature is slowly documenting with increasing urgency. While on the one hand GenAI undoubtedly offers great educational opportunities, including personalisation [6], instructional design support, adaptive feedback [7], and inclusion [8], on the other hand the literature increasingly documents critical risks such as hallucinations [9], algorithmic bias [10], overreliance [11], cognitive offloading [12]. The critical challenge shifts from mere technological access to the cultivation of competencies for pedagogically sound and ethically responsible integration [2, 13].
Existing AI literacy frameworks tend to privilege technical skills or declarative knowledge about AI systems [4, 5], falling short of addressing the more complex dimensions of teacher professionalism highlighted by recent scholarship [3, 14]. According to the AI-TPACK model, a clear conceptualisation is lacking of the competences

that allow teachers to decide when AI is appropriate, how to guide students in critically evaluating AI-generated outputs, and how to select tools according to objectives, disciplinary demands, and contextual constraints [15]. This study addresses this gap by introducing a critical framework (Table 1). The first three dimensions concern the individual teacher's critical engagement with AI outputs: Verification [9]; Explanation [16]; and Reflection [17]. The remaining two dimensions extend this critical stance into the ethical and pedagogical domain: Ethical Awareness [10, 13]; and Pedagogical AI Orchestration. This final dimension extends current conceptions of AI literacy [4, 5] by introducing the notion of informed pedagogical decision-making as a core teacher competence [3, 14].

Table 1. The Critical Framework.

Dimension	Definition	Example
Verification	The capacity to critically assess the accuracy, reliability, and provenance of AI-generated content [9].	The teacher cross-checks AI-generated facts before using them in class.
Explanation	The ability to require and provide argumentation, justification, and conceptual understanding behind AI outputs [16].	The teacher asks students to explain why an AI-generated answer is correct or incorrect.
Reflection	The fostering of metacognitive awareness and epistemic autonomy in relation to AI use [17].	The teacher includes structured reflection prompts evaluate how AI assistance shaped their thinking process.
Ethical Awareness	Sensitivity to issues of bias, privacy, copyright, and accountability in the use of AI systems in educational settings [10, 13]	The teacher discusses with students potential biases in an AI-generated example.
Pedagogical AI Orchestration	The capacity to select, adapt, or deliberately exclude AI tools based on learning objectives, student characteristics, disciplinary demands, and educational context	The teacher decides not to use an AI writing tool for a creative-writing assessment aimed at developing students' voice.

3 Conclusion

By bridging theory and practice, this framework provides a critical foundation for teacher professional development [18]. Its architecture offers benchmarks for the design of pre-service and in-service training programs, ultimately fostering the critical judgment and pedagogical agency educators need to navigate Ai Era.

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Habitual Generative AI Use and Academic Writing Profiles: An NLP and Machine Learning Analysis

Pietro Squeri[1,2][0009-0006-8241-2704], Riccardo Pecori[3][0000-0002-5948-5845], Agostino Marengo[2][0000-0003-2769-5642], Lerina Aversano[2][0000-0003-2436-6835]

[1] CHIMOMO Dept., University of Modena and Reggio Emilia, Modena, Italy
[2] DAPHNE, University of Foggia, Foggia, Italy
[3] DiSTA, eCampus University, Novedrate (CO), Italy
pietro.squeri@studenti.unimore.it, riccardo.pecori@uniecampus.it, agostino.marengo@unifg.it, lerina.aversano@unifg.it

1 Introduction

The widespread adoption of conversational Generative Artificial Intelligence (GenAI) systems is transforming students' learning practices, the way they solve problems and interact with knowledge [1]. Recent studies have raised concerns regarding cognitive offloading, whereby individuals delegate cognitive tasks to external systems, potentially reducing engagement in higher-order cognitive processes and accumulating forms of "cognitive debt" over time [2,3]. Earlier perspectives on the cognitive effects of technology distinguish between effects with technology and effects of technology, highlighting the possibility that interaction with technological tools may have consequences extending beyond their immediate use [4]. While growing evidence suggests that GenAI can influence writing processes and cognitive effort, existing research has primarily focused on the direct effects of AI use on writing performance [5,6]. Comparatively, little attention has been devoted to understanding whether repeated exposure to conversational AI systems is associated with persistent differences in students' independent academic writing when AI assistance is unavailable. This study investigates whether students with different levels of GenAI use exhibit distinguishable academic writing profiles even when writing without AI assistance. The hypothesis is that students with prolonged interaction with conversational GenAI may be progressively influenced in how they organize and externalize their reasoning.

In particular, students may internalize interaction patterns employed with AI systems leading to more standardized communication styles and highly structured forms of written discourse, characterized by greater explicitness of reasoning, more hierarchical organization of content, reduced stylistic variability and recurrent discourse patterns.

2 Materials and Methods

Participants will be students from different disciplinary areas, providing a heterogeneous dataset while accounting for disciplinary differences in writing conventions.

Participants will be asked to write a short argumentative essay (500–700 words) on a computer under controlled conditions and without access to GenAI tools. The essay will address a general contemporary issue requiring no specific disciplinary knowledge. Participants will develop their ideas, provide supporting arguments, and discuss alternative perspectives without prescribed text organization. This task was selected to induce natural writing and spontaneous reasoning while minimizing the influence of domain-specific expertise. Participants will also complete a questionnaire characterizing habitual GenAI interaction through frequency, duration, usage scenarios, and activities including information seeking, idea generation, text generation, revision, summarization, problem solving, and argument development. Trust in AI-generated outputs, perceived dependence, and verification practices will also be considered. GenAI use profiles will combine frequency of use with the purposes and forms of interaction with GenAI. The resulting corpus of texts will be analyzed using Natural Language Processing techniques capturing multiple dimensions of academic writing. In particular, features related to linguistic complexity, discourse organization, and argumentative quality will be extracted, including measures of lexical diversity (Measure of Textual Lexical Diversity, MTLD), syntactic complexity (sentence length and dependency distance), textual cohesion (lexical overlap and discourse connectives), and argumentative structure (claims, supporting evidence, and counterarguments).

Particular attention will be devoted to indicators of textual standardization and recurrent discourse patterns that may show similarities with communication styles commonly observed in AI-generated texts. ML techniques will also be employed to identify patterns that may not be detectable through traditional approaches. Unsupervised methods, such as clustering and dimensionality reduction, will be used to explore latent structures within the text datasets and identify potential writing profiles. Supervised models will be used to investigate whether different GenAI use profiles can be predicted from linguistic, stylistic, and discourse-related features extracted from students' text.

3 Conclusions

The proposed research does not assume that GenAI has either positive or negative effects on students' writing but seeks to provide empirical evidence regarding usual interaction with GenAI systems and its possible association with measurable differences in independent academic writing.

By shifting attention from AI-generated texts to the writing characteristics of AI users, this research may contribute to understanding whether long-term interaction with GenAI is associated with a change in linguistic, stylistic, and discourse-related patterns observable in authentic academic writing, providing evidence for the development of evidence-based educational policies and assessment practices in AI-rich learning environments.

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Artificial Intelligence and Online Training: Trainers' Perceptions within a National Training Network

Serena Gianfaldoni[1][0009-0003-0902-405X], Michele Lanzetta [2][0000-0002-1803-5717] and Pietro Balestri[3][0009-0009-0572-2946]

[1] eCampus University; University of Florence; Coordinator of Laboratorio Link – serena.gianfaldoni@uniecampus.it
[2] CAFRE – Interdepartmental Centre for Continuing Education, Training and Educational Research, University of Pisa - lanzetta@unipi.it
[3] Laboratorio Link, CAFRE, University of Pisa - balestripietro@gmail.com

1 Introduction and Research objectives

Generative Artificial Intelligence is reshaping knowledge production, organisation and transmission, with growing effects on vocational, continuing and digitally mediated education. Existing research has largely focused on higher education institutions and students, while empirical evidence concerning professional trainers remains limited [1–6]. This study explores how experienced trainers use AI and interpret its cognitive, ethical and relational implications. Established in 2016, AssOAFoP connects 61 accredited training organisations and employment agencies operating across regions and in national and European initiatives. Its members deliver approximately 500–600 courses and serve around 7,500 participants annually. The network was selected because it links training providers, universities, institutions and labour-market actors, building also on previous collaboration with CAFRE–University of Pisa. This study examines AI diffusion, frequency and contexts of use, favourable and critical perceptions, and the value attributed to human mediation.

2 Research Design, Findings and Educational Implications

2.1 Research questions and methodology

This study addressed three main research questions: (RQ1) how, how frequently and in which contexts trainers use AI; (RQ2) how they evaluate its benefits and cognitive, ethical and relational risks; and (RQ3) how trainers perceive AI's effects on learner autonomy, educator–learner interaction and their mediating role. These dimensions were operationalised through items on adoption, frequency, applications, opportunities, risks and educational relationships.

An original 51-item questionnaire, including 47 closed or semi-closed and four open-ended questions, was distributed through Google Forms between October 2025 and March 2026. It was reviewed with AssOAFoP and pretested with approximately

ten external participants; no formal psychometric validation was conducted. Of 130 invited trainers, 91 provided valid responses (70.0%). Identifying fields were excluded. Closed responses were analysed using frequencies, percentages, means and standard deviations; open responses were examined qualitatively to identify themes, motivations and experiences. Of respondents reporting professional experience, 64.6% had worked in training for over ten years.

2.2 Main findings

AI use is widespread within the sample: 96.7% have experimented with it, 80.2% use it for work or training and 57.1% for personal purposes. Professional use is mainly occasional (60.4%), while 18.7% report weekly use and 11.0% daily use; 70.3% describe their initial approach as immediately enthusiastic. Applications mainly concern information retrieval, teaching materials, presentations, synthesis, examples, training design, translation and content personalisation.

Attitudes are favourable but ambivalent. Mean enthusiasm is 7.05/10 (SD = 1.66) and perceived support for trainers 6.95/10 (SD = 1.66). AI's potential is considered greater than its criticalities by 44.0%; 44.0% regard them as balanced and 12.1% emphasise criticalities.

The principal concern is cognitive delegation: 94.5% perceive some risk of mental laziness and excessive delegation, 91.2% dependence, 90.1% reduced critical capacities and 85.7% weaker contextualisation. Open responses associate benefits with speed, information access, content preparation, synthesis, personalisation and productivity; concerns focus on over-reliance, weakened autonomy, misinformation and bias, privacy, learner responsibility and human interaction.

2.3 Interpretation, limitations and implications

The findings reveal a complex, non-polarised relationship with AI and support critical integration. Concerns about dependence and reduced autonomy align with recent research on critical thinking, over-reliance and the preservation of the human dimension in AI-supported education [7–9]. Practical AI literacy should emphasise output verification, independent judgement, privacy and educator–learner interaction. The teacher-trainer may thus be reconfigured as a critical mediator within responsible AI adoption [8, 9].

3 Conclusion

Within AssOAFoP, favourable AI adoption coexists with cognitive, ethical and relational concerns. This study supports combining experimentation, critical competence and educational relationships. Given its single-network design, future research should compare other vocational and educational networks.

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Beyond Answers: Lessons from UML Miner for Educational AI

Pasquale Ardimento[1], Mario Luca Bernardi[2], Marta Cimitile[3], and Melanie Scalera[4]

[1] University of Bari Aldo Moro, Department of Informatics, Bari, Italy
pasquale.ardimento@uniba.it
[2] Department of Engineering, University of Sannio, Benevento, Italy
bernardi@unisannio.it
[3] Department of Law and Digital Society, UnitelmaSapienza University, Rome, Italy
marta.cimitile@unitelmasapienza.it
[4] University of Guelph, Guelph, ON, Canada
mscalera@uoguelph.ca

1 Introduction

The widespread integration of Artificial Intelligence (AI) into educational settings is redefining traditional approaches to teaching, learning, and assessment. While many AI-based learning systems remain answer-centric, learning depends not only on outcomes but also on the processes through which knowledge is constructed. This paper uses the lessons learned from the design, evolution, and deployment of UML Miner, [1–6], an AI-enhanced learning environment that analyzes students' UML modeling activities to provide process-aware feedback, to reflect on the opportunities and challenges of AI-supported learning. We argue that the central challenge for educational AI is no longer answer generation, but the transformation of educational evidence into timely, personalized, and pedagogically meaningful support for learners.

2 Key Lessons for Educational AI

UML Miner is evolving from a process mining infrastructure to an AI-enhanced learning environment integrating conformance checking, Retrieval-Augmented Generation (RAG), and Large Language Models, providing valuable insights into the role of AI in education. The lessons discussed in this paper are grounded in both the development of the platform and its evaluation with 94 undergraduate students [6].

One key lesson concerns the value of learner behavior as a source of educational evidence. Since its earliest version, UML Miner has been designed to capture and analyze students' modeling activities through event logs, process mining, and conformance checking techniques [1]. Throughout the development and evaluation of the platform, we observed that modeling actions, task sequences, revisions, and deviations from reference processes often reveal

misconceptions and learning difficulties that are not explicitly expressed by students. This suggests that educational AI systems should not rely exclusively on learners' requests, but should also interpret their activities and interaction patterns.

A second lesson involves the generation of feedback. Our experience showed that meaningful educational support emerges when generative AI is grounded in contextual and process-related evidence. The evolution of UML Miner progressively enriched feedback generation by combining behavioral traces, conformance checking results, natural language descriptions of diagrams, task requirements, and domain-specific knowledge through RAG mechanisms [5, 3, 6, 4]. This grounding mechanism increases transparency, allows feedback to be traced back to observable learner actions, and supports more personalized interventions. More importantly, it shifts the role of AI from answer generation toward evidence-based educational support.

A third lesson concerns balancing guidance and learner autonomy. Inspired by scaffolding principles and the need to support learners within their Zone of Proximal Development, UML Miner was developed as an environment that encourages reflection and progressive improvement, rather than a system that provides solutions [2]. Furthermore, the adoption of declarative process models allows multiple valid modeling strategies to coexist while still identifying behaviors that deserve attention [6]. This experience highlighted the importance of guiding learners without constraining exploration, thereby supporting reflection, self-regulation, and active knowledge construction.

Taken together, these observations suggest a shift from answer-centric educational AI toward what we define as *Educational AI Middleware*: an intermediate layer that interprets learner activities, contextualizes educational evidence, and transforms it into pedagogically meaningful feedback. Such a perspective may help reconcile the opportunities offered by generative AI with the need to preserve reflection, autonomy, and the active role of learners in knowledge construction.

3 Rethinking Educational AI

Our experience with UML Miner suggests that the future of educational AI may have a particular emphasis on the interpretation of learning processes. AI systems should support learners through contextualized, evidence-based feedback grounded in their activities and learning trajectories. However, important challenges remain. Process-aware educational AI requires reliable mechanisms for interpreting learner behavior, validating the pedagogical quality of AI-generated feedback, and preserving learner autonomy. Furthermore, the collection and analysis of behavioral traces raise concerns related to privacy, transparency, and trust. Although these reflections originate from UML modeling, the underlying principles may extend to other educational domains. Future research should investigate how process-aware AI architectures can be generalized and evaluate their impact on learner autonomy, self-regulation, and engagement.

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Beyond Programming: Human-Centered Design in Educational AI Software*

Nicolas Bioul[1,2][0009−0008−0324−7582], Serena Auriemma[4][0009−0006−6846−5826], He Jiang[6], Giustino Claudio Miglionico[5][0009−0003−0093−4735], Thomas Baldassarre[3,1][0009−0004−1459−7466], Corentin Warzée[1,2], Benoit Macq[1,2][0000−0002−7243−4778], and Jean-François Rees[2][0000−0002−8171−6689]

[1] TRAIL Institute, Belgium
[2] Faculty of Sciences and OpenHub, UCLouvain, Louvain-la-Neuve, Belgium
nicolas.bioul@uclouvain.be
corentin.warzee@uclouvain.be
benoit.macq@uclouvain.be
jf.rees@uclouvain.be
[3] Faculty of Engineering, University of Mons, Mons, Belgium
Thomas.BALDASSARRE@umons.ac.be
[4] Department of Philology, Literature and Linguistics, University of Pisa, Pisa, Italy
serena.auriemma@phd.unipi.it
[5] Department of Information Engineering, University of Pisa, Pisa, Italy
giustino.miglionico@phd.unipi.it
[6] Institute of Education and Humanities, University of Wales Trinity Saint David, Swansea, United Kingdom
2217647@student.UWTSD.ac.uk

Generative artificial intelligence (GenAI) is increasingly embedded in higher-education study practices, but many systems still optimize answer generation rather than pedagogical integrity, learner agency, or auditable governance. GenAI can shape source evaluation, effort regulation, and disciplinary knowledge while creating risks related to misinformation, privacy, bias, cognitive offloading, and dependency [1–3]. We examine how ethical and regulatory principles can become design requirements rather than an ex post compliance layer. Three questions guide the study: *RQ1*: How do academic stakeholders position key ethical dimensions as risks or benefits and as individual or community concerns? *RQ2*: How can these judgments become system-design requirements? *RQ3*: Where do AI-generated personas converge with, or diverge from, human ethical judgments?

We apply the framework to RAGAETON, a learning companion that converts teacher-provided materials into a retrieval layer and teacher-validated knowledge graph. Learners receive source-linked explanations and concept-based activities, while educators validate concepts, relations, and assessment heuristics. Its governance-relevant properties are approved source grounding, traceable provenance, educator oversight, and user-controllable adaptation. To operationalize ethical reflection, we adapted the AI Dilemma Card [4] into five dimensions relevant to educational software: *Data*, *Bias*, *Quality*, *Efficiency/Deskilling*, and *Sustainability*. The resulting framework combines human-centered design with the risk-based logic of European AI governance [5].

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The exploratory qualitative study combined development-team focus groups, pretotyping [6], and semi-structured interviews. The twenty participants were professors or PhD researchers, most of whom were purposively recruited from an AI summer school held at the University of Pisa and King's College London. We also included some professors who were unfamiliar with AI or who self-identified as having no prior AI experience, to help assess the adoption curve and consider perspectives from a range of fields of study. Selection required higher-education experience and informed engagement with AI development, use, or ethics. Interviews were recorded, anonymized, and transcribed. Responses were coded by sentiment, risk-versus-benefit framing, individual-versus-community concern, and stated design implication.

To examine synthetic-user methods, the team manually specified ten personas using demographic, educational, motivational, and technology-use attributes. ChatGPT answered the same questions from each profile's perspective. The outputs were not counted as participants; they were analyzed with the same coding scheme and compared with human data for convergence and divergence in thematic positioning and rationale specificity.

The human data reveal a coherent but differentiated ethical map. All twenty participants framed personal-data governance and privacy as risks, especially where personalization could expose learning difficulties, study rhythms, or neurodivergent profiles. Many of the twenty framed efficiency as an individual benefit, valuing structure and time savings while still noting possible deskilling. Many of the twenty treated quality as a community benefit when outputs are grounded in educator-approved sources and remain inspectable. Bias was predominantly understood as a risk, including fixed learner profiling and the privileging of highly visible sources, but participants differed on whether its main impact was individual or collective. Sustainability was consistently located at community level, although its salience varied relative to anticipated educational benefits. These judgments produced actionable requirements: data minimization and opt-in disclosure for sensitive attributes; deletion and export controls; teacher validation; source-level traceability; user-controlled adaptation; source diversity; and transparent consideration of computational cost.

The ten AI personas reproduced the high-consensus patterns on privacy, efficiency, and sustainability. However, they diverged on the more contested dimensions of Bias and Quality and tended to offer generic, stereotyped, or narrowly individualized justifications rather than situated accounts. Synthetic personas may therefore support early ethical horizon scanning and hypothesis generation, but they should not be treated as evidence of stakeholder validation. Human participation remains necessary when evaluation depends on lived experience, uncertainty, affect, and institutional context.

The contribution is an operational workflow linking stakeholder reasoning, ethical analysis, regulatory risk logic, and system architecture, alongside empirical evidence for a bounded role of AI personas. Limitations are the small, professionally homogeneous sample, one early-stage system, and ten personas generated with one model. The findings are analytically rather than statistically

generalizable and require replication across institutions with students, educators, accessibility stakeholders, and less AI-specialized users. Responsible educational GenAI therefore requires recurring human validation, educator oversight, transparent provenance, and learner control throughout the design lifecycle[7, 8].

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From Live Encounters to Deep Inquiry: Deployment Insights from an AI-Augmented Remote Science Platform and Design Directions for Higher Education

Carole Salis[0009-0008-8633-8278], Jose F. Saenz-Cogollo[0000-0002-1800-2616], Stefano L. Monni[0009-0002-0641-8531], Giuliana Brunetti[0009-0004-7169-9936], Fabrizio Murgia[0009-0005-2193-9441], Paola Pinna and Laura Vargiu[0009-0003-0626-9393]

CRS4 – Centro di Ricerca, Sviluppo e Studi Superiori in Sardegna, Pula, Italy
{calis, jsaenz, stefano.monni, giuliana.brunetti, fmurgia, paola.pinna, lvargiu}@crs4.it

1 The RIALE-EU Platform

Most remote laboratory platforms reproduce isolated procedures rather than making the full scientific process — from hypothesis and experimental design through data interpretation and knowledge construction — accessible as a coherent whole. Understanding science as a process, not merely as a collection of results, is a key driver of scientific literacy and STEM motivation [1, 2]. RIALE-EU (Remote Intelligent Access to Lab Experiments in Europe; https://riale.ideab3.it) was built around this commitment [3], connecting secondary school classrooms with active research laboratories across Italy and Europe through a three-modality pedagogical architecture. Two years of deployment have produced data that illuminate both its strengths and the design directions required for its extension to higher education.

The platform structures learning across three modalities. The *Incontro in Diretta* (Live Encounter) is a synchronous session in which students interact with researchers during an ongoing experiment, questioning the scientific process in real time. The *Timeline* is a curated asynchronous resource documenting the complete experimental journey — motivation, methodology, execution, results, implications — for independent exploration. The *Data Lab* (*Laboratorio Dati*) makes real experimental datasets available for student analysis: learners visualise and interrogate data, formulate hypotheses, and draw conclusions. Where the first two modalities position students as informed observers, the Data Lab moves them into the role of active data analysts — a shift in the epistemic stance the activity affords, from receiving warranted claims to producing and justifying them, which research on practical epistemologies identifies as a condition for inquiry to change how students understand scientific knowledge [4]. It is being re-implemented after a first pilot in A.S. 2024/2025. An AI assistant, Helga, operates as a production-grade ReAct + RAG agent [5], answering with source-cited responses drawn from experiment catalogues, video transcriptions, and teaching guides. In A.S. 2024/2025 the platform served 27 active teachers across 21 schools, conducting 44 live sessions with partner institutions in Italy and across Europe.

2 Deployment Observations

Our evidence comes from the end-of-year survey of A.S. 2024/2025, the most complete dataset collected to date: 199 student responses (31% of those invited, ages 12–18) and 24 teacher responses, the latter including an open request for suggestions. The live session performs strongly: the item "the remote lab can help me orient toward STEM subjects" scored 4.00/5, the highest of the questionnaire, and over 70% of students rated both the topics addressed and their interactions with researchers 4 or 5. The Timeline was the weakest element: "the Timeline is simple enough not to require help" scored 2.96/5, the lowest item; 65% of students opened it after the live session, but no teacher used its personalisation functionality.

The teachers' open responses separate two obstacles. Four of the 24 described friction of access and navigation — the link hard to find, difficulty scrolling on mobile — and one asked for materials supporting the videos. Two others judged usability sound and placed the problem elsewhere: students "have not understood its usefulness" and "do not yet see it as a resource for studying". The first obstacle has since been addressed: during 2025 the interface was redesigned and all timelines rebuilt in a chapter-based, mobile-friendly player surfaced at the top of each experiment page. Engagement did not follow. This points to the second as the substantive one — the asynchronous content carries no task that requires it — and calls not for further simplification but for scaffolding that gives the material an epistemic purpose [6].

3 Design Directions for Higher Education

University online learning environments require scalable asynchronous modalities that carry pedagogical weight without depending on synchronised access to researchers. The depth and specificity of research-grade Timelines, which calls for contextualisation at secondary school level, aligns naturally with university-level cognitive demands — analysis, evaluation, and synthesis in Bloom's taxonomy [7]. We propose enhancing the AI scaffolding layer: a Knowledge Graph (KG) of each experiment's knowledge domain would let an agent guide students through the conceptual structure of a scientific process, surfacing connections, identifying prerequisite concepts, and adapting to demonstrated understanding [8, 9].

A first implementation has been built and validated end-to-end in our development environment on several structurally different experiments: a typed graph of concepts, methods, materials and procedural steps is extracted from catalogue and video sources by an LLM pipeline, anchored to a fixed four-stage skeleton of the scientific method, curated by a human reviewer, and served to the agent as a structured retrieval source alongside plain text. Combined with the *Data Lab*, this mirrors authentic scientific inquiry: understanding the process, then enacting it.

Faculty co-design keeps disciplinary standards embedded in the scaffolding and curriculum authority with the lecturer. We are structuring it along the phases of the ADDIE instructional design model, reusing a protocol under development with secondary school teachers: elicitation sessions in which the assistant guides the lecturer

through analysis and design of a teaching unit, producing an artefact validated against the graph. Curated KG elements carry an explicit validation status, and only validated ones reach students.

4 Conclusion

Deployment data confirm that the live session motivates learners and connects them to authentic science; building the AI scaffolding that realises the potential of the asynchronous modalities is the next research challenge, and higher education online contexts are the natural terrain on which to test it.

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Thales' Harmony: Integrating Geometry, Music and AI

Irene Massaro[0009-0007-4896-8378], Rita De Castris[0009-0009-5137-2449], Francesco Saverio Tortoriello[0000-0002-4600-6411] and Ilaria Veronesi[0000-0002-2765-5918]

University of Salerno, Salerno, Italy
imassaro@unisa.it

1 Introduction

This contribution is situated within recent research on the use of digital technologies and Artificial Intelligence in Education (AIEd) in mathematics education, with particular attention to meaning-making processes mediated by multimodal learning environments. Within a STEAM (Science, Technology, Engineering, Arts and Mathematics) perspective, the study proposes an interdisciplinary laboratory focused on Thales' Theorem, integrating geometry, music, and digital tools in order to foster students' understanding of proportionality in upper secondary education. Already known in ancient mathematics and later formalized in Euclid's Elements [1], the theorem describes proportional relationships among segments determined by a set of parallel lines intersected by two transversals. From a didactic perspective, understanding this property requires recognizing an invariant structure within variable geometric configurations, a process that often proves challenging for students. The theoretical framework of the study is grounded in Duval's [2] theory of semiotic representation registers, according to which mathematical understanding depends on the ability to coordinate different forms of representation. In the case of Thales' Theorem, students are required to connect figural configurations, numerical relationships, and symbolic formalizations. The study also draws on research concerning the construction of mathematical concepts [3-4], the role of visualization in mathematics learning [5], and the instrumental mediation provided by digital technologies [6-7]. More recently, AI has expanded opportunities for mathematical exploration by supporting questioning, argumentation, and collaborative meaning-making through dialogic interactions. Such AI-mediated discussions foster mathematical inquiry, reflection, and participatory reasoning [8]. Within this perspective, the introduction of the musical domain adds an acoustic register through which proportional relationships can be directly experienced. The relationship between mathematics and music has its roots in the Pythagorean tradition, according to which fundamental harmonic intervals correspond to simple numerical ratios between lengths or sound frequencies. Ratios such as 2:1 or 3:2, associated respectively with the octave and the fifth, make it possible to connect geometric proportionality with immediate perceptual experience. This relationship has also been revisited within a STEAM perspective through the medieval Quadrivium model, which viewed mathematics and music as interconnected disciplines [9]. Recent studies further highlight the educational potential of integrating mathematics and music [10].

2 Method

The research adopts a qualitative approach inspired by Design-Based Research and develops through the design of an interdisciplinary laboratory structured into three sessions of approximately sixty minutes each. The activities take place within the context of the Liceo Matematico [11]. The Liceo Matematico project is widespread throughout Italy in over 160 schools, and its main objective is to integrate the interdisciplinary aspects of mathematics into the Italian school curriculum. The proposed laboratory activities alternate between individual exploration and collaborative work. The classroom experimentation is planned for autumn 2026 and will involve about 30 students of upper-secondary class enrolled in the Liceo Matematico. Students use dynamic geometry environments such as GeoGebra to construct and manipulate geometric configurations related to Thales' Theorem, observing how the ratios between corresponding segments remain invariant as the figure changes. The activities are also supported by the software Polypad, used to visually represent proportions through discrete models and facilitate the transition between geometric and numerical representations. A central role in the laboratory is played by a chatbot based on Large Language Models, used as a tool for dialogic support and cognitive mediation. Recent research highlights the potential of AI-based chatbots to support students' reasoning through adaptive feedback and guided interactions [12-15]. In the proposed laboratory, the chatbot accompanies students in interpreting proportional relationships and converting between geometric, numerical, and acoustic registers, fostering AI-mediated learning processes and the shared construction of mathematical meaning. The didactic pathway progressively develops from the musical domain toward geometric formalization. In the first phase, students explore fundamental harmonic intervals through references to the Pythagorean tradition and the monochord; subsequently, they transfer these relationships to the geometric configuration of Thales' Theorem, recognizing the analogy between musical ratios and geometric proportions. In the final phase, students construct a multimodal representation of proportional relationships, a sort of "geometric score" in which geometric configurations, numerical ratios, and sound structures converge into a single meaningful representation.

3 Expected Results and Discussion

The aim of the research is to investigate how the conversion between different representation registers, geometric, numerical, and acoustic, mediated by digital tools and AI-based dialogic environments can support the understanding of Thales' Theorem. Students' productions, chatbot interaction logs, and classroom observations will be analysed to investigate the coordination and conversion of geometric, numerical, and acoustic representation registers. The expected results concern the potential of digital technologies and AI-mediated learning environments to foster more exploratory, multisensory, and interdisciplinary forms of mathematical learning, contributing to the design of innovative educational pathways for mathematics education.

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Digital ESG Learning Transformation: AI Integration and ESG Principles in the Educational Processes of an Italian SME. A Longitudinal Case Study with Mixed Methods Design

Maria Gentile[0009-0000-3652-7232] and Raffaele Di Fuccio[0000-0001-8886-3967]

Università Telematica Pegaso, National PhD Programme in Digital Transformation, Naples, Italy
maria.gentile@unipegaso.it
raffaele.difuccio@unipegaso.it

1 Context and Research Question

Artificial Intelligence is changing how higher education and vocational training are organized and delivered. Most of what we know empirically, however, comes from large institutions [1]. Small and medium-sized enterprises (SMEs) face the same transformation with fewer resources and tighter regulatory constraints, and have received far less attention.

This study follows an Italian SME accredited for online and blended higher education and vocational training through two transformation cycles: a first wave of process digitalization (2021–2023, built around Salesforce) and a second wave driven by AI (2024–2026, built around Zoho One, with generative AI, conversational agents and learning analytics). We ask how the progressive integration of digital and AI-based technologies, aligned with ESG principles, reshapes organizational processes, educational services and user experience in a context of this kind.

We read the case through the lens of Digital ESG Learning Transformation [2], which connects digital innovation to environmental, social and governance principles. Rather than trying to monitor the whole ESG spectrum at once, this phase of the study concentrates on three dimensions: accessibility, quality of services as users perceive it, and responsible data management.

2 Research Design and Methods

The research is a longitudinal single-case study [3] with a mixed methods exploratory-sequential design [4]. The qualitative strand leads: interviews and observation generate the interpretive categories, which we then examine against survey data and operational indicators. The NRRP doctoral programme funding this work (Ministerial Decree 117/2023, Investment 3.3) places the candidate inside the partner organization; the first author works there daily, and the qualitative strand therefore takes the form of insider action research [5].

The company was chosen as an information-rich case. It is a medium-sized Italian SME, regionally accredited for vocational training, with an Organization and Management Model under Legislative Decree 231/2001 and an explicit ESG orientation. We operationalize the construct along three axes: process digitalization, AI integration in organizational and educational flows, and ESG outcomes.

Data come from four sources, triangulated [6]: two waves of semi-structured interviews (t1, 2024; t2, 2026) with leadership, functional managers, teachers and learners (18–24 informants, plus two or three external interlocutors at the Institut De Certification Méditerranéen in Tunis); a structured online questionnaire to learners; document analysis [7]; and participant observation during the six-month in-company residency (February–August 2026), recorded in a reflexive field diary [8].

Interviews are analysed with reflexive thematic analysis [9], starting from a coding grid built on the three axes. Quantitative data are processed in jamovi [10] and brought together with the qualitative findings in joint displays [11]. Trustworthiness follows the criteria of Lincoln and Guba [12], as adapted by Nowell et al. [13]. The protocol has been approved by the Ethics Committee of Università Telematica Pegaso.

3 Preliminary Findings and Expected Contribution

What does the material collected so far tell us? A first reflexive pass through the t2 interviews, field notes and observation memos suggests three preliminary themes. Participants describe the second cycle less as a change of software than as a reorganization of processes, data flows and responsibilities around a single ecosystem: a move from fragmented digital tools to integrated process governance. AI, in their accounts, augments rather than replaces. Generative tools help produce content, support tutoring and absorb repetitive tasks, while educational and organizational responsibility stays firmly with people. Finally, digital transformation works as an ESG-enabling infrastructure, with tangible effects on accessibility, traceability, paperless procedures and transparency.

Preliminary aggregated indicators, reported as aggregate ranges agreed with the partner organization, point in the same direction. Software and licensing costs fell by more than 50% after the migration to the new ecosystem. Average administrative processing time dropped by roughly one third. The efficiency of AI-supported e-learning content production rose by around 40%.

Three contributions follow. The study offers an empirically grounded account of AI-driven transformation in an educational SME, a setting the literature has largely overlooked; it translates the Digital ESG Learning Transformation construct into analytical dimensions that other studies can reuse; and it sketches an operational model that other training SMEs can adapt, in line with NRRP objectives. The full paper for the post-proceedings will present the completed t2 analysis and the quantitative comparison between the two cycles.

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Artificial Intelligence and Student Engagement in Online Higher Education: Opportunities, Challenges, and Pedagogical Implications

Irene Mauro[0000-0002-8170-7651]

eCampus Università, Novedrate (CO), Italy
irene.mauro@uniecampus.it

1 Framework

The rapid integration of artificial intelligence (AI) into online higher education is reshaping teaching and learning practices, creating new opportunities while raising important questions about student engagement in digital learning environments [1]. AI-powered technologies—including chatbots, adaptive learning systems, intelligent tutoring systems, automated feedback mechanisms, learning analytics, and generative AI applications—are increasingly being adopted to enhance interaction, personalize learning experiences, and support students' self-regulated learning processes.

Despite their growing presence in higher education, the ways in which AI technologies influence student engagement remain insufficiently understood [2]. This study therefore examines the relationship between AI-supported learning environments and student engagement in online higher education. Drawing on the Community of Inquiry framework [3] and theories of Self-Regulated Learning [4], the review explores how AI-enhanced educational practices may influence behavioral, cognitive, emotional, and social dimensions of engagement.

Particular attention is given to the potential of AI to foster active participation, meaningful interaction, learner autonomy, and personalized learning pathways, while also considering potential risks related to overreliance on automation, reduced human connection, and the changing role of educators. The study aims to synthesize the available evidence and identify the pedagogical conditions under which AI can support more engaging, inclusive, and human-centered online learning experiences.

2 Methodology

The study adopted a scoping review methodology based on the framework proposed by Arksey and O'Malley [5], further developed by Levac et al. [6] and subsequent methodological recommendations for evidence mapping. This approach was selected to explore the breadth and nature of the literature concerning the use of artificial intelligence in online higher education and its relationship with student engagement.

The review considered approximately 180 potentially relevant records identified through searches of major scientific databases. Following the removal of duplicates and the screening of titles and abstracts, approximately 65 studies were selected for full-

text assessment. The final synthesis included 32 studies considered relevant to the objectives of the review.

Studies were included when they: (a) focused on artificial intelligence or AI-supported technologies; (b) addressed higher education in online, blended, or digitally mediated learning environments; (c) examined student engagement, participation, interaction, self-regulated learning, personalization, or teacher–student relationships; and (d) discussed educational or pedagogical implications associated with AI implementation.

Studies were excluded when they focused exclusively on technical or computational aspects of AI without educational implications, referred to educational contexts outside higher education, or examined AI applications without considering their relationship with teaching, learning, or the student experience.

The selected studies were mapped according to the type of AI technology examined, the educational context, the dimensions of engagement considered, and the reported pedagogical opportunities and challenges. This process enabled the identification of recurring patterns and research gaps concerning the role of AI in supporting student engagement in online learning environments.

3 Findings and Conclusions

The synthesis suggests that AI can positively support student engagement when it is integrated within student-centered pedagogical approaches that promote interaction, timely feedback, active participation, and learner support. The studies included in the review mainly addressed adaptive learning systems, intelligent tutoring systems, learning analytics, automated feedback, chatbots, and generative AI applications.

Four main areas emerged from the analysis. First, AI-supported personalization can facilitate learning pathways adapted to students' individual needs and rhythms. Second, automated and adaptive feedback may support continuous participation and self-regulated learning. Third, learning analytics and intelligent systems can help identify learning difficulties and provide more timely educational support. Finally, AI-based tools may create additional opportunities for interaction and access to learning resources.

However, the review also highlights several challenges. The positive effects of AI are not automatic and depend on the pedagogical design of learning environments and the role assigned to educators. An excessive reliance on automated interactions may reduce opportunities for meaningful teacher–student relationships and weaken students' sense of belonging and social presence. Concerns also emerge regarding the responsible and pedagogically appropriate use of AI within higher education.

Overall, the findings indicate that AI should be understood as a resource capable of supporting, rather than replacing, educational relationships. Its contribution to student engagement depends on its integration within intentional pedagogical designs that preserve interaction, human support, and meaningful participation.

The study therefore contributes to the discussion on AI in online higher education by identifying both its potential and its limitations. Future research should further

investigate the long-term effects of AI-supported learning on the different dimensions of student engagement and explore how technological innovation can be integrated with educational practices that maintain the relational and social dimensions of learning.

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Use of Generative AI in Italian Higher Education Data Journalism and Data Visualization Projects: A Multi-Institutional Comparative Study

Andrea Nelson Mauro[1], Giovanni Fulantelli[1] [0000-0002-4098-8311], Davide Taibi[1] [0000-0002-0785-6771]

[1] National Research Council, Institute for Educational Technologies, Palermo, Italy
andrea.nelson.mauro@gmail.com, giovanni.fulantelli@cnr.it, davide.taibi@cnr.it

1 Introduction

Data journalism is increasingly understood as a hybrid journalistic practice that combines data analysis, computational methods, and narrative transparency. Within this framework, methodological disclosure is not considered a supplementary element, but an integral part of the reporting process [1]. The documentation of data sources, analytical procedures, visualization choices, and digital tools therefore becomes central to the credibility and reproducibility of journalistic work. This context is particularly relevant for examining how GenAI tools are incorporated into student final projects, and whether and how such use is explicitly declared [2]. Because transparency and traceability are already embedded within the epistemic culture of data journalism, this context offers a particularly relevant setting for investigating emerging practices of GenAI disclosure in HE. Recent literature frames AI disclosure not merely as a compliance requirement, but as part of broader academic responsibilities concerning authorship, methodological transparency, and epistemic accountability [3-6]. Evidence also suggests that institutional expectations, disciplinary cultures, and assessment practices influence whether students disclose AI assistance in their work [2,7].

A prior study [8] focused on Italian data journalism courses in the 2023–24 academic year found that only 13.0% of student projects contained explicit AI tool declarations, suggesting that the vast majority of any AI usage was not documented. Whether this reflected low actual adoption, lack of awareness of disclosure norms, or deliberate omission could not be determined from that data alone.

The present contribution extends this earlier work by applying the same extraction methodology to a substantially larger corpus collected during the 2025–2026 academic year across three Italian HE institutions with distinct disciplinary contexts. The study explores whether the transparency rate observed in 2024 represented an initial transitional phase toward a new norm of declared AI use in HE student projects.

2 Declared AI Use in Italian HE: 3 Institutional Cases

The corpus analysed consists of 193 student final projects in data journalism or data visualisation (*pdf* files) drawn from three institutions:

- Università degli Studi della Repubblica di San Marino (UNIRSM): an undergraduate Digital Communication programme, 17 projects from the 2025–2026 academic year.
- Università degli Studi di Milano (UniMI): a Sociology undergraduate programme with a data journalism component, 17 projects from the 2025–2026 academic year.
- Università degli Studi di Milano-Bicocca (UNIMIB): a Data Science postgraduate programme, 159 projects across three examination sessions (Jan, Feb, and Jun 2026).

Documents were processed for full-text extraction and searched for 24 AI-related keywords, with false positives removed before classification. Matches were classified as explicit methodological declarations (A), references to AI as research subject (B), or indeterminate cases (C). Only type A instances were included in the transparency rate. Results indicate that 132 out of 193 projects (68.4%) contained explicit AI tool declarations, a fivefold increase compared to the 13.0% rate observed in the 2024 baseline [8]. Transparency rates varied substantially by institution: 100% at UNIRSM (17/17), 67.3% at UNIMIB (107/159), and 47.1% at UniMI (8/17). These differences should be interpreted cautiously, given the unequal size of the three institutional samples and the different disciplinary and educational contexts represented in the corpus; they are therefore treated here as descriptive patterns rather than as evidence of statistically comparable institutional effects. The declared tool landscape has diversified well beyond ChatGPT: Gemini, Claude, Copilot, Grok, Perplexity, Julius AI, and Mistral AI all appear in the corpus. Claude is the only tool present across all three institutions.

Multi-tool usage emerges as a new structural pattern not observable in the 2024 baseline: 73% of UNIMIB students who declared AI used two or more distinct tools in the same project; at UNIRSM the figure is 41%. Declared uses are predominantly technical (code generation, data processing, and visualisation support), with limited evidence of content generation across any of the three institutions. At UNIRSM, a subset of students not only declared tool use but explicitly documented cases where AI outputs were inadequate, and conducted comparative evaluations of competing tools against the same task criterion.

3 Conclusions

The principal finding of this study is not simply the increase in declared AI use, but the emergence of disclosure itself as a pedagogically mediated practice within HE project work. In the specific context of data journalism, such transparency also has a professional and ethical dimension, as documenting AI-supported analytical processes can contribute to methodological accountability, traceability, and ultimately the trustworthiness of data-driven journalistic practices. Compared to the 2024 baseline, explicit references to GenAI tools are increasingly integrated into the methodological documentation of student projects.

The strong variation across institutions suggests that transparency practices are shaped less by the availability of AI tools than by pedagogical cultures, assessment formats, and expectations concerning methodological accountability. The 100% transparency rate observed at UNIRSM, where projects are developed within a structured laboratory format requiring explicit methodological documentation, contrasts with the lower rates observed in less standardised project contexts such as UniMI. While these differences cannot be attributed to pedagogical design alone, they suggest that institutional expectations and assessment formats may play an important role in shaping disclosure practices. The findings also show the emergence of diversified and multi-tool AI workflows. In several cases, students not only declared AI use, but also critically evaluated the adequacy and limitations of different systems for specific tasks, suggesting early forms of reflective AI use.

Overall, the study suggests that the normalization of declared AI use in HE is not merely a technological phenomenon, but also an institutional and pedagogical one. Future research should further investigate how pedagogical design and disclosure expectations shape students' transparency practices regarding GenAI use.

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Large Language Models as Teaching Copilots: A Teacher-in-the-Loop Experience in AI and Database Education

Pietro Ducange[1] and Michela Fazzolari[2]

[1] Department of Information Engineering, University of Pisa, Italy
[2] Institute of Informatics and Telematics (IIT), National Research Council (CNR), Pisa, Italy
pietro.ducange@unipi.it, michela.fazzolari@iit.cnr.it

1 Introduction

Large Language Models (LLMs) are rapidly transforming educational practices and have attracted significant attention in higher education. Most existing studies focus on student-centered applications, including intelligent tutoring systems, personalized learning, writing assistance, and automated feedback generation [2, 3, 5]. More recently, researchers and policy makers have highlighted the potential of generative AI to support instructors in course preparation, content creation, assessment design, and feedback generation [6, 4, 1]. However, practical experiences documenting the use of LLMs from the teacher's perspective remain limited. This work presents a teacher-centered experience conducted at the University of Pisa during the 2025–2026 academic year, where LLMs were frequently employed as teaching copilots to support course preparation, student project supervision, and formative assessment activities.

The experience involved two Master's-level courses: *Large-Scale and Multi-Structured Databases*, offered within the Master's Degree in Artificial Intelligence and Data Engineering (approximately 80 students, 90 teaching hours), and *Intelligent Systems*, offered within the Master's Degree in Computer Engineering (approximately 40 students, 60 teaching hours). Overall, the activities involved approximately 120 students and 150 teaching hours characterized by lectures, laboratory sessions, project-based learning activities, and project idea presentations. The activities were mainly supported using a state-of-the-art conversational LLMs , namely ChatGPT, model GPT-5, with prompts iteratively refined according to the specific educational task.

2 Methods

All LLM-generated outputs were manually reviewed by the instructor for technical correctness, pedagogical appropriateness, and consistency with the course learning objectives before being incorporated into teaching activities. A first area of application concerned the revision and modernization of teaching material accumulated over previous academic years. LLMs were employed to review

lecture notes, slides, examples, and assignments, helping identify outdated references, improve consistency across teaching units, and enhance the quality of English-language material. This support proved particularly valuable in rapidly evolving domains such as artificial intelligence and modern data management technologies.

A second area concerned educational content creation. LLMs were used to generate new illustrative examples, alternative explanations of complex concepts, practical exercises, and self-assessment tests. The possibility of rapidly producing multiple variants of educational resources facilitated the preparation of teaching material suitable for students with heterogeneous backgrounds. Furthermore, LLMs supported the generation of realistic scenarios and case studies used during practical activities and classroom discussions.

A third area involved project supervision and formative assessment. Both courses relied heavily on project-based learning and required students to propose project ideas, discuss methodological choices, and present implementation plans. Across the two courses, LLMs supported the preparation and revision of educational material. In the Large-Scale and Multi-Structured Databases course, approximately 33 project proposals were discussed during the semester, leading to 24 projects successfully presented during the January and February examination sessions. In the Intelligent Systems course, 14 project proposals were submitted and discussed, with the examination process still ongoing and three projects successfully presented at the time of writing.

Within this context, LLMs were employed as preliminary reviewers of project proposals before instructor evaluation. Generated analyses helped identify ambiguities, missing requirements, inconsistencies, and potential methodological weaknesses, enabling more focused discussions with students. Similarly, LLM-generated suggestions were used to support the drafting of formative feedback, which was subsequently revised and validated by the instructor. This approach reduced the effort associated with routine review activities while preserving full human control over academic decisions.

3 Preliminary Results and Discussions

The experience highlights several benefits. LLMs helped streamline the revision of educational material, facilitated the creation of diverse learning resources, and supported project mentoring activities in courses characterized by large cohorts and project-based learning. At the same time, the experience confirmed the necessity of continuous human oversight, as generated outputs occasionally contained inaccuracies, oversimplifications, or pedagogically inappropriate suggestions. Although the reported experience is limited to two Master's courses within a single institution and does not include a formal quantitative evaluation, it provides practical insights into the integration of LLMs into instructors' daily teaching activities. Overall, this experience suggests that, in the considered educational context, LLMs can effectively function as teaching copilots,

supporting instructors throughout the teaching lifecycle while preserving academic responsibility and educational quality

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Before Machine Learning: Mathematical Criticalities in Early AI Literacy Education

Sara Vergallo[1][0009−0006−2129−5583], Maria Cristina Carrisi[2][0000−0002−2837−3971], and Ottavio G. Rizzo[3][0000−0002−4554−1383]

[1] Università degli Studi di Macerata, Macerata, Italy
s.vergallo@unimc.it
[2] Università degli Studi di Cagliari, Cagliari, Italy
mariacri.carrisi@unica.it
[3] Università degli Studi di Milano, Milan, Italy
ottavio.rizzo@unimi.it

Artificial Intelligence (AI) literacy is increasingly regarded as a key competence for future citizens. Because children already interact with AI-based systems embedded in everyday digital technologies, educational institutions are expected to introduce the conceptual foundations of AI from the earliest levels of schooling [1–3]. Several studies indicate that existing AI learning pathways for children frequently privilege the use of AI-based tools over the conceptual understanding of how such systems operate [4, 5]. When their internal mechanisms remain opaque, learners may develop anthropomorphic interpretations of AI and fail to recognise critical issues such as algorithmic bias [2, 3]. Within the broader construct of AI literacy, Machine Learning (ML) literacy requires learners to reason about data, classification, prediction, model construction, interpretation, comparison, and evaluation [6–9]. These forms of reasoning depend on mathematical, logical and semiotic competences that are often treated as implicit prerequisites for ML education. However, limited attention has been devoted to how these competences develop during the early years of schooling and to the difficulties that may arise before learners engage with algorithms. Drawing on a symbolic approach to ML and on the theories of semiotic mediation and semiotic representation registers [10–12], this study investigates the mathematical structures mobilised when students work with representations commonly used to introduce classification and decision-making systems: Euler–Venn diagrams, decision trees, double-entry tables, and rule-based classifications. We analyzed data collected during an unplugged AI literacy pathway involving approximately 100 Italian students aged between 10 and 12. The pathway, described in [13], consisted of four two-hour sessions. The corpus examined comprises pre- and post- tests and outputs produced during group activities. The analysis focused on the mathematical and representational difficulties emerging during students' interaction with the proposed artifacts. Areas of difficulty were initially identified through the shortcomings observed in the pre-tests. Their persistence was then examined by comparing the pre- and post-test evidence and identifying the domains in which students displayed the least improvement. Group outputs and observational data were used to interpret strategies, errors and representational obstacles underlying these results. Two researchers independently coded the ma-

terials and subsequently compared their analyses. Rather than assessing only the acquisition of ML-related terminology or procedures, the analysis examines the mathematical and semiotic conditions supporting an initial understanding of classification and model-based decision-making. Four interconnected domains of difficulty emerged: logical classification, set-theoretical reasoning, negation and complementarity, and transformations between semiotic registers. Students experienced particular difficulties in representing excluded cases, reasoning about complements, coordinating graphical and tabular representations and translating visual structures into quantitative information. These difficulties were not independent: problems in interpreting negation, for example, affected both the construction of set representations and the interpretation of classification rules. We interpret these recurring difficulties as potential epistemic bottlenecks preceding the development of ML literacy rather than as isolated mathematical errors. On this basis, we propose a framework of mathematical and semiotic preconditions for early engagement with ML concepts. The framework connects the four identified domains with the representational practices required to interpret data classifications and rule-based models. The findings suggest that early AI curricula should explicitly address logical classification, set relations, negation, and conversion among verbal, graphical, tabular, and numerical registers instead of treating these competences as already established. A complementary exploratory study employs an LLM-based simulated student within a teacher education project [14]. The simulation is designed for prospective teachers enrolled in Primary Education programmes and for prospective mathematics teachers preparing to teach at lower secondary level. Its purpose is to provide an artifact through which teachers can anticipate, discuss, and critically analyse possible student strategies and errors. The simulated student produces some errors related to those observed in classroom activities, indicating that simulated-student interactions may provide material for examining mathematical misconceptions while simultaneously developing teachers' critical awareness of the limitations of AI-generated representations of student thinking. The relevance of the study to Higher Education therefore lies primarily in teacher education. University programmes preparing primary and lower-secondary teachers need to address not only the technological dimensions of AI literacy but also the mathematical and semiotic knowledge required to identify learners' difficulties, design appropriate mediating artifacts, and critically evaluate AI-generated simulations. Connecting classroom evidence with LLM-based simulated-student activities may support prospective teachers in distinguishing empirically observed reasoning from merely plausible AI-generated responses. Underestimating these mathematical foundations may produce conceptual deficiencies that persist when learners encounter Machine Learning at later educational stages. ML education should consequently be preceded and accompanied by explicit work on classification, set relations, negation, data representation, and conversion across semiotic registers. At the same time, Higher Education should prepare future teachers to recognise and mediate these foundational processes and to use LLM-based educational artifacts in an empirically informed and critically aware manner.

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Context-Aware Retrieval-Augmented Generation for Supporting Teachers in Designing Educational Robotics Activities

Lucio Negrini[1][0000-0001-6793-6258]

[1] Scuola universitaria professionale della Svizzera Italiana, Dipartimento formazione e apprendimento, Laboratorio media e MINT, Locarno, Switzerland

lucio.negrini@supsi.ch

1 Introduction

Large language models (LLMs) in education are increasingly being explored as assistants for lesson planning, production of didactic resources, differentiation, or assessment. However, their educational value depends on more than fluent text generation alone [1 - 3]. In educational contexts, useful activities must for example be age-appropriate, feasible in real classrooms, coherent with learning goals, and aligned with available resources. AI systems should therefore be grounded in local curricula, classroom constraints, student needs, and validated examples of practice, while preserving teacher agency and professional judgement [4, 5].

Retrieval-Augmented Generation (RAG) offers a promising response to these needs by combining an LLM with retrieval from an external knowledge base. This enables the model to generate outputs based on curated documents rather than relying solely on pretrained knowledge [6, 7]. Recent studies on RAG-supported lesson planning suggest that retrieval grounding can help align generated materials with official textbooks, curricula, and other educational resources [7, 8].

This contribution presents a context-aware RAG chatbot designed to support teachers in searching, adapting and generating educational robotics activities, and compares how expert evaluators assess activities generated with RAG, activities produced by the same LLM without RAG, and activities created solely by human educators.

2 The Roteco-RAG tool

The tool presented in this paper is a chatbot built on the materials available through Roteco, a multilingual portal that supports teachers by offering classroom-ready activities, training opportunities, news, further reading materials, and other resources related to educational robotics and computational thinking [9, 10]. The purpose of the chatbot is to help teachers ask questions, find existing activities, and generate new didactic activities using Roteco as a curated knowledge base. The architecture follows a modular RAG pipeline: Roteco activities and supporting documents are collected through APIs and PDF resources, cleaned and transformed into retrieval texts, divided into chunks, embedded and stored in a vector database. The knowledge base includes 286 activities

in Italian, 274 in German and 505 in French, together with scientific or practitioner-oriented PDF documents on educational robotics.

Semantic representations are generated with the multilingual-e5-large embedding model and stored in ChromaDB. In the activity-generation mode, the teacher specifies parameters such as topic, school level, duration, discipline and tools; the system retrieves similar activities and relevant documents, builds a prompt with retrieved context and metadata, and asks the LLM to create a new structured activity.

3 Validation design

The validation compared eight activities generated with the RAG tool, eight generated with the same LLM without RAG, and five human-authored activities from Roteco. The generated activities addressed the same topics as the Roteco activities, while three additional activities covered topics absent from the platform to assess generation beyond the available knowledge base. Four educational robotics experts, blinded to the source, evaluated the activities using seven items on a five-point Likert scale. The items assessed comprehensibility, age appropriateness, coherence, classroom feasibility, overall quality, willingness to use or recommend the activity, and its potential to inspire robotics teaching. Experts also provided comments, identified the presumed source as human or AI, and ranked the activities from most to least preferred.

4 Results

The results show a positive but exploratory trend in favour of the RAG-generated activities. Descriptively, the RAG condition obtained the highest composite pedagogical quality score, followed by the LLM-only condition and the original Roteco activities. RAG activities also received slightly higher mean ratings for comprehensibility, coherence between objectives and activities, classroom feasibility, overall quality, and willingness to use or recommend the activity in a real educational context. However, the Kruskal–Wallis tests did not indicate statistically significant differences among the three conditions. At the same time, inter-rater reliability was very low or negative, indicating that the four experts did not evaluate the activities in a highly consistent way. For this reason, the results should be interpreted cautiously: the RAG system appears promising and was descriptively rated slightly better than the alternatives, but the present study does not provide statistically robust evidence of superiority.

5 Conclusion

The contribution offers a concrete implementation of a RAG system grounded in an existing educational robotics repository. It proposes a comparative evaluation strategy that tests the added value of RAG directly. Furthermore, it positions teachers as central agents in didactic design: the chatbot is intended as an assistant for inspiration, structuring, adaptation and reflection, not as a replacement for professional expertise.

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Educational culture and algorithmic culture: perceptions, barriers and training needs of secondary school teachers in the face of AI

Antonella Nuzzaci[1]
[1]University of Messina, 98122 Messina, Italy
antonella.nuzzaci@unime.it

1 Introduction

The unstoppable technological evolution has undergone an unprecedented acceleration with the spread of Artificial Intelligence (AI) systems and generative architectures (Large Language Models). This change is configured as a cultural revolution that directly affects the school institution [1], redefining the boundaries of knowledge and imposing a pedagogical and methodological reflection [2]. In the educational field, AI offers disruptive potential: intelligent tutoring in real time, didactic personalization against school dropout and bureaucratic automation for teachers [3]. However, the effectiveness of innovation does not depend on the technical tool, but on how teachers integrate it into their practices [4]. The teaching staff today finds itself having to "trespass" between the humanistic-pedagogical culture of the educational relationship and the algorithmic-computational culture of AI [5, 6]. This scenario generates a polarization between technophile enthusiasm and ethical resistance. Teachers feel the risk of de-professionalization and dehumanization of teaching, expressing perplexity about the reliability of content, the privacy of minors and the cognitive passivity of students [7]. It therefore becomes a priority to have empirical evidence to map the existing. The present study investigates the perceptions, attitudes and training needs of secondary school teachers regarding the use of AI.

2 Research

In line with the literature, the survey pursues three main objectives:

- detect the degree of familiarity and use of AI between daily use and professional design use;
- identify perceived benefits and barriers to adoption;
- analyze the training demand and the presence of institutional AI Literacy paths [8].

The study adopts a cross-sectional quantitative design through an anonymous online structured questionnaire, divided into four macro-areas: personal data; familiarity and use of AI (personal and professional); perceived impact and ethical-educational dimensions (4-point Likert-type scales); training needs [9].

Sample. The reference population is made up of teachers in service at secondary schools in Messina. The statistical sample analyzed includes a total of N = 716 participants and shows a specific demographic and professional distribution. Regarding the gender distribution, a clear prevalence of the female component is observed,

representing 87.43% of the sample (n = 626), compared to 11.17% of male respondents (n = 80) and a remaining 1.40% who preferred not to say (n = 10). From a chronological point of view, there is a clear prevalence of teachers of mature age: the age group between 41 and 50 years constitutes the majority share with 39.39% of the sample (n = 282), followed by the component over 50 years of age, which represents 35.75% (n = 256). The share relating to the 30-40 age group stands at 24.86% of the total respondents (n = 178).

3 Results

The statistical-descriptive analysis outlines a complex and polarized panorama:

- *Familiarity and personal use:* the use of common algorithmic technologies (search engines, translators) is pervasive (100%). However, generative AIs (e.g. ChatGPT) split the sample: 50% use them only out of occasional curiosity, 25% show an advanced profile (early adopters) and 25% have never experienced them.
- *Teaching practice:* the translation into educational practice is limited. 62.5% of teachers have never integrated AI into their work. The remaining 37.5% use it to create support materials (handouts, exercises); only 25% use it for lesson planning, while advanced uses related to predictive evaluation are absent.
- *Opportunities and concerns:* 50% attribute to AI a role of administrative facilitator and support for educational personalization (SEN). On the other hand, 62.5% express strong fears about privacy and profiling [10]; 50% fear a contraction in students' critical thinking and a further 50% fear the loss of the relational empathic component.
- *Demand for training:* 100% of teachers say they have never received specific training on AI from schools or the Ministry but consider the immediate introduction of structured courses essential [9].

4 Conclusion

The data highlight the "paradox of invisible technological integration": teachers use AI in their personal routines, but this private skill does not translate into pedagogical-didactic skills. The resistance of 62.5% of the sample derives from an objective skills gap caused by the total institutional training gap. In the absence of guidelines, uncertainty translates into defensive prudence to protect students [10]. On a theoretical level, the study suggests explicitly integrating AI Literacy into teacher competence models such as DigCompEdu [9, 11], including a critical preparation to deconstruct algorithmic biases and assess their ethical impact. On a practical level, the introduction of AI requires national in-service training plans that are: systematic (overcoming occasional webinars); multidimensional (technical, ethical-legal and pedagogical); design-oriented, through practical laboratories where AI acts as a cognitive amplifier and not as a substitute for thought [4]. Only by codifying AI as a professional skill will it be possible to govern change, ensuring the centrality of human relationships and the development of critical thinking.

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From Computational Thinking to Critical AI and Measurement Literacy: Unplugged Activities, Goodhart's Law, and Children's Understanding of Proxies

Rachele Passi[1][0009-0007-0307-1946], Ileana Bodini[1][0000-0003-4904-2044], Andrea Loreggia[1][0000-0002-9846-0157], Valerio Villa[1][0000-0001-7737-499X], Silvia Ceccacci[2][0000-0001-8916-1262], and Agnese I. Telloni[2][0000-0001-8159-8144]

[1] Università di Brescia {r.passi, ileana.bodini, andrea.loreggia, valerio.villa}@unibs.it
[2] Università di Macerata {silvia.ceccacci, agnese.telloni}@unimc.it

1 Introduction

Recent research on unplugged, screenless Computational Thinking (CT) activities highlights their value for primary computer-science education [1,2,3,4] and reflective, embodied learning. Building on unplugged AI activities and AI-literacy accounts [5,6,7], we reframe CT unplugged as a pathway toward early *critical AI and measurement literacy*, centred on children's understanding of *proxies*—grades for competence, likes for appreciation, algorithmic outputs for relevance [8]—which structure perception and increasingly inform AI systems in education. This *position paper* specifies a study rather than reporting results: we (i) reframe unplugged CT around the proxy construct; (ii) operationalise it in a classroom activity (Sect. 4); and (iii) specify a longitudinal research design (Sect. 5).

2 Proxies, Metrics, and AI Systems

A *proxy* is a measurable variable standing in for a construct hard to access directly, and may diverge from what it represents. This is Goodhart's Law—"When a measure becomes a target, it ceases to be a good measure" [9,10]—refined by Manheim and Garrabrant's [11] *regressional*, *extremal*, *causal*, and *adversarial* proxy failure (Fig. 1). AI systems are trained on proxies such as clicks or benchmark accuracy [12], signals that often miss understanding or meaningful learning. Their implications remain underexplored in primary education, even as children grow within recommender- and assessment-shaped environments.

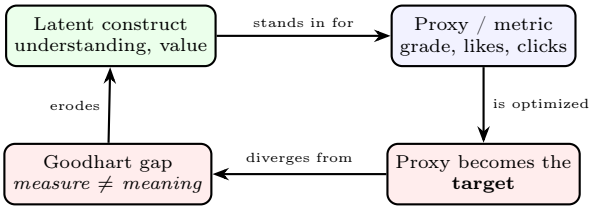

Fig. 1. Once a proxy becomes an optimization target, it can diverge from the construct it was meant to indicate (Goodhart's Law), producing failures Manheim and Garrabrant classify as regressional, extremal, causal, or adversarial.

3 Unplugged CT as Critical AI Literacy

Unplugged CT activities rely on symbolic representations and simplified models of reality. Through semiotic mediation [13,14], artifacts manipulated in a task become, via guided discourse, epistemic meanings—the gap between a measure and what it stands for. Classification games and rule-based collaboration confront children with simplified indicators that proxy complex processes, surfacing: *what is measured, and what is lost?* Following UDL [15], activities offer multiple means of representation, action, and engagement. Goodhart's Law [9,16] names distortions children can recognise through concrete counter-examples, illustrated next.

4 A Classroom Vignette: "The Friendly-Robot Sorter"

We describe one activity for primary-school children (ages 6–11), adapting the CS Unplugged classification/sorting format [2] into a measurement game. Each child holds a paper "robot" card with visible features (dots, a smile/frown); the class picks the "most helpful robots" using a countable proxy—"more dots, more helpful"— sorting into a line. At first dot-count and a hidden "true helpfulness" label agree, as when real systems adopt easy-to-count signals. The teacher then *rewards* dots, and a confederate card—covered in dots but labelled "breaks every book"—invites children to "design a robot that wins". The line-up now ranks an unhelpful robot first: the measure was optimized, the meaning lost. Discussion names the four failure modes: dots no longer tracking helpfulness (regressional), an absurd thousand-dot robot (extremal), dots glued on without changing behavior (causal), and gaming the reward (adversarial). A debrief transfers the insight to likes, grades, and "time on app".

5 Research Design and Expected Outcomes

We outline a longitudinal, mixed-methods design testing whether critical proxy understanding emerges from unplugged CT and *transfers* to AI-mediated contexts; no data have yet been collected. **Participants:** ∼45 children (ages 6–11), Italian primary classes, ethical approval and consent. **Design:** single-group

pre/post with delayed follow-up across three waves—T0 baseline, T1 after a 4–6-session cycle, T2 transfer ≈4–6 months later. **Instruments:** proxy-reasoning scenarios, unseen transfer tasks, interviews, observation, artifacts. **Analysis:** thematic/semiotic coding plus non-parametric within-subject comparisons, exploratory. We expect gains T0→T1 and partial T2 transfer, controlling for maturation, testing, and teacher variability.

6 Conclusions

Unplugged CT is an entry point to critical AI and measurement literacy: beyond algorithmic reasoning, it lets children interrogate metrics, representations, and phenomena in AI-mediated environments. Our contribution is a conceptual framing, a replicable classroom activity, and a specified longitudinal design; empirical validation is the natural next step. Understanding proxies is a foundational competence for navigating AI-powered assessment and recommendation.

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A Policy–Capacity–Tool Alignment Model for Legitimate Human–AI Collaboration in Higher Education

Patricia Khonje[1[0009-0001-3858-2849]] and Patricia Santos[2[0000-0002-7337-2388]]

Department of Engineering, Universitat Pompeu Fabra,
Roc Boronat 138, 08018 Barcelona, Spain
patricia.khonje@upf.edu, patricia.santos@upf.edu

1 Introduction

Generative Al (GenAI) has rapidly moved from experimental deployment to everyday educational infrastructure. Students use these systems for drafting, problem-solving, and information synthesis; educators employ them for feedback, curriculum design, and learning support; institutions increasingly explore strategic digital transformation initiatives [1–3]. Despite widespread adoption, however, a fundamental structural challenge remains, higher education (HE) institutions often lack coherent structures for governing GenAI as a cognitive partner or critical interlocutor within learning activities.

This challenge is reflected in inconsistent institutional policies, uneven educator preparedness, limited oversight, concerns regarding transparency, academic integrity, and accountability [2, 4]. As a result, GenAI adoption occurs in fragmented and reactive ways, creating uncertainty for students, educators, and institutional leaders alike.

This paper argues that legitimate human-AI collaboration in HE emerges only when three structural domains are aligned by design: Policy (normative authorization), Institutional Capacity (operational readiness), and Tool Behavior (governance embodied in design). To explain this relationship, we introduce the Policy-Capacity-Tool (PCT) Alignment Model.

A critical conceptual clarification is necessary. This paper does not treat humans and GenAI as morally or agentically equivalents. Responsibility for learning, assessment, and submitted academic work remains exclusively human. Instead, AI is conceptualized as an artificial participant whose contributions are subject to human oversight and institutional governance structures. We define legitimacy as the institutional and pedagogical acceptance of GenAI in teaching and learning, conditional on accountability, transparency, and human oversight, positioning it as a governed participant. Drawing on emerging perspectives that position AI as a critical interlocutor or provocateur rather than an autonomous collaborator [5], we argue that GenAI's educational value lies in stimulating reflection, critique, and inquiry, not replacing human judgment.

The framework is intended specifically for HE, where governance arrangements, learner autonomy, and accountability structures differ from primary and secondary education.

Legitimacy is not determined by technical sophistication but by governance arrangements defining acceptable use, accountability, and oversight [1, 2, 4, 6]. Policy, however, is insufficient unless supported by institutional readiness and tool design.

2 The Policy-Capacity-Tool (PCT)Alignment Model

The PCT model (Fig.1) synthesizes three literature strands: AI governance and FATE frameworks (Policy), institutional readiness and AI literacy (Capacity), and CSCL and responsible AI design (Tool Behavior) [1, 4, 6–8]. These strands represent the three structural layers through which institutional technologies operate: authorization (Policy), execution (Capacity), and embodiment (Tool). While existing frameworks often address one or two domains in isolation, the PCT model's contribution lies in articulating their interdependence, legitimacy depends on structural coherence across all three.

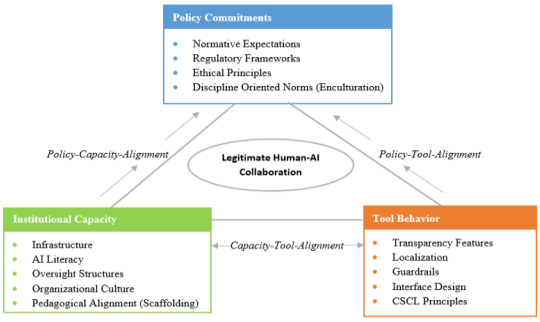

Figure 1. The Policy-Capacity-Tool (PCT) Alignment Model

Policy provides normative authorization. Institutional Capacity operationalizes readiness through professional development, infrastructure, and oversight. Tool Behavior embeds governance through transparency, explainability, safeguards, and human oversight [1, 4, 6–8]. Components like oversight, pedagogical alignment, guardrails, and CSCL principles, may span multiple domains. The figures boundaries highlight primary affiliations while acknowledging relational operation. The model is proposed as an explanatory framework conceptualizing legitimacy as structural alignment across policy, capacity and tool behavior. It also offers a diagnostic lens for analyzing implementation challenges and identifying sources of misalignment in institutions. When policy, capacity, and tool behavior align, conditions for legitimate human-AI collaboration emerge. Educators operate within clear governance boundaries, students encounter systems whose operation is visible and understandable, and institutions demonstrate accountability for AI-mediated learning practices.

Misalignment produces four characteristic instabilities: symbolic compliance (policy exceeds capacity), operational friction (capacity exceeds tool support), governance gaps (policy expectations exceed technical capabilities), and systemic instability (all three domains operate independently). These misalignments are not presented as empirically validated categories but as theoretically derived patterns that may help explain recurrent implementation difficulties observed across HE contexts. Potential indicators for assessing alignment include policy clarity and enforcement (P), availability and uptake of professional development and oversight structures (C), and transparency, configurability, and auditability of AI tools (T). These provide a starting point for future empirical investigation.

3 Implications and Conclusion

The model offers important implications for fostering responsible GenAI use in HE. Governance, professional development, and technological design must be understood as interdependent rather than separate spheres. For institutional leaders, this means treating AI literacy and governance infrastructure as foundational investments. For educators, it provides a diagnostic tool for course and programme design, aligning policy clarity, institutional support, and tool behavior. For developers and procurement officers, it emphasizes that tool design is governance enacted through code, requiring transparency, configurability, and auditability.

Future empirical research is needed to validate and refine the PCT model. Potential avenues include comparative case studies across institutions with varying AI policy maturity, development of a survey instrument measuring alignment across the three domains and longitudinal studies examining how misalignments emerge over time. The diagnostic categories: symbolic compliance, operational friction, governance gaps, and systemic instability could serve as analytical lenses for mapping misalignment.

The transition from GenAI as a productivity tool to a legitimate participant in HE is not a technical inevitability but a structural accomplishment. The PCT Model provides a framework for understanding how legitimacy emerges through deliberate alignment of policy, capacity, and tool. When these domains operate coherently, conditions for legitimate and sustainable human-AI collaboration become possible. When they do not, institutions risk symbolic compliance, operational friction, governance gaps, and systemic instability.

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Socratic Artificial Intelligence as a Framework for Process-Based Assessment

Gaetano Francesco Anastasi[1] and Paolo Musmarra[2]

[1] ITET G. Garibaldi, Marsala (TP), Italy
gaetanofrancesco.anastasi@posta.istruzione.it
[2] Computer Science Department - University of Salerno, Italy
pmusmarra@gmail.com

1 Introduction

The widespread adoption of Generative Artificial Intelligence (GenAI) tools in education raises new challenges for assessment. While concerns exist about over-reliance and potential cognitive decline [1], other studies show that students continue to use these tools despite institutional restrictions, generally perceive them positively, and may experience increased motivation and improved learning outcomes [2–4]. Within educational theory, assessment has long been grounded in process-oriented perspectives—such as in portfolio assessment [5], authentic assessment [6], Bloom's taxonomy [7], and formative assessment [8–10] which emphasize that learning cannot be fully captured by final outputs alone. Compounding this issue, the growing ability of GenAI systems to produce high-quality artifacts such as essays, code, and translations increasingly destabilizes the assumption that final products reliably reflect underlying cognitive effort, while assessment practices in education remain largely product-based [11].

Instead, the focus should move toward learners' orchestration of the process under structured epistemic interaction: how they conceptualize a task, respond to targeted prompts, evaluate the validity of generated responses, and iteratively refine their reasoning. Our proposal has implications for teacher education and professional development programs, where educators could be trained to critically engage with AI-supported learning environments. Embedding process-oriented assessment approaches into such programs would enable educators to better understand how to evaluate learning as cognitive trajectories rather than static outputs, and to transfer these practices into their own teaching contexts.

2 Process-Based Assessment

The decoupling between cognitive effort and final artifacts introduced by GenAI makes product-based evaluation increasingly unreliable as a proxy for student competence and motivates a return to a long-standing perspective in educational theory: the idea that assessment should target the process of learning rather than its final output. However, the "process" in AI-mediated learning cannot be adequately captured by either passive traces or learners' retrospective self-reports. Submission logs and interaction histories record observable actions but provide little insight into the underlying reasoning processes. Conversely, reflective narratives offer access to learners' interpretations of their thinking, yet they are

susceptible to social desirability bias and can be problematic for students with limited metacognitive awareness [12].

Instead, process-based assessment may be better understood as the reconstruction of decisions, revisions, justifications, and conceptual refinements that lead to an outcome. What becomes central is not only what students produces, but how they navigate the problem space, respond to uncertainty, and modify their understanding over time. To operationalize process-based assessment, we propose a framework aligned with emerging perspectives in Socratic AI [13–16], capable of actively eliciting and structuring observable cognitive processes through dialogical interactions. Unlike traditional conversational agents, optimized for providing answers, Socratic AI is designed to perturb reasoning, generate targeted questions, and expose the implicit structure of student thinking through dialogue. The key design principle is that assessment emerges from interaction: each Socratic intervention functions as a cognitive probe that forces articulation, justification, or revision of partial ideas. Through iterative questioning, the system externalizes otherwise latent aspects of reasoning, producing a traceable dialogue that reflects the evolution of understanding. In this perspective, the AI is not merely a tutor or evaluator but an instrument for making thinking observable. Operationalizing Socratic AI requires moving from static evaluation criteria to dynamic, interaction-based indicators. We define three complementary dimensions of process-based assessment that emerge from Socratic interaction: epistemic trajectory, perturbation sensitivity, and dialogic resilience. Epistemic trajectory refers to the reconstruction of the student's evolving line of reasoning over time: rather than focusing on isolated responses, assessment targets the structure of conceptual development, emphasizing how ideas are introduced, revised, reorganized, or abandoned throughout the dialogue. Perturbation sensitivity measures how students respond to Socratic AI interventions: each question or challenge acts as a cognitive perturbation that exposes implicit assumptions or gaps in reasoning, emphasizing the ability of recognizing inconsistency, adjusting arguments, and integrating feedback into subsequent responses. Dialogic resilience captures the stability and adaptability of reasoning under sustained interaction and reflects whether students can maintain coherent lines of thought while engaging with repeated questioning, ambiguity, or counterarguments. Together, these three dimensions define assessment not as evaluation of outputs, but as analysis of cognitive behavior. Socratic AI functions as the mechanism that elicits and makes these dimensions observable through dialogue.

3 Conclusion

The shift enabled by GenAI forces a reconsideration of the epistemological basis of educational assessment. If high-quality artifacts can be generated independently of meaningful cognitive engagement, then assessment must increasingly focus on the processes that lead to them rather than the artifacts themselves. Socratic AI offers a concrete instantiation of this shift by transforming assessment into an interactive process of structured questioning that makes cognition observable and analyzable.

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Rethinking AI in Higher Education through Metaheutagogy: A Thematic Analysis of Opportunities and Challenges

Alexander Mikroyannidis[1[0000-0002-9518-1443]] and John Domingue[2[0000-0001-8439-0293]]

[1] Knowledge Media Institute, The Open University, Milton Keynes MK7 6AA, UK
Alexander.Mikroyannidis@open.ac.uk
John.Domingue@open.ac.uk

1 Introduction

The rapid integration of Artificial Intelligence (AI) into higher education is fundamentally reshaping teaching and learning practices, as its applications extend beyond automation to influence feedback processes, knowledge construction, learner engagement, and educational outcomes [1-7]. To fully realise this potential, it is essential to examine the deeper pedagogical transformations needed for the integration of AI into higher education. In this context, the present study positions AI as a catalyst for rethinking the epistemic and pedagogical foundations of higher education.

More specifically, this study adopts metaheutagogy [8] as its core theoretical framework. Metaheutagogy extends pedagogy, andragogy, and heutagogy by positioning AI as a reflective and dialogic partner in the cognitive and social learning processes. Rooted in meta ("beyond", "after", "at a higher order") and heutagogy ("self-directed learning"), metaheutagogy goes beyond self-direction by embedding AI within the processes of inquiry, reflection, and capability development. Metaheutagogy emphasises metacognitive regulation, judgement centred capability, ethical technology use, constructionism, and social sense-making as core learning components, thus ensuring that AI enhances human agency and epistemic responsibility.

Metaheutagogy is especially relevant in distance and open education settings, such as the Open University (OU), where there is a strong need for personalised support at scale and flexible access to learning, which AI is well positioned to enhance [9, 10]. However, realising this potential depends on embedding AI within pedagogical approaches that explicitly prioritise metacognition and learner agency. This study is therefore motivated by the need to understand how educators conceptualise AI when viewed through a metaheutagogical lens, and to identify the systemic conditions required to support AI-mediated learning.

2 Methodology

The study employed a thematic analysis of qualitative data collected during a series of workshops with a total of 40 participants belonging to a wide range of OU module teams. A purposeful sampling strategy was employed, selecting participants based on

their expertise in educational technology and their experience in developing OU distance learning materials. During the workshops, participants worked in small groups to brainstorm and document perceived opportunities and challenges associated with AI in teaching and learning, generating ideas through collaborative discussion and completing structured activity templates that captured their reflections and examples from practice. The collected data were initially coded inductively to identify recurring patterns, with codes subsequently grouped into higher-level themes. The resulting themes were iteratively refined and interpreted through a metaheutagogical lens to examine their alignment with or divergence from AI-mediated learning principles. To enhance trustworthiness, themes were reviewed by the research team, ensuring coherence, distinctiveness, and consistency with the underlying data. The analysis resulted in a set of themes representing opportunities, interpreted as emergent features of AI-mediated learning environments, and a set of themes representing challenges, interpreted as structural and pedagogical barriers to such environments.

3 Findings

The findings of the study point to key transformations required for higher education in order to meaningfully integrate AI. In particular, a shift is needed from content delivery to metacognitive development, where the focus moves beyond transmitting knowledge toward supporting learners in critically engaging with, reflecting on, and regulating their own learning processes. In AI-mediated contexts, the ability to evaluate and make sense of information becomes more important than simply acquiring it. Additionally, the findings of the study highlight a transition from isolated tools to integrated learning environments, emphasising the need to embed AI coherently across curricula, platforms, and pedagogical practices. AI tools should therefore be part of a connected ecosystem that supports continuous interaction between learners, educators, and learning resources. Finally, a transformation is required from instructional control to co-regulated learning, where learning is no longer directed solely by instructors but emerges through collaboration between learners and educators, mediated by AI. In this model, AI acts as a partner in inquiry and reflection, thus facilitating personalised and self-regulated learning.

The study makes a significant contribution by reframing AI in higher education through the lens of metaheutagogy, offering both empirical and theoretical insights. It demonstrates that the emerging conceptions of educators regarding AI align with the core metaheutagogical principles, which suggests a strong foundation for transformative change. Additionally, the study provides a diagnostic framework for understanding the barriers to AI adoption, highlighting how institutional structures, pedagogies, and assessment practices remain misaligned with AI-mediated learning. The study concludes that the transformative potential of AI lies in its capacity to support metaheutagogy, enabling knowledge to be constructed through metacognition, guided by reflection, and grounded in ethical and informed judgement. Realising this potential requires a fundamental reconfiguration of educational design, practice, and institutional culture.

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Special Track 3

Human rights-based approach and practices for preventing and countering online hate speech: digital strategies and educational challenges in Higher Education

Organizers:
Giovanni Fulantelli, National Research Council of Italy, Institute for Educational Technology, Italy
Davide Taibi, National Research Council of Italy, Institute for Educational Technology, Italy
Rete Nazionale per il contrasto ai discorsi e ai fenomeni d'odio, National Network for the Fight against Hate Speech and Hate Phenomena, Italy

From Local Cases to Sociomaterial Assemblages: A Human Rights-Based Media Literacy Approach to Countering Online Hate in an International Master's Programme

Stefano Pasta[1][0000-0002-7756-5427]

[1] Catholic University of the Sacred Heart, Milan
stefano.pasta@unicatt.it

1 Introduction

Within the emerging field of Postdigital Intercultures [1], online hate speech can no longer be understood solely as the expression of individual prejudice or as the direct consequence of digital technologies [2]. Rather, it emerges through the continuous interaction between local cultures, social practices, platform architectures and algorithmic infrastructures. This perspective poses important educational challenges for Higher Education, particularly when future educators, communication professionals and social practitioners are expected to develop human rights-based approaches capable of addressing online hostility across culturally diverse contexts.

This paper presents a teaching and research experience conducted within the MISEI – Master International en Sciences de l'Éducation Inclusive, an Erasmus Mundus Joint Master's programme jointly delivered by the Université de Lorraine, the Università Cattolica del Sacro Cuore, and the Université de Neuchâtel. Specifically, it focuses on the Master's-level course *Media Literacy against Hate Speech*, designed and taught by the author within the MISEI programme. The course brings together an international cohort of postgraduate students from Europe, Africa, Asia and Latin America, with a particularly strong representation from the Global South.

Rather than considering cultural diversity merely as a characteristic of the classroom [3], the course adopted it as an epistemic resource for investigating how hate speech is recognised, interpreted and addressed across different socio-cultural, political and media environments.

2 Educational design and findings

The course was organised around two complementary educational activities grounded in Human Rights Education and Media Literacy [4; 5].

The first invited students to analyse and discuss concrete cases of online hate speech originating from their own countries and digital environments. Through collaborative analysis, participants examined the targets of hate, the role of protected characteristics,

platform dynamics, legal frameworks and culturally specific meanings attached to hostile communication.

The second activity required students to design media education campaigns aimed at preventing and countering online hate speech in their own local contexts. Working in multicultural groups, students developed educational strategies that combined universal human rights principles with context-sensitive communication practices, reflecting on audiences, media ecologies and pedagogical objectives.

The comparison among the projects generated both significant commonalities and equally significant differences. On the one hand, students consistently identified recurring patterns across contexts, including processes of dehumanisation, emotional polarisation, misinformation, stereotyping, and the amplification produced by platform affordances and algorithmic visibility [6]. On the other hand, substantial contextual differences emerged regarding the social groups targeted by hate speech, the historical memories shaping public discourse, legal definitions, political sensitivities, linguistic repertoires, religious references and educational priorities. The same communicative practice could therefore acquire different meanings depending on the local socio-cultural context.

These findings progressively transformed the central research question discussed throughout the course. Rather than asking whether social media reshape local social practices or whether local cultures shape digital communication [7], students increasingly interpreted online hate as the outcome of reciprocal interactions between both dimensions. This led the educational process towards a glocal perspective, where global platform infrastructures and situated cultural practices continuously co-produce one another.

3 Conclusion

The paper argues that one of the main educational outcomes of this Master's-level experience was the progressive reinterpretation of online hate speech as a sociomaterial assemblage [8]. Drawing on insights from Science and Technology Studies (STS) [9] and postdigital scholarship [10], this perspective understands hate speech as emerging from the dynamic interactions among technological infrastructures, algorithmic systems, platform governance, legal frameworks, historical memories, cultural norms, media practices and human agency, rather than being attributable exclusively either to digital technologies or to pre-existing social attitudes [11].

This shift has important implications for Higher Education. Human rights-based approaches to online hate cannot rely exclusively on universal normative frameworks, nor can they be reduced to culturally specific interpretations. Instead, they require educational environments where international students critically compare experiences, negotiate meanings and collaboratively develop context-aware yet globally informed responses. In this sense, internationally diverse Master's programmes become spaces where intercultural dialogue is not simply promoted but mobilised as a pedagogical and epistemic resource for critically investigating online hate across different social and cultural contexts.

By connecting Human Rights Education, Media Literacy, the framework of Postdigital Intercultures [12], and insights from Science and Technology Studies, the paper proposes the notion of sociomaterial assemblage as a productive conceptual lens for both research and educational practice in preventing and countering online hate speech in Higher Education.

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Countering Hate Speech In Hybrid Contexts: Evidence From University Students' Experiences During COVID-19

Lieve Gies[0000-0002-8760-8865]

University of Leicester, Leicester, UK
lg149@leicester.ac.uk

1 Introduction

In this paper, I will draw on previous empirical research into university students' experiences of the COVID-19 pandemic to explore options for countering hate speech [1, 2]. The data was collected in the period 2020–21, coinciding with the height of the pandemic. The pandemic is widely recognised as having fuelled both online and offline hate speech, often by intensifying the public desire to identify and blame a perceived 'out-group' for the spread of disease [3].

Post-pandemic, the toxicity of social media has become a major societal concern, prompting policymakers in several countries to adopt legislation aimed at restricting access for younger users. While politically expedient, such measures have been criticised as overly simplistic responses to complex socio-technical problems. Research suggests that hate speech online is shaped by interacting factors including platform governance, political rhetoric and broader societal tensions, and cannot be addressed through single-policy solutions alone [4].

2 Findings From The UniCoVac Study

Our earlier work has shown that hate speech during the pandemic was by no means an exclusively online problem [1]. Microaggressions were often—and in some cases predominantly—encountered in offline settings such as streets, shops and public transport. For example, students working in retail reported verbal abuse from customers when attempting to enforce mask-wearing regulations. This reflects research showing that online and offline forms of anti-social behaviour overlap and reinforce one another [5]. Treating hate speech as an exclusively online issue therefore risks overlooking the mutually reinforcing relationship between online and offline victimisation.

We also identified important bystander effects. Witnessing hate speech did not only affect direct victims but also shaped the behaviour of observers. Participants reported modifying their behaviour to reduce the risk of victimisation—for example, avoiding certain places, limiting their movements, or ensuring they were accompanied when outside. Such findings suggest that even vicarious experiences of hate crime generate fear and insecurity among individuals who share characteristics with targeted groups [1]. This supports conceptualisations of hate speech as a "message crime", extending harm beyond immediate victims by signalling fear and exclusion to wider communities [4].

Another bystander effect concerns the reluctance to intervene. Turning a blind eye is a well-documented phenomenon in criminology, and research on online hate similarly shows that bystanders frequently fail to challenge harmful content, allowing it to persist and escalate [6]. Empirical studies further highlight the complexity of bystander responses, identifying distinct roles such as passive observers, defenders and contributors [7]. A lack of intervention, in turn, contributes to perceptions of unsafety in both online and offline environments.

Finally, our findings revealed clear patterns of self-censorship online. Participants described avoiding posting content perceived as carrying a high risk of harassment or trolling. They refrained from engaging with or challenging misinformation online despite recognising its presence [2]. For example, some reported reluctance to express pro-vaccine views in the context of rising anti-vaccination sentiment. More generally, participants described routinely encountering misinformation but choosing not to challenge it out of concern for their personal safety. We describe this behaviour as a form of "social media hesitancy", whereby individuals who possess the knowledge and skills to challenge misinformation refrain from doing so out of fear.

This phenomenon reflects broader dynamics identified in the literature. Research shows that self-censorship can lead to withdrawal from mainstream online discourse, contributing to echo chambers in which users are primarily exposed to like-minded perspectives [8, 9]. Such environments facilitate the spread of misinformation while limiting opportunities for meaningful debate and contestation.

3 Discussion and Conclusion

The consequences of the bystander dilemma are manifold. First, misinformation is allowed to spread relatively unchecked, undermining public health responses and contributing to harmful outcomes [10]. Second, echo chambers thrive, creating insulated communicative spaces that reinforce existing beliefs. Third, rather than fostering civility, online interactions may become increasingly polarised and hostile. Finally, self-expression and creativity are stifled, as individuals withdraw from participation due to fear of negative reactions. More broadly, hate speech contributes to the silencing of opposing voices and the normalisation of exclusionary discourse [4].

Higher education affords a unique opportunity to address these challenges. As a highly educated and socially engaged population, students are well placed to contribute to the development of safer online environments. Media literacy should therefore be embedded more systematically within the university curriculum to support a deeper understanding of the technological architectures and political economy of the internet. Such approaches should avoid framing online incivility as a matter of individual moral failure and instead emphasise the importance of collective action and responsibility. In addition, curricula should equip students with the philosophical and legal frameworks necessary to critically engage with digital environments and advocate for more inclusive and respectful online spaces.

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Digital Citizenship and Human Rights in the Context of Online Hate Speech: Evidence and Challenges for Higher Education

Teresa González-Ramirez[1 [0000-0001-8738-565X]], Maria Giuseppina Bartolo[2 [0000-0002-2160-8432]], Simona Perfetti[2 [0000-0001-8148-8463]], Angela Lopez-Gracia[1 [0000-0001-7541-2534]] and Rosario Ponziano[2 [0000-0002-7172-4570]]

[1] Departamento de Métodos de Investigación y Diagnóstico en Educación, Universidad de Sevilla, Spain
[2] Department of Culture, Education and Society, University of Calabria, Italy

1 Introduction

The expansion of digital technologies has profoundly transformed how university students communicate, participate in society, and construct their identities. Social media have become central spaces for interaction, information, and self-expression, while also providing fertile ground for the spread of hate speech, discriminatory narratives, and polarizing dynamics that challenge democratic values and human rights [2].

Understanding online hate speech requires moving beyond simplistic interpretations and considering it as a multidimensional phenomenon shaped by technological, psychological, social, cultural, and educational factors [1–7]. In this context, particular attention should be paid to the motivations underlying young people's use of social media. These motivations can be broadly interpreted through two complementary orientations: a hedonic orientation, centred on immediate gratification, entertainment, and social recognition, and a eudaimonic orientation, focused on personal growth, critical reflection, meaningful participation, and responsibility towards others [8].

Although this distinction has received limited attention in hate speech research, it offers a useful framework for understanding why some forms of digital interaction reinforce polarization, dehumanization, and exclusion, whereas others foster more inclusive and responsible participation. Features of contemporary digital ecosystems—such as the search for social validation, exposure to emotionally charged content, algorithmic amplification, and misinformation—may reinforce predominantly hedonic patterns of engagement, contributing to the circulation and normalization of online hate speech [3].

2 Method

Building on this interpretative framework, the present contribution examines university students' perceptions, experiences, and behaviours regarding online hate speech through a comparative study conducted in Spain and Italy.While based on the same comparative dataset presented by González-Ramírez et al. [5], this contribution addresses a different research question by interpreting the findings through the hedonic–

eudaimonic framework and discussing their implications for digital citizenship, human rights, and higher education. The research involved a sample of 418 students from the University of Seville (Spain) and the University of Calabria (Italy). Data were collected through a structured online questionnaire administered using a convenience sampling strategy. A quantitative methodology was employed through the administration of a questionnaire specifically designed to explore participants' knowledge of the phenomenon, perceptions of its prevalence in digital environments, experiences of exposure to hate speech, and responses adopted when confronted with such situations. Comparing these two European university contexts makes it possible to identify both shared tendencies and potential differences associated with sociocultural and educational factors.

3 Results

The findings reveal a widespread perception of the growing presence of hate speech across digital environments. The comparative analysis revealed largely consistent patterns across the Spanish and Italian samples, suggesting that the observed dynamics extend beyond country-specific contexts. Participants identified cyberbullying, online gender-based violence, racism, xenophobia, discrimination based on sexual orientation, and other forms of social exclusion as particularly concerning manifestations. The results also demonstrate that students are not merely passive recipients of these dynamics but may assume different roles as observers, victims, defenders, or participants, highlighting the complexity of interaction processes occurring within digital spaces.

4 Discussion and Conclusion

These findings suggest the importance of analysing hate speech not only as a problem of digital content or behaviour, but also as an expression of different ways of relating to technology and participating in digital social life. From this perspective, uses primarily oriented toward immediate gratification, external validation, and constant stimulation may encourage impulsive responses, reduce opportunities for critical reflection, and increase exposure to confrontational dynamics. Conversely, eudaimonic uses of digital technologies—grounded in deliberation, empathy, responsibility, and commitment to the common good—appear to function as potential protective factors against the dissemination and normalization of hate speech [8]. Beyond describing the phenomenon, the study invites reflection on its broader educational and social implications. The normalization of aggressive communicative practices may contribute to the deterioration of social coexistence, the weakening of empathy, the reduction of capacities for democratic dialogue, and the consolidation of polarization processes that affect both interpersonal relationships and social cohesion. From this perspective, hate speech represents not merely a technological or communicative issue but also an educational challenge that directly concerns Higher Education institutions. Drawing on the findings, this paper argues for the adoption of a human rights–based approach to preventing and countering hate speech within digital university environments. Such an approach places values such as human dignity, equality, inclusion, respect for diversity, and democratic participation at its core. Consequently, the study advocates the development of comprehensive educational models that integrate critical digital literacy, emotional

education, critical thinking, digital ethics, and citizenship education across curricula. This proposal is consistent with recent educational research highlighting the importance of integrating media literacy, human-rights education, and critical digital competences to prevent online hate speech [7]. Furthermore, it argues that the creation of safe and inclusive digital environments requires multilevel interventions involving universities, academic staff, students, public institutions, and civil society organizations.

The main contribution of this study lies in linking empirical evidence from two European university contexts with the formulation of educational strategies aimed at strengthening democratic resilience against hate speech. It also proposes the hedonistic–eudaimonic framework as an innovative perspective for understanding the relationship between social media use and the emergence of online dynamics of exclusion and hostility. This approach shifts attention away from the mere regulation of content and toward the promotion of more conscious, reflective, and socially responsible forms of digital participation. In doing so, it contributes to the international debate on the role of Higher Education in fostering inclusive digital cultures and preparing citizens capable of engaging critically in societies increasingly shaped by digital technologies and artificial intelligence. This perspective also aligns with recent evidence highlighting the growing importance of digital well-being and responsible online participation among younger generations [6-9-4].

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From Inclusive Digital Readiness to Safe Digital Participation: Towards a Human Rights-Based Self-Assessment Framework for Higher Education

Lidia Scifo[1[0000-0002-0876-668X]] and Giovanni Fulantelli[1-2[0000-0002-4098-8311]]

[1] LUMSA University, Palermo, Italy
[2] National Research Council, Institute for Educational Technologies, Palermo, Italy
l.scifo@lumsa.it, giovanni.fulantelli@cnr.it

1 Introduction

The growing integration of digital technologies, online learning environments, and AI-supported systems is reshaping participation, communication, and learning processes in higher education. At the same time, digital environments may reproduce exclusionary dynamics, online hate speech, discriminatory discourse, unequal participation, and harmful interactions, raising important ethical and educational challenges for universities.

Recent research increasingly emphasises that inclusion in higher education should not be interpreted solely as physical access to academic spaces, but also as meaningful participation in digitally mediated learning ecosystems [1,2]. At the same time, growing concerns have emerged regarding the ethical implications of AI systems, algorithmic bias, unequal digital participation, and the potential reproduction of exclusionary dynamics within online educational environments [3, 4]. While AI systems may support accessibility, multilingual communication, personalised learning, and early identification of exclusionary patterns, they may also reproduce bias, opacity, and unequal participation if implemented without adequate human oversight [3, 5]. Within this perspective, safe and inclusive digital environments become essential conditions for democratic participation, student wellbeing, respectful online communication, and human-rights-based education.

This paper builds upon a previous study in which the authors developed the Inclusive Digital Readiness Model (IDR) to analyse how Italian universities address the inclusion of refugee and migrant-background students through governance, pedagogy, student support, and digital transformation strategies [6]. The previous study highlighted how many institutional initiatives remained fragmented and project-based rather than embedded into long-term institutional governance, thus confirming results from previous research [7,8]. While the original IDR Model focused on the specific barriers experienced by refugee and migrant-background students, its underlying dimensions (governance, pedagogy, student support, and digital transformation) address institutional capacities that are relevant to inclusive digital participation more broadly. Building on this foundation, the present contribution extends the model from the inclusion of specific vulnerable groups to a systemic perspective on safe digital participation,

examining how universities can prevent exclusionary dynamics, discriminatory discourse, and online hate speech across their digitally mediated environments. In particular, the paper argues that preventing online hostility and hate speech in higher education requires not only moderation technologies or automated detection systems, but also institution-wide capacities for inclusive governance, critical digital literacy, ethical AI integration, and participatory educational design.

2 Operationalising Inclusive Digital Readiness

The proposed framework adopts a human rights-based perspective on digital inclusion. In this view, digital participation is connected not only to technological accessibility, but also to equity, wellbeing, respectful participation, and institutional responsibility. The framework operationalises the Inclusive Digital Readiness Model through a set of interconnected institutional domains: digital accessibility and participation; inclusive online pedagogy; multilingual and intercultural communication; wellbeing and sense of belonging; ethical AI governance; digital citizenship and respectful participation; institutional governance and strategic planning.

Together, these domains are intended to provide institutions with a structured basis for identifying strengths and vulnerabilities in their capacity to ensure safe digital participation and, following empirical validation, may provide the conceptual basis for the development of an Inclusive Digital Readiness Index supporting institutional self-assessment and longitudinal monitoring.

For each domain, the framework proposes progressive maturity descriptors corresponding to four levels of institutional readiness: Emerging, Developing, Established, and Transformative.

At the Emerging level, institutions typically adopt fragmented or reactive approaches, often dependent on temporary projects or individual initiatives. The Developing level is characterised by pilot experiences and growing institutional awareness regarding inclusion and digital participation. The Established level includes coordinated strategies, structured support systems, and institution-wide policies for inclusive digital learning. Finally, the Transformative level reflects the integration of inclusion, ethical governance, digital citizenship, and respectful participatory approaches into strategic planning, quality assurance processes, and institutional culture. For example, responses to online hate speech may evolve from isolated or reactive interventions at the Emerging level to institution-wide prevention strategies at the Transformative level, integrating reporting mechanisms, digital citizenship education, staff development, student participation, and responsible AI governance.

Importantly, the framework is not conceived as a ranking or auditing tool. Instead, it is intended as a participatory self-assessment instrument supporting institutional reflection and organisational learning. In this sense, the framework may help universities identify strengths, gaps, and priorities for developing safer and more inclusive digital campuses capable of preventing discriminatory and exclusionary online dynamics.

3 Conclusions

The paper proposes a first operationalisation of the Inclusive Digital Readiness Model previously developed in the context of refugee and migrant inclusion. By extending the framework toward broader questions of digital participation, online safety, and hate speech prevention, the study argues that countering harmful digital dynamics requires not only technological solutions, but also institution-wide cultures of inclusion, ethical governance, critical digital literacy, and democratic participation.

Future developments will focus on the empirical validation of the framework through participatory workshops and institutional case studies involving higher education stakeholders working on digital inclusion, AI governance, human-rights-based education, and online hate prevention. This validation process will also explore the feasibility of translating the maturity descriptors into an Inclusive Digital Readiness Index, enabling institutions to monitor their progression towards safer, more inclusive, and rights-based digital participation.

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Migrant Learners and Inclusive AI: An Exploratory Case Study on Italian as a Second Language (L2) in CPIAs

Francesco Pio Dilillo [1][0009-0000-9892-1331], Arianna Beri [2][0009-0003-5122-9884] and Laura Sara Agrati [1][0000-0003-0108-5176]

[1] Telematic University of Pegaso, Naples, Italy
[2] University of Bergamo, Bergamo, Italy
francescopio.dilillo@unipegaso.it; arianna.beri@unibg.it; laurasara.agrati@unipegaso.it

1 Introduction

Provincial Centres for Adult Education (CPIA) currently represent one of the educational settings in which schools engage most directly with the complexity of contemporary society. Within these centres coexist diverse migration histories, heterogeneous levels of language proficiency, often fragmented educational backgrounds, and learning needs related not only to the acquisition of Italian language skills but also to social participation and access to services [1].

From this perspective, the use of technology can be framed within a broader reflection on Diversity Management, as well as on the reception, support, and inclusion of learners from different cultural and linguistic backgrounds [2]. CPIAs also play a central role in adult education pathways and in the processes of linguistic and social inclusion of foreign learners, as learning Italian as a second language (L2) is an essential tool for participation in the host community and for social and professional integration [3]. In this sense, the CPIA is not merely a place of learning, but also an environment for reception, guidance, and intercultural mediation.

2 Exploratory Case Study

This paper presents an exploratory empirical study conducted at CPIA 1 Bari "Alessandro Leogrande" with the aim of investigating possible forms of migrant learning, understood as the processes through which individuals with a migration background acquire new linguistic, professional, and social competences that are essential for integration into a new socio-cultural context. The study adopts an exploratory-descriptive quantitative research design [4] aimed at examining the use of Artificial Intelligence (AI) technologies for inclusive purposes within Provincial Centres for Adult Education (CPIAs). The questionnaire was designed to investigate perceptions, attitudes, organizational conditions, and challenges related to the introduction and use of AI in the educational and inclusion processes of the institution.

Drawing on the collected data, the study reflects on the conditions required to design AI-supported Italian as a Second Language (L2) learning pathways for adult migrants.

Particular attention is devoted to the relationship between learners' linguistic needs, the school's organizational capacity, and the role of the digital team as a mediating

actor between technological innovation and everyday teaching practices. AI can support Italian L2 learning pathways by adapting educational materials, providing feedback, and facilitating language comprehension; however, its use requires pedagogical mediation and careful consideration of the ethical implications associated with AI technologies and educational data [5]. Descriptive statistical results (n. 6) reveal an overall positive orientation of the CPIA digital team toward the use of AI in adult education programmes. The most highly valued benefits concern support for the linguistic inclusion of foreign learners ($M = 4.50$), the promotion of innovative teaching practices ($M = 4.50$), the contribution to more inclusive and diversity-sensitive CPIAs ($M = 4.33$), and the production of differentiated teaching materials ($M = 4.17$).

Positive evaluations also emerged regarding AI's capacity to address the needs of learners with different linguistic, cultural, and educational backgrounds ($M = 4.17$) and to personalize learning pathways ($M = 4.00$). More moderate levels of agreement were found concerning AI's potential to enhance the engagement of learners experiencing participation difficulties ($M = 3.17$) and to support the early identification of situations at risk of educational dropout or exclusion ($M = 3.67$). Spearman's rho showed a positive association between age and the importance attributed to equity and inclusion principles ($\rho = 0.894$, $p = 0.016$), a negative association between age and the perceived need to strengthen learners' digital competences before AI use ($\rho = -0.894$, $p = 0.016$), and a negative association between years of professional experience and perceptions of AI's potential to support the early identification of educational exclusion or dropout ($\rho = -0.875$, $p = 0.022$). These findings should be interpreted as exploratory due to the very small sample size.

Overall, AI is perceived as a promising resource for supporting more inclusive, personalized, and innovative educational processes, while also requiring careful attention to the ethical and training-related issues associated with its implementation.

3 Discussion and Conclusion

Although the findings refer to an exploratory case study based on a very small sample (n. 6), they reveal a generally positive attitude toward the integration of AI into adult education pathways. This limitation should be interpreted in light of the fact that the study involved the entire target population, corresponding to 100% of the members of the CPIA digital team. Particularly noteworthy is the association between AI, linguistic inclusion, and the personalization of learning, dimensions that are of strategic importance within CPIAs, which are characterized by highly heterogeneous educational trajectories and learning needs. This contribution is situated within the framework of school Diversity Management and offers a critical perspective on digital innovation in CPIAs. Managing diversity in educational settings requires inclusive organizational practices and leadership capable of recognizing and valuing learners' cultural, linguistic, and social differences [6].

From this perspective, AI may represent an opportunity to develop more flexible, accessible, and personalized learning pathways. At the same time, however, its implementation may risk amplifying existing inequalities if factors such as access to technology, users' digital competences, the availability of adequate infrastructure, and teacher training are not adequately addressed.

In conclusion, this study aims to contribute to the ongoing debate on socially responsible educational AI, capable of responding to learners' actual needs and the concrete conditions of educational institutions. Future research, based on larger samples and mixed-method approaches, may provide a deeper understanding of the role of AI in supporting linguistic and social inclusion within adult education contexts.

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Special Track 4

Press Start to Research! Exploring Artificial Intelligence and Gamification for Social Inclusion

Organizers:
Pierpaolo Limone, Pegaso University, Italy
Giusi Antonia Toto, University of Foggia, Italy
Luigi Traetta, University of Foggia, Italy
Viviana Vinci, University of Foggia, Italy

Teaching Artificial Intelligence through Game-Based Learning in Higher Education: A Review of the Literature

Massimiliano Andreoletti[1[0009-0009-4668-4974]], Andrea Tinterri[2[0000-0001-5891-505X]], Maria Concetta Carruba[2[0000-0001-9316-6509]], Maria Clara Dicataldo[2[0000-0001-6999-4128]], Marika Lamacchia[3[0009-0008-9944-9217]], Francesco Facciorusso[3[0009-0003-7563-5182]], Anna Dipace[2[0000-0001-9826-073X]]

[1] Department of Pedagogy, Università Cattolica del Sacro Cuore, Milano, Italy
[2] Faculty of Humanities, Education and Sports, Pegaso Telematic University, Naples, Italy
[3] Department of Education, Cultural Heritage and Tourism, University of Macerata, Italy
m.andreoletti@unicatt.it

1 Introduction

Artificial Intelligence (AI) is increasingly recognised as a transformative technology with significant implications for education, employment, and civic participation. As AI-driven systems become progressively integrated into everyday and professional contexts, educational institutions are expected to equip learners with the competencies required to understand, critically evaluate, and effectively interact with these technologies. Recent international frameworks identify AI literacy as a key educational priority, emphasising the need to foster technical understanding, critical awareness, and responsible engagement with AI systems [1]. AI literacy has been defined as the set of competencies that enables individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI systems, and use them appropriately [2]. There is an increasing need for instructional approaches capable of promoting active engagement and meaningful knowledge construction. Game-Based Learning (GBL) has emerged as a promising pedagogical approach, supporting participation, problem-solving, collaboration, feedback, and higher-order cognitive processes [3]. These characteristics appear particularly relevant for AI education. Recent empirical studies have reported positive outcomes associated with the use of game-based approaches for teaching AI-related concepts [4,5]. The available evidence remains fragmented across disciplines, instructional designs, and educational contexts [6,7]. Existing reviews have primarily examined AI education or Game-Based Learning as separate fields of inquiry, providing limited insight into how game-based approaches are specifically employed to support the teaching and learning of Artificial Intelligence in Higher Education. Consequently, there is currently no comprehensive synthesis of evidence regarding the AI topics addressed, the instructional strategies adopted, the assessment methods employed, and the educational outcomes reported. To address this gap, the present study adopts a scoping review methodology to map and synthesise the existing literature on the use of Game-Based Learning for teaching Artificial Intelligence in Higher Education.

2 Methods and Materials

This study adopts a scoping review methodology to map the existing literature on the use of Game-Based Learning (GBL) for teaching Artificial Intelligence (AI) in Higher Education. The review is reported in accordance with the PRISMA-ScR guidelines [8].

The review was guided by the following research question: How is Artificial Intelligence taught through Game-Based Learning approaches in Higher Education?

A structured search was conducted in Scopus, ERIC, and Web of Science, selected for their relevance to educational research and higher education studies. The search strategy combined terms related to Artificial Intelligence, Game-Based Learning, and Higher Education.

3 Preliminary Results

The search identified 214 records across the selected databases (Web of Science = 88, Scopus = 81, and ERIC = 45). After removing 62 duplicates, 152 unique records underwent title and abstract screening. Fifty-six studies were excluded, mainly because they lacked Artificial Intelligence components or Game-Based Learning features, resulting in 96 studies eligible for full-text review. A preliminary analysis of these 96 eligible publications reveals a clear upward trend in annual research output, particularly within higher education contexts. Empirical quantitative designs predominate, alongside design-based interventions and machine learning framework evaluations. The primary educational objectives addressed center on soft skill assessment, such as time management, decision-making, and planning, as well as personalized academic guidance and student performance prediction. Initial synthesis demonstrates a burgeoning interest in synthesizing adaptive artificial intelligence algorithms with serious game mechanics to foster responsive, learner-centered learning environments.

4 Conclusions

The increasing relevance of AI literacy and the complexity of AI-related concepts require innovative instructional approaches capable of fostering meaningful learning experiences [1,2]. By mapping the available evidence, this scoping review aims to provide a systematic overview of how Game-Based Learning is being employed to teach Artificial Intelligence in Higher Education. The findings are expected to support evidence-based curriculum design, instructional practices, and future research in AI education [3,6,7].

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Human-in-the-Loop in Schools: A European Study on Instructional Design Within the STIAEM Project

Viviana Vinci[1[0000-0002-4091-0098]], and Pierangelo Berardi[1[0009-0005-3073-5360]]

[1] Foggia University, Foggia 71100; ITALY
viviana.vinci@unifg.it

1 AI Literacy in Schools: The Multilevel Approach of the STIAEM Project

Generative Artificial Intelligence (GenAI) in educational contexts outlines a radical epistemic and evaluative restructuring of learning processes and knowledge construction [1]. This systemic shift calls into question international programmatic priorities, including those outlined by the European Commission's Digital Education Action Plan (2021-2027), forcing pedagogical research to overcome the fragmentation and makeshift nature of local application experiences in order to structure systematic reflections on the level of algorithmic literacy (AI Literacy) and actual behavioral responses to emerging technologies [2]. In this scenario, the present contribution is situated within the scientific activities and research lines of the European project "Slow Tech Innovation: AI, Ethics, and New Teaching Methods" (STIAEM, 2025-1-IT02-KA220-SCH-000365213), an international cooperation initiative funded by the Erasmus+ program under partnerships for school education. The project is configured as a multilevel research-intervention action, aimed at articulating systemic synergies among educational institutions, regional governance offices, and universities. The core objective of the consortium, which brings together organizations located across five European countries (Italy, Greece, Turkey, Spain, and Lithuania), lies in enhancing the digital and methodological competences of the teaching staff to promote an introduction of AI in educational contexts that is authentically ethical, critical, and reflective.

2 Algorithmic Literacy Between Critical Awareness and Instructional Design

In line with the guidelines of the OECD and the European Union [3], algorithmic literacy is anchored on the triad of knowledge, skills, and attitudes. On the cognitive level, this requires demystifying the functioning of the machine, explaining that AI does not think like a human being but generates responses based on statistical calculations and probabilities [4], thereby distinguishing the output from authentic human intentionality [5,6]. In this approach, ethical reflection cannot be configured as a separate topic, but must unveil the structural problems linked to these technologies: from hidden biases to privacy violations in dataset training [7,8].

To remain faithful to the Human-in-the-Loop horizon, school-based Instructional Design must therefore enable a responsible posture [9,10] capable of protecting

educational action from the hallucinations of language models [11], ensuring that it is the teacher, and not the artificial agent, who governs the didactic transposition and the epistemic core of the lesson.

On these bases, two research questions are articulated: the first assesses the impact of macro-exogenous variables (seniority and national context) on self-efficacy and security; the second verifies whether the Slow Tech choice is linked to mere technical confidence or mediated by a genuine ethical-critical awareness.

3 Research Design and Data Collection Instrument

The study adopts a transnational quantitative research design. The investigation capitalizes on empirical data collected through a standardized multilingual instrument administered to a large sample of 1,355 secondary school teachers active in the five consortium countries (Italy, Greece, Turkey, Spain, and Lithuania). Integrating validated scales and three dilemma scenarios, the instrument showed high psychometric reliability across languages. The instrument allowed for the measurement of general digital-pedagogical self-efficacy in AI usage, technological anxiety, and digital safety according to the DigComp 3.0 framework. The experimental and evaluative core of the survey lies in the submission of situated dilemma scenarios. Specifically, scenario SD01 explored teachers' behavioral responses and strategic instructional design choices when faced with the risk of cognitive offloading and the loss of professional agency, measuring the propensity to abdicate the role of creators in favor of algorithmic efficiency versus safeguarding intentionality and the educational relationship.

4 Data Analysis and Results

The analytical workflow was executed entirely within the R environment to overcome the barriers of local linguistic nesting inherent in nominal data. Data analysis was structured into two successive phases. In the first phase, the application of a Type III ANOVA revealed that teachers' general self-efficacy in AI usage is strongly influenced by both years of service and country of origin ($F = 9.70$, $p < 0.001$). Conversely, competences relating to digital safety and environmental sustainability are uniformly distributed, showing no significant differences across the different generations of teachers ($F = 0.16$, $p = 0.91$).

In the second phase, a binary logistic regression model was estimated to understand what drives a teacher to choose the path of using AI as scaffolding, meaning using AI only for initial brainstorming while creating lessons and slides independently. The results show that high general technological self-efficacy reduces the probability of choosing this active posture by 19% (Odds Ratio = 0.811, $p = 0.0052$): indeed, those who feel technically highly confident tend to delegate material creation to the machine instead of preserving their own creative effort. In contrast, awareness of digital safety does not affect this decision (Odds Ratio = 0.941, $p = 0.4687$). This evidence demonstrates that teachers' resistance is not driven by concerns over data privacy, but rather by an intrinsic motivation linked to educational passion and the safeguarding of classroom relationships.

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The Inclusion Paradox: When AI-Driven Serious Games Risk Reinforcing Algorithmic Exclusion

Nadia Di Leo [0009-0004-2919-4096], Antonino Tarantino [0009-0006-0845-8173] and Giusi Antonia Toto [0000-0001-5538-5858]

Department of Humanities, University of Foggia, Foggia 71121, Italy
{nadia.dileo; antonino.tarantino; giusi.toto}@unifg.it

1 The Inclusion Paradox

This position paper examines AI-driven serious games in formal and non-formal education, with a focus on disabled and neurodivergent learners. Recommender systems and dynamic difficulty adjustment (DDA) depend on a model of normal participation. If training data underrepresent how a learner reads, navigates, communicates, or uses assistive technology, adaptation may misread difference as low engagement or ability [1-4]. We call this the inclusion paradox: a game designed for inclusion can exclude through the inferences that determine a learner's path. Based on narrative synthesis, the paper connects AI ethics in education [1, 2], human-centered learning analytics and disability inclusion [3, 4], algorithmic bias [5], and disability scholarship [6]. It asks what project teams must disclose and test before claiming that an adaptive serious game is inclusive.

2 Where Exclusion Enters Adaptation

Recommender systems select the mission, story branch, or task a learner encounters next, often by optimizing time on task, completion, or return visits. A learner who rereads, uses a screen reader, or plays through switch access may resemble a disengaged user in the training data. The system may then route that learner toward shorter or easier material. The optimization target and behavioral baseline produce exclusion without an explicit rule. DDA changes challenge in response to performance. Slower input or nonlinear exploration can trigger easier tasks before competence can be demonstrated. That adjustment shapes later data: after advanced work is withheld, the system sees fewer observations that could correct its estimate [5]. Representative data may reduce errors, but they cannot define engagement, success, or appropriate support. Those are pedagogical choices with distributional consequences [3, 4, 6].

3 Checklist Development and Design Checks

The checklist was developed from the narrative synthesis in three passes. Recurring risks and safeguards were extracted from the four literature strands above, mapped to

data, optimization, adaptation, evaluation, or governance, and screened for questions that a project team could answer with records or outcome data [1-6]. This procedure turns the conceptual argument into a design and reporting aid. It does not establish certification criteria.

Project teams should identify the populations used for training and tuning and those expected in deployment; large gaps should be treated as unvalidated transfer. They have to separate engagement proxies from learning outcomes and justify each optimization target, and to record adaptive moves and make them legible to the learner and educator. It's important to provide a full-content, non-adaptive route with no penalty for choosing it, and to test subgroup outcomes and whether post-adjustment data can revise the system's initial estimates. These teams should involve affected communities in paid co-design during development and evaluation, and record when an AI layer is refused because it adds no educational value.

4 Implications and Limits

Personalization alone is not evidence of inclusion. Evaluation should examine whether named groups retain comparable access to tasks and opportunities to demonstrate learning. Learners and educators also need to understand and reverse adaptive moves. Reports should present subgroup outcomes and failure cases alongside aggregate results.

The argument relies partly on evidence from adjacent domains, and the checklist has not yet been validated in serious-game studies. Future case studies should log adaptive decisions, compare adaptive and non-adaptive routes, and examine whether particular groups are repeatedly moved toward lower-value content. This would test whether an intervention broadens participation or merely changes the form of exclusion.

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When error becomes connection. AI-assisted relational analytics in gamified educational robotics for cognitive and socio-emotional inclusion

Tripaldi Mariella[1][0009-0001-3274-0818], Brandao De Souza Camilla[2][0009-0002-3380-8922], Barca Alessandro[3][0000-0003-1980-5178]

[1]Ca' Foscari University, Venice, Italy, mariella.tripaldi@unive.it
[2]Ca' Foscari University, Venice, Italy, camilla.brandaods@unive.it
[3]Link Campus University, Rome, Italy, a.barca@unilink.it

The growing convergence of gamification, educational robotics, visual programming, and artificial intelligence is reshaping learning environments, modes of participation, and students' access to cognitive, social, and relational opportunities. However, increased engagement does not necessarily equate to inclusion. A game-based learning environment may appear motivating and participatory without producing a genuine redistribution of opportunities for initiative, voice, cooperation, recognition, and agency, particularly in heterogeneous classrooms that include students with special educational needs, specific learning disorders, mathematics learning difficulties, and neurodivergent profiles. From this perspective, the present contribution reports the findings of a quasi-experimental pilot study on a gamified educational robotics intervention in lower-secondary education and proposes a model of AI-assisted relational analyticsfor the critical examination of the observational and narrative data generated by the learning experience. The study investigates whether the participation fostered by game-based activities also corresponds to substantive forms of cognitive, socio-emotional, and relational inclusion. The theoretical framework is grounded in the construct of Embodied Relational Scaffolding (ERS), developed to describe how robotic mediation can transform error from an individual sign of inadequacy into an externalised, visible, negotiable, and collectively correctable event. The construct integrates three converging perspectives: embodied cognition, which situates cognitive processes within bodily interaction with artefacts and environments [1, 2]; cultural-historical theories of mediated learning, which interpret tools as means of reorganising action and intersubjectivity [3, 4]; and Self-Determination Theory, which identifies autonomy, competence, and relatedness as fundamental motivational conditions for meaningful learning [5, 6]. From this perspective, the robot is not regarded as a mere technical aid, but as an embodied mediator that renders mathematical reasoning physically traceable, socially discussable, and pedagogically revisable. The empirical component is based on a quasi-experimental pilot study conducted in three second-year lower-secondary classes, sections B, C, and D, at a school in Grottaglie, Southern Italy. The initial sample comprised 73 students. One student began the programme but subsequently transferred to another school and was therefore excluded from the final analyses. The analytical sample consequently consisted of 72 participants, equally distributed between the experimental and control groups: 36 students in the gamified educational robotics group and 36 in the control group. The classes reflected the ordinary complexity of an inclusive

educational context, comprising both typically developing students and students with different types of special educational needs. The twelve-week intervention consisted of two 45-minute sessions per week and integrated curricular mathematics, problem solving, visual programming, and collaborative learning. In the experimental group, students used Ozobot EVO both in an analogue mode based on physical colour-coded sequences and in a digital mode through OzoBlockly, together with SAM Labs, a modular platform programmed through a drag-and-drop interface. The activities addressed core curricular topics, including arithmetic operations, powers, factorisation, greatest common divisor, geometry, and multi-step problems related to everyday situations. The control group worked on the same curricular content through conventional instructional methods. Data collection combined pre- and post-intervention mathematics tests, systematic observations of classroom behaviour, self-report questionnaires on motivation and mathematics anxiety, teacher interviews, qualitative feedback from families, and a delayed follow-up assessment. At post-test, the experimental group significantly outperformed the control group in mathematics achievement. The robotics group obtained a mean score of 75% (SD = 17.6), whereas the control group obtained a mean score of 60% (SD = 14.8), with a statistically significant difference and a large effect size, $t(70) = 3.91$, $p < .001$, Cohen's $d = 0.92$. Follow-up findings suggested that the improvements observed in the experimental group were partially sustained over time, $t(35) = -5.87$, $p < .001$. At the socio-emotional and relational levels, structured observations indicated increased active participation, collaborative engagement, and willingness to engage with challenging tasks in approximately 70% of the students in the robotics group. A significant negative correlation was also found between mathematics anxiety and motivation ($r = -.42$, $p = .004$). This association is particularly relevant in an environment in which error is not presented as a personal judgement but becomes a visible point in the robotic process that prevents the robot from proceeding and that the group can review, discuss, and correct. The pedagogical distinctiveness of the intervention therefore lies in the reconfiguration of error. In conventional tasks, error often tends to become attached to the student, especially when the learner has a history of difficulties or an educational profile already perceived as vulnerable. In the gamified robotics environment, by contrast, error materialises as an interruption of the path, a deviation from the sequence, or a mismatch between instruction and movement. It consequently becomes a shared object of inquiry, decoupled from personal stigma and made available for collective reflection. It is through this transformation that the Embodied Relational Scaffolding framework demonstrates its theoretical plausibility. The robot neither replaces the teacher nor automates the educational relationship. Rather, it contributes to constructing a participatory space in which students can assume cognitively meaningful roles, negotiate solutions, support one another, and experience error as a generative stage in the learning process. The artificial intelligence component is situated at a methodological and evaluative level. The paper proposes a protocol of AI-assisted relational analytics aimed at analysing, under researchers' supervision, the observational and narrative data produced by the robotic serious game. These data include episodes of error, requests for help, conversational turns, role distribution, correction strategies, persistence in the task, peer support, and possible signs of marginalisation. AI is not used to classify students, infer emotional states through biometric data, or replace the

pedagogical judgement of teachers and researchers. Its function is heuristic and critical: it supports the identification of recurring patterns of participation, co-regulation, dependence, initiative, and belonging by comparing human coding with an AI-assisted analysis of qualitative evidence. From this perspective, inclusion is not equated with a mere increase in motivation or with students' physical presence within the group. Rather, it is understood as an effective opportunity to participate in the construction of reasoning, take initiative, be recognised by peers, contribute to problem solving, and transform error into a shared learning opportunity. The risk of an "illusion of inclusion" – technological participation without genuine cognitive, emotional, and relational belonging – requires gamified environments to be evaluated not only in terms of performance and engagement, but also in relation to the quality of the interactions they generate and the inequalities they may conceal. This contribution offers three main elements of relevance to the international debate. First, it provides preliminary evidence of the effectiveness of gamified educational robotics in improving mathematics performance and supporting motivation and participation in heterogeneous classrooms. Second, it proposes Embodied Relational Scaffolding as a theoretical framework for understanding the pedagogical function of error in game-based robotic environments. Third, it introduces AI-assisted relational analytics as a model for critically evaluating the inclusive quality of serious games, avoiding both the reduction of AI to a mere instrument for task personalisation and the naïve assumption that technology automatically produces inclusion.

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Special Track 5

The Digital Self: Creative Practices and Non-Linear Languages for Building Socio-Emotional and Affective Skills in the Age of AI

Organizers:
Nadia Carlomagno, Suor Orsola Benincasa University, Italy
Ada Manfreda, Pegaso University, Italy
Salvatore Colazzo, Mercatorum University, Italy

Inhabiting Experience, Narrating Territories: Audiovisual Languages in a Situated Research-Training Process

Eleonora Greco[1] and Angela Mancarella[2]

[1] Pegaso University, Naples, Italy
[2] University of Bari Aldo Moro, Bari, Italy
eleonora.greco@unipegaso.it
a.mancarella11@phd.uniba.it

1 Introduction

The increasingly widespread use of digital technologies, now further reshaped by the rise of Artificial Intelligence, has progressively transformed how knowledge is produced, shared, and reworked in educational and research contexts [1]. Languages such as photography, video, audio recordings, and graphic representations make it possible to document and rework dimensions of experience that are often implicit and not fully accessible through verbalization alone [2], including gestures, relationships, ways of inhabiting space, and forms of proximity. The methodological relevance of these languages becomes particularly evident when framed within an embodied and situated conception of learning [3]. From this perspective, the integration of audiovisual languages makes it possible to engage more closely with the multisensory and multidimensional nature of experience, while opening up hypermedia and transmedia forms of knowledge construction, interpretation, and restitution. This is particularly true when research and educational processes are rooted in territories [4], understood as living environments, that are the outcome of a complex interweaving of design, relational, and symbolic practices [5]. Capturing this complexity requires, in our view, the construction of data capable of interconnecting the multiple dimensions of territorial experience. In this respect, audiovisual languages can enable observation of and interaction with the territory from multiple perspectives, expanding how space is perceived and understood [6].

Building on these premises, this paper aims to examine the role of the audiovisual as a methodological option through which to connect data production, analysis and interpretation, and the restitution of research findings, with particular attention to their impact on socio-emotional and affective dimensions. It does so by drawing on a series of field-based experiments that we conducted between September 2025 and June 2026 as part of the 14th edition of the School of Performing Arts and Community Care.

2 Audiovisual Languages in Situated Research-Training: the Case of School of Performing Arts and Community Care

The School of Performing Arts and Community Care is a research-training-intervention initiative for community activation. Since 2012, it has engaged small rural communities in south-eastern Salento affected by depopulation, educational poverty, and social and economic impoverishment. In its 14th edition, the experience extended beyond the geographical boundaries of Salento, building relationships with other communities located in peripheral and marginal areas across different Italian regions. Among its various field-based activities, this new edition introduced the so-called "Attraversamenti", research journeys in which the group participating in the School engages with host organizations and local actors through the exchange of narratives, artefacts, and experiences, exploring their cultural specificities, challenges, and strategies of "restanza". The "Attraversamenti" involved a research group comprising five PhD students, two full professors of Experimental Pedagogy, a videoreporter, a photographer, local witnesses, residents, and participants in the School. The research group adopted a participatory role: it took part in the activities, interacted with the local actors encountered, and directly contributed to the production, organization, and analysis of the materials progressively collected throughout the different stages. We produced photographs, videos, audio recordings, and transcripts, amounting to a total of 5,312 resources, building a multimodal corpus through which to observe and examine how communities narrate themselves, their heritage, and territorial transformations. The collected materials were archived, catalogued, and subsequently discussed and reworked in dedicated group settings: the polyexpressive workshops, which provided a space for the negotiated analysis and interpretation of the data. Through the selection and association of keywords, transcript excerpts, observations, images, voices, and visual sequences, we progressively constructed a shared thematic and analytical digital map. This map was used to identify connections, recurring patterns, and cores of meaning cutting across the different stages. The thematic and interactive process of analysis and reworking resulted in the creation of a photographic narrative and a video narrative, which constitute our proposed form of research "report".

3 Conclusion

The methodological challenge that this paper addresses concerns the possibility of preserving the complexity of audiovisual data throughout the entire research process. From this perspective, treating audiovisual language as complex research data means moving beyond its merely documentary use and developing an equally articulated process of reading, analysis, and interpretation that reflects its nature. The interpretative outcome then takes shape through the audiovisual language itself. In the "Attraversamenti", this methodological option assigned audiovisual language a dual function: as a tool for con-

structing the data and as a language through which the data could be analysed and interpreted, generating the research outcome. Within the polyexpressive workshops, this dual function was operationalized through the decomposition and recomposition of the qualitative, multi-format corpus produced. This process transformed the recurring elements identified across the materials, experiences, and different contexts encountered into interpretative connections. This required the research group to reflect on its own ways of representing the communities encountered and to engage with a plurality of perspectives, including those of experts. The workshop thus became a space for the negotiated and shared analysis and interpretation of the data, which took shape in the photographic narrative and video narrative. The two visual products therefore function as scientific reports because they extend conventional text-based modes of representation. The restitution to the communities brings the interpretation back into the contexts and relationships in which the corpus was constructed, opening it up to discussion and comparison. Within this intermediate, genuinely liminal space, audiovisual language can also become an opportunity for recognition: a symbolic space in which a community can reinterpret itself, engage with an external perspective, and reimagine itself.

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FROM HERITAGE TO AGENCY: THE DYNAMIC COMMUNITY MAP FOR SITUATED PARTICIPATION AND COLLECTIVE CREATIVITY

Ada Manfreda [0000-0003-2309-7418] and Riccarda Boriglione

Pegaso Telematic University, Naples, Italy
ada.manfreda@unipegaso.it
riccarda.boriglione@unipegaso.it

1 Introduction

Is it possible to revitalise a sense of belonging to a territory without first restoring the community's capacity to recognise itself in and through it? And what is lost–in terms of social cohesion and the capacity for collective action – when this capacity is eroded and the community delegates the narration and stewardship of its heritage to others?
Against a backdrop of increasingly pervasive digitalisation and the transformation of forms of social participation, this contribution, situated within the epistemological framework of community studies and cultural heritage enhancement, reflects on the protocols, devices, and operational dynamics that need to be designed in order to bring physical presence, corporeality, and situated intersubjectivity into productive dialogue with digital spaces for co-design and knowledge sharing, within participatory practices aimed at fostering community agency through the enhancement of cultural heritage. The contribution proposes the Dynamic Community Map (DCM) [1] as a physical and digital relational space in which the community can recognise itself once again and, in the very act of doing so, learn and develop capacities for collective action. The co-construction of the map activates a process of situated learning rooted in interaction among participants, in the exchange and comparison of personal memories, and in the mutual recognition of shared values and forms of belonging, thereby fully configuring itself as an educational device. Through a reflective process, otherwise invisible symbolic, representational, and emotional dimensions of the self and of the territory emerge, enabling the community to become aware of its collective creative and transformative potential, while developing shared knowledge of the territory. This, in turn, provides a foundation for strengthening active citizenship and the community's capacity to consciously shape its own processes of change.

2 The Dynamic Community Map as a hybrid methodological device

The DCM is a methodological device theorised within the research of the PLACE Laboratory (Participatory Local Action for Community Empowerment), starting from the observation of a recurrent and widely documented limitation of participatory mapping

practices: the tendency to privilege the final product over the relational process through which it is generated, thereby returning to the community a representation of the territory rather than restoring its capacity to co-construct it [2]; [3]. The Dynamic Community Map is interpreted here as a co-design device that develops the restitution of the Needs Mapping (NM) [4] – a narrative, semiotic, and iterative practice aimed at bringing to the surface the tacit meanings through which a community interprets itself and its living environment – through the Community-Centered Design (CCD) approach [5], which reconfigures the logic of design thinking around the interdependencies and relationships that hold a community together [6]. In this contribution, we explore the creative, educational, and transformative dimensions activated by the process of constructing the DCM: an informal and reciprocal learning space in which participants co-produce knowledge through interaction and through the emergence and sharing of symbolic – emotional elements, recognising themselves as bearers of local knowledge and as actors capable of collective action within their own territory. The concept of the *third place* [7] provides a further framework through which to understand the DCM itself: an accessible, informal, and conversational space that shares its relational nature, while adding a prospective and generative dimension, insofar as it enables the community to collectively imagine what it may become. The case study of Ortelle (LE), a municipality classified as an *Intermediate Area* by the National Strategy for Inner Areas [8] and as a *sub-coastal hinge territory* by the Puglia Regional Landscape Territorial Plan (PPTR) [9], shares several critical challenges, including depopulation, population ageing, and a fracture in community identity among younger generations, thus providing the empirical setting in which this approach is tested. Particularly fertile ground is provided by the co-design and activation process of the Ecomuseum of the Communities of South-Eastern Salento, a process in which creative methods constitute the means through which people traditionally excluded from formal participation mechanisms gain access to the DCM space and come to recognise themselves within it [10]; [11]. Finally, the contribution addresses the question of how this learning space can extend beyond physical co-presence without losing its relational nature. The development of a Hybrid Participation Kit, integrating analogue components in the public spaces of Ortelle with a modular ecology of digital platforms for participation and co-design, responds to the need to include a dispersed community: generations who have left the territory for study or work but who maintain a sense of identity and belonging connected to their place of origin.

3 Conclusion

The educational challenge that this contribution seeks to bring to the debate is how to preserve the quality of encounters with others and their intrinsic particularities in the 'here and now' of embodied presence, as bodies come into contact and resonance. This constitutes an irreducible condition for informal learning, social generativity, and, above all, the 'care' of places, relationships, and heritage, understood as an act of responsibility and emotional and affective investment. The Dynamic Community Map, experimented with in the case study of the Ortelle ecomuseum, emerges as a device that

transcends the representational function of participatory cartography to become a generative space for relational learning, collective creativity, and the promotion of agency. It thus operates as a hybrid space of care and symbolic-emotional investment in the construction of the self and of places of belonging, aimed at reactivating community bonds and generating new possibilities for shared action, including in contexts marked by social and demographic fragmentation. Moreover, the integration of analogue and digital dimensions opens up scenarios of hybrid participation, in which the relational continuity of the process can extend beyond physical co-presence. From this perspective, the central challenge remains that of designing socio-technical environments capable of sustaining genuinely relational co-learning practices while preserving the function of encounter as a practice of *vis-à-vis*, of co-inhabiting a shared space in which corporeality becomes a performative and formative vehicle [10]; [11] for symbolic-emotional experiences that need to be expressed, shared, processed, and transformed through reciprocal presence.

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Dramaturgies of the Self: The Digital as a Mediator in the Development of Emotional Competences

Valeria Vadalà[1] [0009-0000-9166-9356], Arianna Ricciardi[1],
Rosabel Roig-Vila[2] [0000-0002-9731-430X], Nadia Carlomagno[3] [0000-0001-8840-1113]
[1]Pegaso University, Naples 80143, Italy
[2]Alicante University, Alicante 03690, Spain
[3]Suor Orsola Benincasa University, Naples 80135, Italy
valeria.vadala@unipegaso.it - arianna.ricciardi@unipegaso.it
rosabel.roig@ua.es - nadia.carlomagno@unisob.na.it

1 Theoretical Framework

Algorithmic ecosystems continue to pervade our daily lives. Faced with the risk of an isolated and purely algorithmic Self-world [1], and the danger of a progressive deskilling of human and emotional faculties due to a passive delegation to machines [2], pedagogical research has the duty to question the possibilities of critically inhabiting this onlife dimension, in which barriers between analog and digital, or between natural and artificial, blur into an experiential continuum [3]. One wonders, then, whether the screen, rather than acting as a tool of separation and defense, can instead be redefined as an emotional and experiential amplifier. This question finds fertile ground within practices rooted in *Embodied Cognition* [4] or in the more current paradigm of the 4Es (Embodied, Embedded, Extended, Enacted) [5, 6], whereby cognitive and emotional processes do not reside solely in the brain, but emerge from the situated and embodied action of the organism in the world, making the use of artistic and performative practices fully plausible and fruitful as true embodied pedagogical devices [7, 8]. In light of these premises, the following study revolves around the following research question (RQ): *Can the integration of digital devices within pedagogical-artistic and embodied practices resignify the use of technologies as mediators and enhance emotional competences in future teachers?*

2 Context and Methodology

This contribution illustrates an exploratory pilot study conducted within the laboratory *Giocando s'impara - tecniche per l'animazione e la comunicazione teatrale*, a 3rd-year course of the Bachelor's Degree in Education Sciences at the *Università degli Studi Suor Orsola Benincasa* in Naples. The intervention involved a sample of 90 male and female students and was structured in 6 meetings of 3 hours each, for a total of 18 hours of training. The study fits within the methodological framework of Art Based Research (ABR) [9] declined through the experimental approach CReAP+T

(*Creativity/Corporeality, Relationship, emotion/emphaty Action, Performativity + Technology/Training*) [10]. In line with this choice, data analysis follows a mixed methods approach a structured Pre-test (T_0) and Post-test (T_1) questionnaire and the administration of a metacognitive report and an authentic task at the end of the path. The focus of the laboratory is experiential, performative, and theatrical: students took an active part in physical training, guided improvisations, and dramatic games that accompanied the entire duration of the meetings. A guided performative experience was also provided, in which participants were invited to interact with physical stations (Boxes) equipped with NFC (Near Field Communication) sensors. By bringing their smartphone close to the boxes, each participant individually listened in headphones to multimedia stimuli aimed at guiding the recognition, identification, and intimate awareness of their emotional states in the here and now, to then translate the emerged emotion into the creative writing of dramaturgical texts (fragments). Data collection involved the use of the *Emotion Regulation Questionnaire* (ERQ) [11], standardized and validated in the Italian version [12], aimed at mapping two macro-strategies that individuals use to regulate and manage their emotional states: 1) *Cognitive Reappraisal* (Cognitive Reappraisal) and 2) *Expressive Suppression* (Expressive Suppression). Among the emerged results, the Expressive Suppression scale recorded a statistically significant reduction in the post-test ($t(89) = -3.44$, $p < .001$), with a mean difference between before and after equal to -8.56. Furthermore, the analysis of qualitative data testifies how the technological interaction did not cool down the experience, but rather made it more intimate.

3 Conclusion

The pilot study demonstrates a real and possible integration of digital devices as mediators of meaningful training experiences [13]. The smartphone, on the other hand, can be converted into a catalyst for presence and self-awareness, if supported by an embodied and experiential architecture such as the theatrical one. The quantitative data and the participants' narratives highlight how the devices carried out a clear function of *creative inhibition* [14] which manifested itself through the acoustic isolation of the headphones and the audio/video materials that acted as a *functional inhibition*. This allowed the participants to reduce distractions, to gather in the *here and now*, and to make room for a deep, spontaneous, and unprecedented expressive choice. By significantly reducing the tendency to suppress emotions, the training experience provided future educational figures with a key emotional competence for their professional well-being, demonstrating that the New Digital Humanism is realized when technology stops replacing the human being and transforms into a resource that enhances their irreplaceable presence [15, 16].

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Special Track 6

Exploring the Role of "Expressive Mediators" in Inclusive Higher Education within Digital and Hybrid Environments

Organizers:
Leonardo Menegola, eCampus University, Italy
Paola Cortiana, eCampus University, Italy
Francesca Berti, Free University of Bolzano, Italy

Reflective Supervision, Communities of Practice and Expressive Mediators in Youth Work: A Pedagogical Proposal for the Training of Supervisors

Mattia Lamberti[0000-0003-1743-8917]

Catholic University of the Sacred Heart, Milan, Italy
mattia.lamberti@unicatt.it

1 Introduction and Pedagogical Framework

Professional learning for those who educate through reflective, symbolic, and expressive languages cannot rely on transmitting techniques alone. To form educators able to facilitate meaning-making in others, training must itself enact the reflective and relational qualities it seeks to cultivate. This contribution examines the training of supervisors in youth work — non-formal educational and participatory practices with young people [1] — a field in which supervision remains fragile and unevenly structured, and supervisors rarely have stable spaces for shared reflection and community learning [2]. The case comes from a European project developing a blended programme for future supervisors through a shared framework and a transnational community of practice. Although the setting is non-formal rather than academic, the underlying question — how educators are formed in the use of expressive and relational mediators within digital and blended environments — increasingly concerns higher education teaching staff.

The programme rests on a principle that organises its design: isomorphism. Future supervisors do not learn reflective and symbolic devices as content to be acquired; they undergo them first-hand, as recipients of a process resembling the one they will later facilitate. Two pedagogical traditions converge here. The first is the community of practice [3], where professional identity is built through participation, shared repertoires, and situated learning rather than transmission of technique. The second is socio-cultural animation [4], in which the emancipatory and consciousness-raising aims of educational work are not stated but embodied in coherent methodological choices [5]: the method already enacts the end it pursues. Together they give isomorphism a pedagogical genealogy in which form is inseparable from purpose. The principle extends to facilitation: trainers conduct the process non-hierarchically and non-judgementally, oriented to reflection and trust, implicitly modelling the supervisory posture participants are learning to inhabit as a relational space of listening and reflection [6]. Within this frame, expressive mediators are not ancillary aids to communication or engagement, but methodological and relational devices. Photolangage [7, 8], practices drawn from the aesthetics of the oppressed [9], and the shared digital portfolio [10] activate meaning-making discursively and in bodily, affective, and symbolic dimensions [11]. The bodily register is not incidental: where professional learning is

enacted rather than merely represented, the sensory and gestural engagement these mediators require is itself a mode of knowing [12]. Their pedagogical value lies in what resists full discursive or digital translation: the register of image, gesture, and sensory experience through which professional memory and imagination are mobilised [13]. Crucially, these mediators are turned toward the formation of the supervisors themselves: future supervisors do not study photolangage only as a technique, but experience the symbolic and affective activation they will later facilitate. The same device thus operates twice — as an object of future practice and as a present medium of the trainees' own learning — enacting, at the level of tools, the isomorphism that organises the programme.

2 Programme Architecture and Assessment

The programme unfolds as a single arc across two phases. An intensive four-day residential phase introduces the foundations of supervision and enacts its reflective and experiential posture; a six-month online phase consolidates this work with the same twenty-one participants in three language-based subgroups and the same trainers. The community of practice guides the second phase, stabilising an emerging professional belonging rather than adding new content. Three supervision meetings per participant provide the connective thread and material for collective online re-reading. The online devices embody the isomorphic principle at the level of architecture: shared digital boards hold a living memory of the group's trajectory, while an asynchronous channel sustains the community between meetings. Across the arc, trainers deliberately recede: structured prompts give way to group-led exchange until the community can sustain itself, modelling the movement from guided to mutual support participants will later enable as supervisors. Assessment follows the same logic rather than standing outside it: a pre/post self-assessment frames the residential phase, while the online phase shifts to reflective, relational appraisal sustained through group and tutor interaction rather than measured against fixed standards, with no separate individual artefact.

3 Design Principles and Implications

Two design principles outlast this non-formal setting. The first is isomorphism: educators are prepared to facilitate reflective and expressive processes by experiencing those processes themselves, as participants before practitioners. The second is the designed recession of the facilitator: guidance is progressively withdrawn until a reflective community can sustain itself. Both extend beyond youth work to the formation of higher education faculty in the use of expressive, embodied, and symbolic mediators within online and hybrid environments, rather than mere instruction in the platforms that host them. The programme offers a worked example, not a model to transpose, of coherence between method and aim. These principles form a design argument grounded in a case still unfolding; their test lies in ongoing implementation and transfer to higher education.

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Designing the irreducible: expressive mediation for inclusive hybrid higher education

Leonardo Menegola[1] [0000-0003-4712-4740], Antonio Balestra[2] [0000-0001-6204-6723], Daniela Maggi[1] [0000-0002-6886-8725]

[1] e-Campus University
[2] Link Campus University
leonardo.menegola@uniecampus.it, a.balestra@unilink.it, daniela.maggi@uniecampus.it

1 Problematising platform pedagogy

Innovation in digital higher education is frequently shaped by what may be termed platform pedagogy: a design culture centred on virtual learning environments, content delivery, learning analytics and data-driven optimisation, equating educational quality with connectivity and digital competence. Instructional design is thereby reduced to its technological and logistical dimensions, leaving in the background the social, bodily and relational processes through which student participation and human mediation take shape [1,2]. This theoretical-design contribution problematises that reduction and proposes expressive mediation as a principle of inclusive design: in online, blended and hybrid settings, the formative relationship cannot be exhausted by access to a platform or interaction with an interface, and design must instead integrate students' corporeal and situated presence, symbolic production, multimodality and participation.

2 Reframing mediation

The argument recomposes two conceptions of mediation within a single epistemological frame. In the first, mediation is a set of facilitating functions performed by an adult who orients learners' attention, regulates complexity, gives intentionality to meaning and conveys a sense of competence and reciprocity [1,2]. In the second, the mediator is an experiential, performative, bodily, symbolic and ritual device through which educational processes become possible and communicable in a shared form [3,4].

The two converge in that facilitating functions are never purely abstract: they are enacted through the body, voice, rhythm, timing, gaze, gestures and shared rituals of work. Every expressive mediator has a dual nature. It functions as a code, a language or grammar that makes expressivity and transmissibility possible, and as a channel, the physical medium that carries it: a space, an object, or the body itself. The epistemological specificity of mediation precedes any digital instantiation. As long as digital media operate within an irreducibly corporeal and material context, no education is, nor will ever be, purely digital. Learning environments are therefore always already hybrid.

3 Designing for inclusion

The framework adopts Universal Design for Learning as a design grammar for preventing barriers and making inclusion structural, built into the environment from the outset for the full range of students [5,6,7]. Its three principles - representation, action and expression, and engagement - structure expressive mediation, from which four interconnected design dimensions emerge: access, expression, relation and agency.

The proposal is also grounded in enactive and ecological paradigms, which understand learning as a situated, distributed process generated through the interaction of body, environment, tools and social practices [8,9,10]. Here mediators are constitutive devices, not motivational supports grafted onto an already complete cognitive process: through them students access tasks, construct meaning and join learning communities. The paper thus understands cognition as enacted, embedded and embodied. The fourth E, extended, is bracketed not to deny extension as a cognitive fact, but to suspend its platform-centred reduction to digital infrastructure, connectivity and instrumental expansion.

4 Operational grounding in Hybrid Learning Circles

These dimensions find operational grounding in the Hybrid Learning Circles (HLC) model, developed through a three-year action-research study at Milano-Bicocca University (2022–2024, N = 252, 52 groups, 99.6% completion rate) [11]. It is presented as the framework's operational anchor, not a new empirical evaluation. HLC emerge as extended pedagogical ecologies in which bodies, materials, media, documentation and collaboration jointly construct meaning, beyond a juxtaposition of presence and online delivery [12,13,14]. The model foregrounds the enacted, embedded and embodied texture of mediation, without reducing it to the artistic domain alone [15]: mediation is enacted because meaning emerges through action; embedded because action is inseparable from the material, technological and social environment that sustains it; and embodied because it is inscribed in the situated corporeality of the participants. Cognition is not a mental act that subsequently recruits the body: one thinks with and through things, not merely about them [16].

The digital, then, does not replace corporeal, sensory, material and ritual experience; it makes such experience observable, shareable and transferable, while that experience, in turn, resists full digital translation, marking an irreducible epistemological dimension that is, for that very reason, pedagogically indispensable. The tension between the code that travels and the channel that resists is not a problem to be dissolved, but a generative condition to be inhabited through design.

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Collaborative Creativity in AI-Mediated Lesson Design: A Thematic Analysis

Daniele Agostini[1], Elena Benini[1], and Helga Ballardini[1]

Department of Psychology and Cognitive Sciences, University of Trento, Trento, Italy
{daniele.agostini,elena.benini,helga.ballardini}@unitn.it

1 Introduction

Didactic mediators are not neutral channels: they connect learners with cultural objects and symbolic representations [1]. In collaborative lesson design, ChatGPT can function as a generative and expressive mediator when its linguistic outputs externalise pedagogical possibilities into shared, revisable representations. This role is relational and conditional: AI may widen collective meaning-making, but premature uptake may also compress the dialogue through which ideas are challenged and transformed.

Building on prior work that positioned ChatGPT as a peer-like feedback provider in collaborative lesson-design tasks [2], this study asks how ChatGPT shapes collaborative creativity during inclusive lesson design. Distributed creativity [3] and the five-A framework [4] locate creative agency across participants, prompts, AI outputs, constraints, and evolving lesson artefacts. Mini-c/little-c creativity further frames the activity as everyday professional sense-making and pedagogical adaptation [5]. Together, these perspectives focus attention on divergence, convergence, negotiation, and contextual judgement rather than creativity as a decontextualised outcome score.

2 Methods

Across two cohorts, 195 student-teachers worked in 44 groups of four to six. Each group completed two sequential authentic tasks: selecting and justifying inclusive technologies aligned with a learning objective, and producing a structured lesson/intervention design. Groups were randomly assigned to use ChatGPT in either the first or the second task, alternating AI-mediated and non-AI phases. Students were instructed to treat ChatGPT as a peer-like contributor, keep it "in the loop" of the group conversation, negotiate AI-generated ideas, and retain full responsibility for decisions.

Written feedback was embedded in the activity and collected immediately after each task phase. Elicitation questions asked groups to describe how they organised their work, how ChatGPT was used, and what strengths and weaknesses emerged. These task-embedded accounts document prompting practices, handling of AI outputs, and negotiation of AI suggestions in relation to inclusive design goals, mapping how prompts and outputs were taken up within peer interaction.

We are conducting an ongoing, first-cycle hybrid codebook thematic analysis [6]. Deductive codes draw on Rhodes' distinctions among creative process, product, and press [7], alongside distributed action; inductive codes capture brainstorming, collaborative prompting, idea expansion, critical mediation, premature convergence, and originality concerns. The lead author conducted AI-assisted corpus preparation and initial coding; the co-authors are reviewing the codebook, excerpts, and candidate themes. AI accelerated organisation and retrieval, while interpretive decisions remained with the researchers. Themes continue to be refined against the full corpus.

3 Preliminary Results

The ongoing analysis generated four candidate themes. First, *creativity was distributed across human dialogue, AI output, and lesson artefacts.* Groups located idea development in peer discussion, professional experience, prompts, AI proposals, and the evolving design rather than in any single actor.

Second, *AI expanded and structured the design space.* ChatGPT surfaced unfamiliar tools, inclusive strategies, examples, and lesson structures, providing starting points and helping groups organise objectives, activities, technologies, and assessment.

Third, *creative value depended on human critical mediation.* Groups described AI as useful when suggestions were selected, revised, contextualised, or rejected. Collaborative prompting became meta-design: participants negotiated what to ask, how to refine the request, and how to evaluate the answer.

Fourth, *AI could compress collaborative divergence.* Some groups reported faster agreement, less discussion, reduced reworking, lower originality, or over-reliance. AI sometimes stabilised the task while weakening the peer friction through which alternatives were explored and transformed. The non-AI phases made visible what could be displaced: slower discussion, professional memory, and productive uncertainty.

4 Discussion

ChatGPT's status as an expressive mediator was orchestrated rather than intrinsic: it emerged when groups made AI output into shared material for interpretation and revision, and weakened when fluent output displaced peer negotiation. This connects symbolic, relational, and generative mediation with distributed creativity.

The question is not whether AI increases creativity, but when it enriches or impoverishes the group's creative process. Phase-specific accounts reveal agency, prompt negotiation, revision, contextual judgement, and creative tension beyond prompt logs. Human brainstorming before AI use, explicit roles, requests for alternatives, alternating supported and unsupported phases, and debriefs may preserve group agency. Ongoing analysis will refine the candidate themes.

Disclosure of Interests. The authors declare no relevant competing interests.

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Drawing Beyond Boundaries: Expressive and Digital Mediators in a Workshop for Inclusive Teacher Education

Paola Cortiana [1] [0009-0001-1330-4367] and Eleonora Zorzi [2] [0000-0001-9337-9109]

[1] ECampus University, 22060 Novedrate, Italy
paola.cortiana@uniecampus.it
[2] Padova University, 35100 Padova, Italy
eleonora.zorzi@unipd.it

1 Introduction

The growing digitisation of higher and continuing education calls for pedagogical approaches that go beyond platform management and content delivery, engaging instead the affective, relational, and symbolic dimensions of learning [1]. Within this framework, expressive mediators hold significant potential for fostering inclusion, self-awareness, and community-building, even in fully digital environments [2, 3]. This paper presents a case study of a redesigned and digitally adapted laboratory workshop, originally conceived for in-presence settings and reconfigured for online delivery via Zoom in 2026, within an education programme on inclusion for in-service primary school teachers. The workshop, titled *"Limits Are in the Eyes of the Beholder"*, involved 12 female participants from Veneto Region, aged 30-50, and was designed around the concept of "limit" as a reflective and narrative resource for self-orientation and inclusive identity construction. Methodologically, this contribution is framed as an exploratory case study informed by the principles of design-based research. Its core objectives were to explore the pedagogical potential of graphic storytelling as expressive mediator in a digital environment; to underline the role of scaffolding of generative AI tools as support to creation of storyboard; to foster the creation of micro-communities of discourse [4] and shared meaning-making; and to examine how digital expressive tools can sustain relational, affective, and inclusive dimensions of learning in online settings.

2 The workshop

The workshop, lasting 4 hours, was structured around a progression of expressive and collaborative activities, with the graphic novel *Simona Atzori: una storia oltre il limite* [5] serving as the primary expressive mediator and narrative prompt. The session

opened with a whole-group brainstorming activity using a digital word-cloud tool, through which participants collectively mapped nouns and verbs associated with the concept of "limit." Participants were then divided into three small groups, each forming a micro-community of discourse, to share personal stories related to limits and their overcoming. In plenary, key narrative frameworks were introduced, including the use of metaphor, narrative thinking [6], and the essential structure of the hero's journey [7]: character, goal, and obstacles. Each group then selected meaningful keywords from the shared brainstorming, identified the minimal narrative elements for their own story, and used ChatGPT as a generative AI tool to co-create a visual storyboard from those keywords. The AI-generated image sequences, deliberately text-free, were then used as a basis for improvised oral storytelling in plenary [8], with participants alternating in the narration. In this sense, generative AI functioned not as a replacement for human creativity, but as a collaborative partner in the meaning-making process [9]. The experience confirms that the integration of expressive mediators in a digital workshop setting can effectively support the emergence of micro-communities of discourse and facilitate processes of self-knowledge and narrative self-orientation. At the end of the workshop the participants answered a semi structured questionnaire to investigate the coherence with the principles of UDL (items 1-4) and the scaffolding role of digital tools (items 5-12). Consistent with the principles of UDL [10], the workshop activated multiple means of representation, action, and engagement: participants were offered diverse expressive forms through which to represent the concept of limit, to act creatively, and to sustain motivation and relational involvement. Notably, the scaffolding provided by digital tools, including Zoom breakout rooms, word-cloud software, and ChatGPT, allowed participants to overcome technical and organisational constraints, redirecting their energy towards the communicative, relational, and symbolic dimensions of the experience.

3 Conclusion

A critical reflection emerges regarding the role of expressive mediators in digital environments: their pedagogical value lies not in their capacity to replicate embodied, in-presence experience, but in their ability to open new relational and symbolic spaces, precisely through their partial resistance to full digital translation [11]. It should be acknowledged that this contribution presents an exploratory case study based on a short final questionnaire and the authors' reflective practice, with a small group of 12 participants. Beyond its immediate context, this contribution speaks to a broader

challenge in contemporary teacher education and higher education: how to design digitally mediated learning experiences that do not sacrifice the relational, embodied, and symbolic dimensions of pedagogy. The proposed model, grounded in UDL principles, multimodal expression [12] and human-AI collaboration [13], offers a transferable and replicable design framework for educators and instructional designers working across diverse higher education contexts.

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Teaching with Changing Languages: Educational and Assistive Technologies as Expressive Mediators in Inclusive Primary Teacher Education

Silvio Marcello Pagliara[1], Ilaria Tatulli[1], Daniele Bullegas[1], Gianmarco Bonavolontà[1], Antioco Luigi Zurru[1], and Antonello Mura[1]

University of Cagliari, Cagliari, Italy
silviom.pagliara@unica.it

Appropriate use of educational and assistive technologies cannot be reduced to technical proficiency or to the adoption of the newest digital tool. In initial teacher education, this issue is intensified by the changing languages through which university students access, produce, and circulate knowledge: visual, audiovisual, platform-based, multimodal, and increasingly AI-assisted forms of meaning-making. From the perspective of Special Pedagogy, didactic mediation, and inclusive education, these shifts do not simply require more technology; they require a stronger pedagogical capacity to interpret languages, anticipate barriers, and design inclusive mediation [4–6, 8]. The paper therefore asks how future primary teachers can be prepared to use educational and assistive technologies in ways that expand accessibility, participation, expression, and educational relationship rather than merely increase digital saturation [7, 9, 13].

The contribution is grounded in the Laboratory of Educational and Assistive Technologies for Inclusion in the fifth year of the five-year Primary Education degree programme at the University of Cagliari. The laboratory is interpreted as a situated professional learning environment in which pre-service teachers work on concrete design problems rather than generic tool demonstrations. Activities include analysing primary-classroom scenarios through an accessibility and participation lens; redesigning learning activities using Universal Design for Learning (UDL) criteria and accessibility checks; comparing mainstream, low-tech, and assistive options for the same educational objective; producing multimodal artefacts such as captioned micro-videos, symbol-supported instructions, visual planners, accessible storyboards, and simplified materials; and critically discussing the use of generative AI in the preparation and revision of educational resources. In this setting, technologies are approached as mediators embedded in pedagogical decisions rather than as external add-ons [1–3, 9, 11, 12].

Within this framework, the paper proposes a reflective and practice-based model articulated in three interconnected dimensions. The first, *accessibility and participation*, concerns barrier reduction, flexible entry points, accessible resources, and the deliberate integration of assistive and accessible technologies [1–3, 12]. The second, *expressive multimodal mediation*, concerns the pedagogical use of voice, image, gesture, narrative, symbol systems, video, storytelling, and other hybrid languages to widen possibilities for representation and expression

[5, 7, 11, 13]. The third, *critical and ethical intentionality*, concerns the educator's responsibility to decide why a technology is used, what it enables or constrains, whose agency it may amplify, and how issues such as inaccuracy, bias, opacity, privacy, dependency, and unequal access are addressed, particularly in relation to generative AI [10, 14]. Together, these dimensions move beyond instrumental conceptions of educational technology and place pedagogical judgement at the centre of inclusive design [4, 6, 8, 9].

The present contribution does not report a systematic empirical study of student outcomes. The considerations arising from the laboratory are therefore presented as teaching-based pedagogical reflections rather than as exploratory findings. Three recurring tensions have informed the proposed model: the tendency to begin from the tool rather than from the educational purpose; the need to make multimodal and accessibility choices explicit within design tasks; and the need to subject AI-supported outputs to human verification and pedagogical justification. These reflections are used to frame the design model, not to claim measured changes in student competence. In this sense, the laboratory foregrounds iterative cycles of design, critique, justification, and redesign as a way of cultivating more intentional uses of technology [3, 10, 14].

The implications for teacher education are twofold. First, UDL can be addressed not only as a declarative framework but as a recurrent design practice through which future teachers connect accessibility, multimodality, assessment, and classroom mediation [3, 12]. Secondly, in a post-digital and AI-saturated environment, professional competence cannot be reduced to generic digital confidence; it also involves the capacity to orchestrate technologies as tools, mediators, and environments while preserving the human, relational, and inclusive quality of education [8–10, 14]. From this perspective, students' changing languages are neither a deficit to normalise nor a trend to imitate uncritically, but a pedagogical field to be interpreted and transformed into opportunities for access, participation, expression, and agency [7, 13].

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The VoiceKids Knowledge Hub as an Inclusive Expressive Mediator: Co-Creation, AAC-Supported Storytelling, and Teacher Education in Digital and Hybrid Contexts

Silvio Marcello Pagliara[1], Branislav Gerazov[2], Katerina Mavrou[3], Eleni Theodorou[3], Dimitar Taskovski[1], Danche Todorovska[4], Francesco Zanfardino[5], Antonio Spera[6], Ilaria Tatulli[1], Mariella Pia[1], Gianmarco Bonavolonta'[1], Anna Rybińska[7], May Agius[8], Nefi Charalambous-Darden[9], Katarzyna Łuszczak[10], and Antonello Mura[1]

[1] University of Cagliari, Cagliari, Italy
[2] FEEIT, Ss. Cyril and Methodius University in Skopje, Skopje, North Macedonia
[3] European University Cyprus, Nicosia, Cyprus
[4] Association for Assistive Technology – OPEN THE WINDOWS, Skopje, North Macedonia
[5] GLIC, Bologna, Italy
[6] Manè, Bari, Italy
[7] Adam Mickiewicz University, Poznań, Poland
[8] University of Malta, Msida, Malta
[9] APIS, Limassol, Cyprus
[10] ATABI, Tulce, Poland

The VoiceKids Knowledge Hub (VKKH), developed within the Erasmus+ KA220-SCH VoiceKids project, is a digital environment for organising and sharing resources on accessible storytelling, Augmentative and Alternative Communication (AAC), Text-to-Speech (TTS), assistive technology, and teacher education. It is conceived not only as a repository but as a structured environment linking methodological documentation, training resources, protocols, tools, and piloting materials within a multilingual framework. This orientation is consistent with approaches that relate AAC and assistive technologies to communication, participation, learner variability, and contextual accessibility [1–3].

The contribution connects two strands of the VoiceKids work. The first is methodological. A co-creation protocol translates the perspectives of teachers, parents or caregivers, and therapists with direct AAC experience into traceable design requirements for AAC- and TTS-supported storytelling. Structured, stimulus-supported focus groups generate stakeholder accounts that are interpreted through reflexive thematic analysis and then translated into prioritised requirements concerning functionality, accessibility, interface, content configuration, and implementation support. Participatory design, reflexive thematic analysis, and requirements-engineering principles underpin this sequence [4–6]. The resulting chain is explicit: stakeholder perspectives inform analysis; analysis informs design requirements; and these requirements guide the development and organisation of VoiceKids resources within the VKKH [7].

The second strand concerns teacher education. The VKKH is intended primarily for continuing professional development and training of in-service teachers. It will also be introduced as an informative resource for pre-service primary teachers enrolled in the five-year Primary Education degree programme at the University of Cagliari, particularly within the Laboratory of Educational and Assistive Technologies for Inclusion. In this higher-education context, students will consult and critically discuss selected VoiceKids resources on accessible storytelling, AAC/TTS, assistive technologies, and piloting scenarios, relating them to accessibility and inclusive educational design.

The VKKH is interpreted here as an *expressive mediator* only in relation to these pedagogical uses. Its mediating function does not follow automatically from storing expressive resources; it emerges when teacher-education participants use selected materials to examine symbol-supported narratives, TTS outputs, accessible storytelling choices, and the relationships among text, symbols, voice, narrative structure, accessibility, and participation. The hub thus provides an organised environment in which communicative, pedagogical, and technical dimensions can be considered together. This use is coherent with Universal Design for Learning [3] and with the participatory logic underpinning the project [4].

A planned evaluation phase will examine acceptance and perceived applicability in teacher-training contexts through a UTAUT-informed questionnaire addressing performance expectancy, effort expectancy, facilitating conditions, and intention to use [8]. Where organisational conditions permit, this will be accompanied by a small-scale pilot using selected VKKH resources and collecting brief feedback on accessibility, usability, relevance for practice, and potential transfer to educational activities. The paper therefore does not report effectiveness outcomes. Its design-oriented contribution is to make explicit the connection among stakeholder co-creation, qualitative analysis, requirements formulation, AAC/TTS-supported storytelling, knowledge-hub architecture, and teacher education, while defining a feasible next step for evaluation. In this sense, the VKKH is proposed as a developing environment for supporting informed and context-sensitive uses of accessible storytelling in both in-service training and selected higher-education settings.

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Visual And Expressive Mediators For Inclusion And Participation In Digital Higher Education

Farnaz Farahi[1][0000-0002-0473-4154]

[1] eCampus University, Novedrate, Italy
farnaz.farahi@uniecampus.it

1 Introduction

The growing digitalization of higher education has expanded opportunities for access and connectivity, while simultaneously raising crucial pedagogical questions concerning the quality of relationships, emotional participation, intercultural dialogue, and meaningful student engagement. In many online and hybrid learning environments, communication risks becoming predominantly verbal, standardized, and task-oriented, often reducing the expressive, symbolic, and embodied dimensions of educational experience [14, 12].

This contribution explores the pedagogical role of images and visual narratives as expressive mediators within digital and hybrid higher education contexts. Drawing on visual pedagogy, intercultural education, communication studies, image-based education, and theories of multimodal learning, the study investigates how photographs and visual devices can foster generative communication, emotional resonance, self-narration, and intercultural encounter in university environments.

The theoretical framework integrates perspectives from aesthetic education [7, 1, 8], narrative identity [4, 5], multimodal literacy [12], media education in the post-media condition [14] and transmedia literacy [11, 17]. Particular attention is devoted to the concept of generative communication, understood as a relational process capable of fostering identity construction, social exchange, participation, and shared processes of meaning-making.

The contribution argues that images can function as pedagogical mediators capable of facilitating communication beyond linguistic and cultural barriers, especially within intercultural and digitally mediated university contexts. Unlike exclusively verbal interaction, visual mediation allows plural interpretations, reflective dialogue, emotional expression, and forms of participation less constrained by right/wrong dichotomies. In this sense, images may support inclusive educational processes by encouraging listening, self-expression, empathy, and collaborative interpretation [9, 10, 16].

2 Methods

From a methodological perspective, the contribution presents a pedagogical reflection grounded in educational practices developed within university and training contexts through photographs, visual sequences, autobiographical images, and dialogical

activities mediated by digital platforms. Rather than reporting an empirical study, the contribution develops a theory-informed pedagogical reflection based on educational practices implemented in university and professional training contexts. These practices show how images can become relational and expressive spaces in which students negotiate meanings, recognize differences, and co-construct shared narratives.

Particular attention is given to visual storytelling practices and multimodal communication processes capable of promoting student agency, symbolic elaboration, community building, and embodied participation within online and blended environments [5, 12, 15]. The contribution also considers inclusive educational perspectives connected to Universal Design for Learning [6] and to the pedagogical potential of visual mediation in supporting participation and accessibility.

3 Results and Discussion

The first reflections emerging from the educational practices analyzed highlight how visual mediators can foster more dialogical, emotionally engaging, and participatory learning environments. For example, visual storytelling activities based on personal photographs encouraged students to share autobiographical experiences, negotiate meanings collaboratively, and engage in intercultural dialogue. Photographs and autobiographical visual narratives appear to support students in expressing personal experiences, exploring identity dimensions, negotiating meanings, and participating in intercultural dialogue through multimodal forms of communication.

The use of visual and expressive mediators also seems to encourage collaborative interpretation processes and forms of relational participation often less accessible within exclusively verbal academic interaction. In digitally mediated contexts, images may therefore function not only as communicative supports but also as pedagogical devices capable of activating reflexivity, empathy, symbolic elaboration, and shared construction of meanings.

At the same time, the contribution discusses the pedagogical need to avoid superficial or purely aesthetic uses of images, emphasizing instead the importance of intentional educational mediation capable of connecting visual practices with critical reflection, intercultural dialogue, and inclusive participation. These practices were designed with particular attention to respectful image use, participants' privacy, and informed consent.

4 Conclusion

The contribution ultimately proposes the integration of visual and expressive mediators within digital higher education as a possibility for strengthening relational quality, inclusion, active participation, and emotional engagement in contemporary university teaching and learning processes.

Within post-digital educational ecosystems, visual mediation may represent an important pedagogical resource for fostering dialogical, reflective, and intercultural

learning environments in which students are not only recipients of information, but active participants in processes of shared meaning-making and narrative co-construction.

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Photovoice as an Expressive Mediator: Bridging Research and Teaching in Digitally Mediated Inclusive Higher Education

Donatella Camedda [1][0000-0002-0569-2101]

[1] Trinity College Dublin, Dublin, Ireland
cameddad@tcd.ie

1 Introduction

Contemporary higher education is increasingly shaped by digitally mediated environments [1, 2], yet these often remain centred on content delivery and data optimisation, overlooking embodied, sensory, and symbolic dimensions of learning [3, 4]. In this context, art-based approaches can act as expressive mediators that enhance participation, engagement, and academic performance in inclusive higher education [5]. This paper presents photovoice [6, 7] as an *expressive mediator* that integrates embodied experience [8], multimodal expression, and relational engagement across physical and digital learning environments. While photovoice is well established as a participatory research methodology, particularly with marginalised communities [6, 9], its pedagogical potential in higher education remains underexplored[10, 11]. The paper addresses this gap through a reflective, practice-informed analysis guided by the question: How does photovoice operate as an expressive mediator linking research and teaching in digitally mediated inclusive higher education?

To answer this question, the paper adopts a qualitative reflective approach grounded in the author's photovoice projects at a leading Irish university. Originally designed as UDL-based participatory research-teaching initiatives [12], these projects involved image production, reflection, dialogue, and dissemination. Here, they are re-examined to explore how photovoice functions as an expressive mediator within digitally mediated research-teaching contexts.

2 Methodology

To address the research question, this reflective analysis draws on multiple applications of photovoice as a pedagogical and research mediator conducted between 2022 and 2026 at Trinity College Dublin, Ireland. The projects involved undergraduate and postgraduate students with and without disabilities enrolled in modules on human rights (2022–2024) and inclusive education (2025–2026).

The analysis is structured around four dialogical dimensions, namely **didactic, relational, inclusive, and generative**, derived from the HELMeTO 2026 Special Track n.6 framework. These dimensions serve as an analytical lens for examining photovoice projects that incorporated visual artefacts (photographs and captions), focus groups, surveys, group discussions, and students' reflections. Primary data are reflectively

reinterpreted through the concept of mediation, exploring how photovoice operates between experience and knowledge (didactic), self and others (relational), access and agency (inclusive), and expression and knowledge production (generative). This exploratory application of the framework does not seek generalisable findings. Rather, it offers contextually grounded insights into the pedagogical and research potential of photovoice in inclusive and digitally mediated higher education.

3 Findings

At a **didactic level**, photovoice supports meaning-making and critical reflection by enabling students to engage with academic content through lived experience and visual inquiry. Abstract concepts such as human rights and inclusion become accessible through photographing, selecting, and narrating, transforming theoretical knowledge into situated and personally meaningful understanding [10].

At a **relational level**, photovoice sustains presence, dialogue, and recognition, particularly in digital and hybrid environments. The co-creation and sharing of visual artefacts through physical and digital exhibitions generate dialogic spaces where students' voices become visible and open to negotiation. Digital platforms such as Padlet extend these interactions beyond the classroom [13], supporting community-building while repositioning lecturers as facilitators and students as active contributors.

At an **inclusive level**, photovoice aligns with UDL by offering multiple means of engagement, representation, and expression. Its visual and multimodal character creates accessible pathways for participation and supports agency, self-advocacy, and the articulation of complex experiences. Inclusion is understood not only as access, but also as epistemic participation, whereby students are recognised as legitimate producers of knowledge [10, 14].

At a **generative level**, photovoice creates opportunities for collective knowledge production through the collaborative identification of themes, negotiation of meanings, and dissemination of outcomes. These dynamics position both physical and digital classrooms as sites of inquiry and shared knowledge production [13, 14].

4 Conclusion

The paper shows how photovoice can be interpreted as an expressive mediator across the research–teaching nexus and within a UDL-informed framework, and how it exemplifies a broader shift towards integrating expressive, multimodal, and participatory practices within inclusive higher education.

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The Synthetic Tide: Music, Generative AI, and Embodied Inclusion in Ocean Literacy Education

Lorena Rocca[1], Piergiorgio Simoni[2], Alessandro Fagiuoli[2], Andrea Manganaro[3]
[1] SUPSI, University of Applied Sciences and Arts of Southern Switzerland, Locarno.TI, 6644
[2] Liceo "Concetto Marchesi", 35100, Padua, Italy [3] Composer, 35100, Padua, Italy.

lorena.rocca@supsi.ch; piergiorgio.simoni@iismarchesi.edu.it; alessandro.fagiuoli@iismarchesi.edu.it; andrea.manganaro@gmail.com

1 Introduction and Case Context

Technology is not a neutral tool but a sociomaterial actor that produces knowledge, relationships, responsibilities, and controversies. This raises a central question for teacher education: how can multimodal, place-based educational experiences involving generative AI be orchestrated while governing the ethical, ecological, and authorial tensions they generate? Within a research programme on Ocean Literacy, Human Governance, and teacher education at SUPSI, we address the question through a theoretically informed case vignette, supported by exploratory evidence, examining an Ocean Literacy event in which music, voice, video, AI, bodies, and place become co-constitutive mediators of educational meaning, inclusion, and controversy. The empirical case builds on *Un mare di corti*, a place-based Ocean Literacy project recognised by the ArQus UNIPD Teaching Excellence Award (2022–2023) [1–3], which engaged more than 150 fourth-year student teachers at the University of Padua in producing short films about their marina del cuore without AI. The case centres on a National Sea Day public event involving the Liceo "Concetto Marchesi" (Padua), a student orchestra of more than ninety performers, and an audience of approximately 800. Four AI-generated audiovisual works accompanied the live performance, intertwining music, images, words, audience, and place. The event set four bodies in relation: the conducting body (Alessandro Fagiuoli), embodying gesture and mutual listening; the performing bodies of the orchestra; the authorial body of the composer; and the disembodied generation of AI, mediated by the video author (Piergiorgio Simoni). One work, Mare d'inverno ("Winter Sea"), is central: a composition by Andrea Manganaro, a composer who lives with multiple sclerosis. It was performed live while an AI-generated video, independently created by Simoni as his personal interpretation of Manganaro's book and life [4] and initially shared with no one, was projected. Deeply moved by the completed work, Manganaro subsequently approved its public use. Here AI does not displace or replace authorship: through Simoni's AI-mediated interpretation, approved by the composer and embodied by the orchestra, an existing authorial voice is relayed into public space rather than substituted. The event unexpectedly generated controversy. Some students challenged the use of AI on ethical, ecological, and artistic grounds, citing its energy footprint, the displacement of human creative labour, questions of authorship, and the embodied meaning of musical practice. We interpret these objections not as

noise but as constitutive voices within the event itself. Although an assembly to discuss these issues was envisaged, it never took place. The absence of a deliberative space in which these tensions could be collectively explored constitutes the pedagogical core of this contribution.

Methodologically, the study adopts a theoretically informed case vignette aimed at theoretical transferability rather than statistical generalisation. The corpus combines documentary analysis, first-hand accounts (Simoni's technical diary, Fagiuoli's rehearsal diary, structured interviews with Fagiuoli and Manganaro, and Manganaro's autobiographical materials), and questionnaire data from 118 students, interpreted polyphonically through an epistemology of listening [5]. Preliminary questionnaire findings suggest a perceived increase in students' connection and attachment to the sea through the multimodal experience. Given the retrospective, single-administration design without a control group, these findings are exploratory and hypothesis-generating. Autobiographical materials are used with explicit informed consent, while the views of anonymised underage students are reported indirectly.

The analysis is framed by four complementary perspectives: Ocean Literacy, foregrounding the reciprocal relationship between humans and the ocean [6,7]; place-based education, understanding the sea as an educating landscape [2,8]; sociomaterial and post-digital perspectives, positioning AI as a mediator that reconfigures bodies, sounds, images, and responsibilities [9,10]; and Human Governance, which approaches controversy as a participatory practice of deliberation [11].

2 Discussion and Educational Implications

The "synthetic tide" names the central paradox of the case: the very apparatus that appears to strengthen affective connections with the sea also contains, in its generative dimension, what some students experience as ethically and artistically problematic. AI thus emerges as an ambivalent mediator—both narrator of the sea and contested condition of its representation. Yet the Manganaro case shows the other side of this ambivalence. Across its reinterpretations—from Manganaro's score to Simoni's video and the workshops that follow—the case suggests a creativity distributed among actors and across time. It operates through a relay in which each actor receives, autonomously transforms, and passes on an educational value core—a constellation of educational purposes, ethical orientations, and pedagogical commitments—that remains recognisable while continuously taking new forms. The teacher's role is to steward this continuity across bodies, technologies, and places rather than preserve fixed artefacts. The case engages the AI for Good discourse [12,13] critically, repositioning AI's ethical tensions as objects of educational inquiry, dialogue, and deliberation. This contribution is embedded in an exploratory service-learning initiative on Ocean Literacy within the Primary Teacher Education programme at the University of Padua. During the event, two graduates whose theses addressed Ocean Literacy designed and led the workshops and collected the data; the initiative extends this work by creating the deliberative space that the case lacked, with a view to adapting and transferring it to teacher education at SUPSI DFA/ASP (Ticino). Building on "Un mare di corti", it fosters critical AI literacy

[14,15], participatory facilitation grounded in Human Governance [11], and inclusive educational design grounded in listening [5]. The deliberative extension includes a facilitated assembly on the AI controversy and a critical mapping of the data, labour, and energy behind generative AI, with assessment focused on argumentation, inclusive facilitation, and reflexive engagement. Educating about the sea therefore also means preparing teachers to hold together multimodal experience and the participatory governance of the controversies it opens.

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Beyond Platform Pedagogy: Expressive Mediators and the Relational Dimension of Inclusive Higher Education

Leonardo Menegola[1[0000-0003-4712-4740]], Francesca Berti[2[0000-0001-8621-2503]],Paola Cortiana[1[0000-0001-9950-4150]]

[1] eCampus University, Novedrate, Italy
[2] Free University of Bolzano, Italy
leonardo.menegola@uniecampus.it, francesca.berti@unibz.it, paola.cortiana@uniecampus.it

1 Abstract

As higher education increasingly explores digital and hybrid environments, the challenge of fostering meaningful educational experiences poses new questions both for special education and for technology-enhanced learning design. Drawing on Dewey's reflection on education experience [1], this paper introduces the conceptual horizon of the Special Track, by revisiting the qualities of educational experience in light of contemporary digital and hybrid contexts. While Dewey primarily focused on the individual dimension of experience, the present contribution suggests that current educational settings require renewed attention to its relational dimension in supporting both motivation and learning. In digitally mediated environments, where distance and fragmentation may weaken educational relationships [2], the challenge is therefore not only to ensure access and participation, but also to sustain meaningful forms of interaction capable of supporting learning as a shared and transformative experience.

Digital higher education, however, has largely been conceived in structural declinations, such as learning objects design, content delivery, activity tracking, learning environment management. This orientation is what we refer to as "platform pedagogy" [3]. Our contribution draws on the pedagogical traditions of expressivity [4,5], of enacted, embedded and embodied cognition [6,7], of arts-based pedagogy [8] and of play [9,10], in the idea that connectivity alone is not sufficient to constitute a formative relationship. Teaching and learning rest on a further dimension, that of expressive mediators: creative, artistic-performative, ludic and generative languages and means, which engage embodied and sensory experience, symbolic imagination and relational presence.

Mediation has two distinct meanings in pedagogy. In the first, mediation is what the human educator does: a presence that makes learning possible by orienting it, sustaining it, giving it sense [11,12]. In the second, mediation is the languages and means, the artefacts and forms through which learning is conveyed [13,14]. What the two senses share is the corporeal, sensory, nonverbal and experiential dimension —the lowest common denominator of a grammar of experience that is at once individual and interactional. Human mediation —as well as learners' experience— is never disembodied: it works through voice, gaze, timing, rhythm and the shared ritual-ness of co-presence,

the very materials from which creative and performative mediators are made. Mediation, in both senses, is established before and independently of any digital instantiation. On this basis the paper proposes three possible paths of investigation. The first one addresses the mediator as code and channel: each mediator is both what is expressed and what carries the expression —a language and the material support that bears it. That support is never fully absorbed into the digital. Even solitary online study is done by an embodied subject in a physical place, with its sensory conditions [15]. Since the screen cannot subsume the whole sensory situation, every learning environment turns out to be hybrid; what resists digitalization is read not as a deficiency but as a clue to where formative value lies.

The second line of inquiry focuses on the intersection of play and storytelling, narrative and ludic practices —storytelling, imagination, role-taking, cooperative writing—, which function as expressive mediators that sustain presence, belonging and agency, fostering dialogue, negotiation and the co-construction of knowledge against distance and isolation [16,17,18].

The third lens zooms in on visual mediators: the iconic dimension offers the opportunity to link multiple aspects of expressions in an inclusive perspective. Visive metaphors [19], graphics [20], illustrations [21] contribute to convey meanings to visual storytelling in different learning environments.

The paper investigates the way the pedagogical significance of expressive mediators is closely bound up with what resists full digital translation, suggesting that this tension is not a limitation but a generative condition to be inhabited by design. It thus offers both a conceptual map of the Special Track and a broader argument: that innovation in online and hybrid higher education should be driven not only by technological development but by renewed attention to expressive, embodied and relational mediation, placing human relationships at the center of educational innovation, in the service of inclusion, educational relationship and pedagogical quality.

Keywords: expressive mediators; platform pedagogy; relational dimension; human mediation; code and channel; playful narratives; multimodal literacy; embodied learning; inclusive hybrid higher education.

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Special Track 7

Embodied and Adaptive Learning Environments: Serious Games, Educational Robotics and AI for Personalized Education

Organizers:
Elena Dell'Aquila, Pegaso University, Italy
Michela Ponticorvo, University of Naples Federico II, Italy
Raffaele Di Fuccio, Pegaso Unversity, Italy

Designing Adaptive AI Support for Concept Mapping Without Cognitive Offloading: The Future Development of MapAble

Alessio Manfredini[1], Clara Nobile[1,2]*, Onofrio Gigliotta[1], Alessandro Ciasullo[1], Michela Ponticorvo[1]

[1] University of Naples Federico II, Naples, Italy
alessio.manfredini2@unina.it, onofrio.gigliotta@unina.it, alessandro.ciasullo@unina.it, michela.ponticorso@unina.it
[2] University of Macerata, Macerata, Italy
c.nobile2@unimc.it

1 Introduction

The integration of Artificial Intelligence (AI) into educational contexts is opening new opportunities for the development of personalized and adaptive learning environments [1]. However, an emerging concern involves the risk of cognitive offloading, namely the tendency of learners to excessively delegate cognitive processes to AI systems, thereby reducing active information processing, metacognitive reflection, and deep learning [2,3]. This issue is particularly relevant in educational systems that support complex activities such as concept map construction, where the educational value lies not only in the final product but also in the process of selecting, processing, and organizing information [4].

This contribution proposes a theoretical and design framework for the evolution of MapAble, a step-by-step concept mapping construction tool for students with Specific Learning Disorders (SLD) [5,6], into an AI-based tutoring system, with the aim of: (1) personalizing the support provided to learners during concept map construction; (2) preventing forms of cognitive offloading and cognitive debt; (3) preserving and enhancing active cognitive processing and metacognitive engagement.

1.1 Problem Statement

Students with SLD exhibit heterogeneity in the cognitive abilities involved in concept map construction, including: reading skills, text comprehension skills, summarization and information processing abilities, metacognition, and self-regulation skills [7]. Intelligent Tutoring Systems such as MapAble can provide structured and guided scaffolding that helps overcome instrumental deficits while encouraging and supporting high-level cognitive processes. However, such support may not adequately address individual, specific needs and profiles of learners. The current version of MapAble has some limitations in that regard. Overall, MapAble guides learners step by step through the concept mapping process,

* Corresponding author.

providing a uniform scaffold for all users and supporting the decision-making of students during map construction. Nevertheless, it does not dynamically adapt the level of support that accounts for learner performance and does not sufficiently integrate AI-based functionalities capable of overcoming instrumental difficulties through multimodal support.

2 Proposal for a Cognitively and Emotionally Aware Adaptive Framework

We propose the development of an adaptive framework for MapAble based on principles of cognitive engagement preservation, structured around the following components, based on Artificial Intelligence in Education (AIED) applications [8].

Dynamic Scaffolding Adaptation The level of support provided by the system varies according to learners' performance. In cases of difficulty it provides progressive hints, guided examples, and structured prompts. In cases of successful performance, it supports with gradual reduction of assistance, increased learner autonomy, and greater responsibility in concept map construction [9].

Metacognitive Support The AI system incorporates metacognitive prompts aimed at encouraging learner reflection, such as evaluating confidence in one's responses, explaining the rationale behind decisions, and articulating the strategies used during task completion [10,11].

Support for Emotional Self-Regulation The framework integrates support for emotional processes, cognitive processes, and interactional processes. This component is based on the Emotional, Cognitive, and Interactional (ECI) model [12,13].

Adaptive Task Complexity The system dynamically adjusts task difficulty according to a learner model that incorporates recurring errors, task completion time, help requests, interaction patterns, and performance progression over time. Based on these indicators, the system adapts the number of concepts to be processed, the complexity of relationships among concepts, and the depth of the hierarchical structure.

3 Expected Contribution

The paper offers a theoretical and design-oriented reflection on the evolution of AI-based educational systems, with particular attention to balancing adaptive support and the preservation of learners' active cognitive engagement. From this perspective, MapAble is presented not only as a concept mapping support system but also as a case study for the design of adaptive educational environments that are both cognitively and emotionally aware, promoting meaningful learning while preventing excessive reliance on AI assistance.

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A Phygital Escape Room Experience for Risk Awareness with students in the Campi Flegrei Area Context

Elena Dell'Aquila[1[0000−0002−5233−5107]], Andrea Miano[1[0000−0001−6638−1983]], Agostino Carbone[1[0000−0003−0249−8888]], Antonella Bianca Francavilla[1[0000−0002−5669−4107]], Angelo Rega[1[0000−0002−0641−7347]], Gianluca Cavalaglio[1[0000−0003−4164−493X]], Giuseppe Mazzeo[1[0000−0001−6204−9940]], Francesco Fabbrocino[1[0000−0001−8712−1048]], Alessandro Gennaro[1[0000−0003−3138−9875]], and Raffaele Di Fuccio[1[0000−0001−8886−3967]]

Pegaso University, Centro Direzionale, Isola F2, 80143 Naples, Italy
elena.dellaquila@unipegaso.it, andrea.miano@unipegaso.it, agostino.carbone@unipegaso.it, antonella.francavilla@unipegaso.it, angelo.rega@unipegaso.it, gianluca.cavalaglio@unipegaso.it, giuseppe.mazzeo@unipegaso.it, francesco.fabbrocino@unipegaso.it, alessandro.gennaro@unipegaso.it, raffaele.difuccio@unipegaso.it

1 Introduction

Disaster risk education and emergency communication are increasingly relevant in territories exposed to complex natural hazards, such as the Campi Flegrei area, where volcanic risk, earthquakes, and bradyseism shape both environmental and social awareness. International frameworks on disaster risk reduction and school safety emphasise the importance of education, preparedness, resilience, and community awareness in reducing vulnerability and promoting safer behaviours [1], [2]. However, communicating risk-related knowledge to young learners requires approaches that are scientifically grounded, accessible, engaging, and able to foster active participation.

This contribution explores the educational potential of NFC-based educational escape rooms as tangible and phygital serious games for promoting risk awareness and transversal competences. By combining storytelling, problem-solving, collaboration, and physical-digital interaction, educational escape rooms may support learning experiences in which knowledge is not only transmitted, but enacted through action, decision-making, and social interaction [3], [4].

2 Background

The study is grounded in research on game-based learning and gamification [5], [6], educational escape rooms [3], [4], tangible user interfaces [7], embodied interaction [8], [9], and disaster risk reduction education [1], [2]. From this perspective, learning is understood as a situated, social, material, and interactive

process. Tangible and phygital learning environments can enrich educational experiences by connecting physical artefacts, digital content, embodied action, and collaborative meaning-making [7], [9].

Although serious games and educational escape rooms are increasingly used in education [3], [4], their application to disaster risk education and emergency communication remains underexplored, particularly in interdisciplinary contexts involving universities, schools, professionals, and local communities.

This gap is relevant because risk education requires not only domain-specific knowledge, but also collaboration, problem-solving,communication, decision-making, socio-relational skills. In this sense, NFC-based escape rooms can provide a meaningful format for integrating scientific knowledge, emergency procedures, and transversal competence development through active and collaborative learning.

3 Methodology

The study addresses the following research question: how can NFC-based educational escape rooms support risk awareness and the development of transversal competences in interdisciplinary educational contexts?

An exploratory case study was conducted within the Spring School "Risk Mitigation Strategies for the Built Environment and Communication to Citizens", promoted by Università Telematica Pegaso and held from 25 to 28 May 2026. The Spring School integrated engineering, psychology, and communication studies to address risk mitigation, emergency communication, collective memory, and citizenship awareness. During the final laboratory session at Luram Lab, four NFC-based educational escape rooms were designed and implemented with pupils from local schools in the Campi Flegrei area.

The activities were developed using the TAITALE platform, which supports the creation of educational escape rooms through gamification, storytelling, physical-digital interaction, and tangible user interfaces. The experience involved four groups, four risk scenarios, approximately 40 pupils, 5 teachers, 3 facilators, and 4 doctoral students. The scenarios addressed earthquakes, bradyseism, volcanic risk, and emergency escape strategies. By interacting with NFC-enabled physical objects and solving narrative-based challenges, participants were required to collaborate, interpret clues, make decisions, and identify appropriate behaviors in emergency-related situations. Data were collected through non-participant observation, documentation of the escape room activities, analysis of the solutions produced by each group, and feedback from teachers and doctoral students

4 Expected results

The expected results are understood as exploratory insights rather than as evidence of measurable learning gains. They are expected to indicate whether and how NFC-based educational escape rooms can create favourable conditions

for supporting risk awareness, domain-specific understanding of natural hazards and emergency behaviours, and transversal competences such as collaborative problem-solving, communication, decision-making, and self-regulation.

By integrating tangible technologies, narrative-based challenges, and collaborative tasks, the case offers preliminary insights into how phygital learning environments may translate complex interdisciplinary content into participatory and age-appropriate educational activities.

In this perspective, the experience connects scientific knowledge, emergency communication, and citizenship education, providing indications for future instructional design practices and community-based educational initiatives aimed at resilience, sustainability, and prevention.

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Preliminary testing of a virtual reality escape room for shared learning

Angelo Rega[1[0000-0002-0641-7347]] ,Lucia Miranda[1[0009-0005-9701-3880]],Carolina Mele[1[0009-0009- 7954-6244]] , Chiara Scuotto[2[0009-0002-6628-5179]] , Raffaele Di Fuccio[3[0000-0001-8886-3967]] , Emanuele Marsico[3[0000-0003-1642-7562]] , Caterina Sapone[2[0009-0003-7118-8354]] , Stefano Triberti[2[0000-0001-5691-5531]] , Luigi Gallo[4,5[0000-0002-1281-404X]]

[1] SPRINT lab, Department of Psychology and Health Sciences, Pegaso University, Italy
[2] LAHTI Laboratory for Advanced Human-Technology Interaction, Department of Psychology and Health Sciences, Pegaso University, Italy
[3] Department of Education and Sport, Pegaso University, Italy
[4] xRAI Research Center, Department of Information Science and Technology, Pegaso University, Italy
[5] Institute of High Performance Computing and Networking, National Research Council of Italy (CNR-ICAR), Italy
angelo.rega@unipegaso.it
lucia.miranda@unipegaso.it
carolina.mele@unipegaso.it
chiara.scuotto@unipegaso.it
raffaele.difuccio@unipegaso.it
emanuele.marsico@unipegaso.it
caterina.sapone@unipegaso.it
stefano.triberti@unipegaso.it
luigi.gallo@unipegaso.it

Virtual Reality (VR) is a powerful tool for education, psychology and healthcare. Traditionally, its main strengths as an experimental and intervention tool are the possibility to administer complex stimuli (e.g., entire simulated environments) in the controlled context of the laboratory, and the opportunity to support different kinds of measurement (i.e., behavioral, self-report, psychophysiology, performance). Focusing on education, VR allows trainers to support learning of specific behaviors, to exercise skills through roleplaying , and to teach curricular contents through concrete example, based on a "learning by doing" perspective. Studies describing the educational use of VR span many settings, from universities and workplace training to healthcare, engineering, and teacher education [1]. Within constructivist learning theory, this fits neatly: immersive worlds can support knowledge building through interaction with situations that feel meaningful, pushing learners toward active involvement and learning by doing. Related ideas appear in the Cognitive-Affective Model of Immersive Learning (CAMIL), which argues that immersive tools affect learning through linked cognitive, motivational, and emotional pathways [2]. For VR to be effective, it is not enough that environments and tasks are simulated faithfully: a VR user has to experience the subjective sensation of actually being in the virtual environment. This is related to the concept of sense of presence, or the psychological equivalent of technological immersion. According to recent research, the sense of "being there" deserves to be recognized as a psychological phenomenon that is not a mere byproduct of the sophistication of devices, nor of their technical features such as graphic fidelity or movement speed: sense of presence is the outcome of the impression of being able to enact intentions, and it is influenced by users' predispositions including previous experience and knowledge, personality and especially a clear motivational structure to enact in the environment, being it real or virtual [3]. In a scenario where the use of immersive VR is relatively widespread, one relatively underexplored subfield is that of shared/social VR and its effects on learning and user experience. Any meaningful educational experience is predicated upon a relationship with an educator who could support the learner with personalized information and scaffolding [4] In this sense, in educational VR another may be present alongside the learner, assuming the role of a teacher or mentor. It is interesting to assess the possible effects of a mentor presence or absence within a problem-based VR experience. The possibility of a learner-

mentor relationship in the educational environment depends on social presence, or the sensation of being in the company of others within a mediated environment [5;6]. Thanks to reaching a satisfying level of social presence, learners have the possibility to develop relationships with each other as well as with mentor figures, consolidating learning [7]. To this aim, one interesting problem-based VR use case is represented by escape rooms, namely real-life or digital games where one or more players have to employ observation and reasoning skills to solve progressive puzzles in order to be able to exit the room. Prior work suggests these activities can support motivation, teamwork, critical thinking, and active participation, and therefore have been already employed in numerous educational and team-building interventions [8].

In the present study, 12 participants (4 females; mean age=29.8, SD=3.2) played an escape room inside immersive VR for approximately 60 minutes. The VR escape room was developed within the internal research project "Virtual Campus" of Pegaso University, designed for deployment on Windows 11 and compatible with Meta Quest 2, Meta Quest Pro and Meta Quest 3 head-mounted displays. The application featured 6 progressive puzzles developed by the authors, that required logical thinking, basic general knowledge and spatial cognition abilities to be solved. The experimental design entailed two distinct data collection conditions. In the fully collaborative condition (Condition 1), participants completed the entire experience of the escape room by actively and continuously cooperating with a second player who was already familiar with the environment and the puzzles. In contrast, in the semi-autonomous condition (Condition 2), participants operated independently throughout the session, with the second player intervening exclusively to address specific puzzles whose resolution structurally mandated a dual interaction. Participants completed Qualtrics questionnaires administered at different stages of the experience. The first questionnaire collected demographic information, the Self-Assessment Manikin (SAM) [9], a non-verbal measure of emotional experience assessing valence, arousal, dominance. At the end of the VR session, participants completed the second questionnaire including the ITC-Sense of Presence Inventory (ITC-SOPI) [10], the SAM, and the Social Presence Scale [11], in order to assess presence, emotional experience, and perceived social interaction within the virtual environment.

Results showed some interesting patterns. First of all, the whole sample reported increased emotional pleasantness after the activity, supporting the escape room as an overall positive experience. Subscales of the sense of presence measure, instead, revealed an unexpected pattern: participants who played the escape room with little support from a mentor (the control group) reported higher levels of engagement and lower levels of cybersickness. Regarding social presence, instead, the group that played the escape room along with a mentor reported higher levels on the subscales message and affective understanding, associated with the effectiveness of informational and emotional communication respectively. As a pilot study with a sample on the small side, the present study identifies some interesting hints for future research. It is possible that adding a mentor figure within educational VR, while desirable and effective from a communication viewpoint, may be associated with extraneous cognitive load that could improve negative effects of VR. Future research should explore other ways to include educational agents within technology-mediated experiences, in order to support inclusion and the learning experience as a whole.

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From dichotomy to synergy: rethinking the educational environment through embodied learning and adaptive AI

Giuseppe Filippo Dettori[1[0000-0003-3493-5237]] and Marialuisa Pinna[2[0009-0002-4524-7755]]

[1] Università degli Studi di Sassari, Sassari, Italy
[2] Fondazione Eurispes, Rome, Italy
f.dettori@uniss.it
marialuisa.pin@gmail.com

1 Somatic pedagogy and the body as an epistemic site

Within the contemporary pedagogical debate, there is a growing focus on redefining learning paradigms. Against this backdrop of potential transformation, there is a significant interest in embodied cognition, embodied learning and the intrinsic dimension of emotions [11]. Moving beyond the traditional Cartesian dichotomy [2], this perspective suggests that cognitive processes are not abstract entities, but arise from the dynamic interaction between the brain, the body, emotions and the environment [9, 2]. Knowledge is thus woven into the dialogue between physicality, emotional experiences and mental processes, revealing how the body functions as a 'vehicle of being-in-the-world' [8].

Within this epistemological horizon, this contribution proposes a reflection aimed at exploring the intersections between embodied cognition and the integration of specific forms of artificial intelligence (AI) in higher education, and at identifying its main strengths and critical issues.

In this framework, knowledge is understood as a relational and situated process, in which the body acts as the primary mediator of cognitive experience, even when mediated by technological devices.

A pedagogy that values corporeality must promote multisensory engagement capable of enhancing students' subjectivity and emotional resonance [4, 6]. Read through the interpretive lens of Somatic Pedagogy, the body represents a primary epistemic site: the place where posture, gesture, rhythm, emotion and perception co-construct understanding. The question that then arises is how this dimension can be technologically mediated without being betrayed.

Artificial intelligence (AI) emerges, in the post-modern landscape, as a powerful enabler, a genuine scaffolding capable of opening up access to disciplinary content [3, 5], without neglecting other fundamental aspects involved in the teaching-learning process. Generative AI and adaptive systems have the potential to transform learning environments into dynamic and reactive spaces, offering real-time feedback and

personalised pathways [3, 5]. In this highly complex scenario, it appears essential that personalisation stems from an intentional educational process, capable of recognising the vital importance of emotional engagement and motivation in the neurocognitive mechanisms of learning. To avoid purely transmissive tendencies, the adoption of the Embodied AI paradigm is hypothesised, which proposes that digital tools should not function as mere content providers, but as 'relational infrastructures', capable of simulating presence, sustaining attention and promoting situated learning [6].
The integration of AI with the principles of embodied learning opens up new avenues, enabling traditional barriers to be overcome. Within this landscape, one particularly promising avenue involves Embodied Conversational Agents (ECAs).

2 ECAs: potential and operational models

Research into ECAs has mainly been carried out in areas such as student guidance support and the management of academic stress. Empirical applications specifically aimed at teaching in an academic context appear to represent a promising area of research, capable of opening up new perspectives in the study of the relationship between artificial intelligence and innovative learning environments.
ECAs can certainly help to shape a somatic pedagogy of artificial intelligence [9]: if designed wisely and in accordance with somatic principles, these tools – based on non-verbal communication and social agency [1] – can transcend the role of mere assistants to become genuine 'epistemic partners' [10]. ECAs embody a presence that shapes reflection through gestures and rhythm, facilitating the emergence of tacit knowledge without cognitively overloading the student. At the same time, they support inclusive instructional design by encouraging teachers' reflective practice [10] and facilitate student guidance by offering immediate and personalised interactions.
In this context, AI can act as a mediator within inclusive educational ecologies, capable of enhancing emotional skills even in contexts – such as the university setting – where this dimension appears to be less valued than in other fields, whilst the environment is elevated to a complex ecosystem that encompasses body, mind, emotions and culture, promoting relational and epistemological sustainability.
The most promising areas of research focus on the integration of Large Language Models (LLMs), which are believed to be capable of enhancing the conversational abilities of ECAs, thereby fostering more natural, contextualised and adaptive interactions. Indeed, the most recent literature reviews identify the integration of LLMs and generative artificial intelligence techniques as one of the main avenues of development for educational ECAs [12].
In summary, the integration of Embodied Conversational Agents (ECAs) represents one of the most promising frontiers at the intersection of human–machine interaction and the learning sciences. In the university setting, characterised by highly complex content and the latent risk of student isolation, the design of these agents cannot be separated from robust theoretical and methodological frameworks. The scientific literature highlights how the educational effectiveness of ECAs depends on the synergy of three major theoretical pillars: the theory of multimedia learning [7], which offers

precise guidelines for optimising cognitive load; the embodied cognition approach, which integrates the principles of imitation and modelling whilst respecting the constraint of multimodal synchrony; and the socio-affective dynamics of the pedagogical relationship, according to which instructional design must carefully define the agent's social architecture in line with the learning objectives. The agent must also implement adaptive scaffolding strategies, constantly monitoring the user's responses or states of frustration through affective computing systems.

Despite the endless possibilities it offers, the adoption of AI in education nevertheless raises ethical and pedagogical challenges: it is essential to promote AI literacy that rises to the level of reflective and critical thinking, capable of interacting with intelligent systems [5].

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Natural Teacher Language for Conflict Style Classification with SLMs

Elena Dell'Aquila[1 [0000−0002−5233−5107]], Davide Marocco[2 [0000−0001−5185−1313]], Raffaele Di Fuccio[1 [0000−0001−8886−3967]], Pierpaolo Limone[1 [0000−0003−3852−4005]], and Umberto Barbieri[1 [0009−0000−0357−3371]]

[1] Pegaso University, Naples, Italy
elena.dellaquila@unipegaso.it, raffaele.difuccio@unipegaso.it, pierpaolo.limone@unipegaso.it, umberto.barbieri@unipegaso.it
[2] University of Naples Federico II, Italy
davide.marocco@unina.it

1 Introduction

Serious games are increasingly used in teacher education by enabling safe, realistic practice of complex professional skills. Through simulation, teachers can test strategies, observe consequences, and reflect on their behaviour without real-classroom risks [1], [2], [3]. This is particularly relevant for classroom conflict management, involving authority, inclusion, cultural diversity, stereotyping, and student resistance.

Recent developments in language models make it possible to move from scripted serious games, based on predefined dialogue options, to adaptive serious games, where teachers can write free-text responses and the system interprets them in real time. A recent work [4] showed that a locally deployed Small Language Model (SLM), Ministral 3-3B-Instruct, optimized through prompt engineering and contrastive in-context examples, can classify teacher utterances according to Rahim's five conflict management styles with high agreement on a controlled corpus [5]. However, their study used written utterances collected from two ACCORD scenarios.

Therefore, an important question remains open regarding whether the same SLM approach can also work with spontaneous natural-language responses produced by real teachers during interaction with a serious game. This study addresses this gap through the following research question: to what extent can an optimized SLM on the device classify spontaneous teacher responses according to Rahim's five conflict management styles during ACCORD serious game interactions?

2 Background

Rahim's model describes conflict management through two main dimensions: concern for self and concern for others. Their combination produces five styles: integrating, obliging, dominating, avoiding, and compromising [5].

Previous work on SG-ACCORD used this theoretical framework to design role-playing serious games for soft-skills training in school contexts, where teachers interact with virtual agents and receive feedback on their choices [6], [7]. More recent studies have explored the use of Large Language Models in conflict resolution training and dialogue simulations [8], [9]. However, cloud-based models can raise problems of cost, latency, privacy, and dependence on the internet connection. These issues are relevant in educational settings, especially when teacher responses can contain sensitive classroom situations.

SLMs offer a possible alternative because they can run locally on ordinary hardware. This allows classification without sending data to external servers and can support real-time interaction inside the game. At the same time, previous research shows that prompt design, examples, and error-based refinement can improve language-model classification tasks [10], [11], [12]. The next step is therefore not only to test whether an SLM works on controlled examples, but whether it remains reliable with natural teacher.

3 Method

The study extends the analysis to two ACCORD scenarios addressing different intercultural and inclusion-related tensions in the classroom, specifically stereotyping and ethnic humor, and religion, and will involve approximately 100 in-service and pre-service teachers.

Each scenario will be organised as a multi-turn interaction in which a virtual student, or group of students, presents a conflictual situation and the teacher responds freely in writing. At each turn, the SLM (class of models with the Ministral-3B dimension) will classify the teacher's response through a context-aware prompt including the scenario, the previous virtual-student utterance, and the teacher's answer. The prompt will contain Rahim's five styles, decision cues, and in-context examples, and will remain fixed during the main evaluation.

To create a human reference standard, the collected utterances will be independently coded by at least two trained experts. Inter-rater reliability will be calculated before discussion, and disagreements will be resolved to define a final gold standard. SLM predictions will then be compared with expert annotations using accuracy, macro-F1, Cohen's kappa, and confusion matrices. Additional analyses will examine recurrent misclassifications and possible performance differences across the five ACCORD scenarios.

4 Expected results

This study moves from technical feasibility to ecological validation. If the SLM maintains substantial agreement with expert coders, the results will support its integration as a real-time classification layer in adaptive serious games for teacher training. In this case, the game engine could use the classification to adapt the behaviour of virtual students, build individual profiles of teachers' conflict-management styles, and provide personalized feedback after the simulation.

If performance decreases with spontaneous teacher language, the study will still be useful. It will show where the model is less reliable and which conflict styles are more difficult to distinguish in natural interaction. This information can guide future improvements, such as prompt refinement, richer contextual information, larger annotated datasets, or fine-tuning on domain-specific teacher responses. Overall, the study aims to understand whether locally deployed SLMs can become reliable pedagogical tools, not only technical components. Demonstrating robust classification across the ACCORD scenarios would support the development of privacy-preserving, low-cost, and scalable adaptive serious games for teacher conflict-management training.

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Co-Designing Educational Escape Rooms with Taitale: Benefits and Recurring Challenges

Clarissa Lella[1[0009-0000-3415-4436]], Anna Trifonova[2[0000-0003-1172-9940]], Marc Fuertes-Alpiste [3[0000-0003-4262-7154]], Nuria Molas-Castells[3[0000-0002-4784-9672]], Christianna Mavrou[4], Paula Nadbrzeska[5[0009-0004-9993-5830]], Valeria Formisano[6], Łukasz Tomczyk[7[0000-0002-5652-1433]], Angelo Basta[8[0009-0008-3954-997X]], Ines Villano[1[0000-0002-1755-358X]] and Raffaele Di Fuccio[1[0000-0001-8886-3967]]

[1]Università Telematica Pegaso
[2]Creatic Nens
[3]Universitat de Barcelona
[4]Odyessea
[5]Advantech srl
[6]Smarted srl
[7]Uniwersytet Jagielloński
[8]Università Telematica e-Campus

clarissa.lella@unipegaso.it

1 Introduction

This paper presents an exploratory study conducted within the Erasmus+ project named TAITALE (Training Activities for In-service and pre-service Teacher for empowering Learning with Educational escape rooms), a European cooperation partnership involving six organisations from higher education, industry, and educational technology sectors across Italy, Spain, and Poland. The TAITALE project aims to support teacher professional development in designing and implementing Educational Escape Rooms through a combination of training activities, methodological guidelines, and a dedicated digital authoring environment.

Educational Escape Rooms (EERs) are increasingly adopted as game-based learning environments that foster engagement, collaboration, and problem solving through narrative-driven and puzzle-based activities [1–3]. Unlike recreational escape rooms, EERs are explicitly designed to support learning outcomes by integrating instructional objectives, storytelling, and assessment into coherent learning experiences. While existing literature has largely focused on learner outcomes, comparatively less attention has been devoted to the collaborative design processes through which educators develop these environments. From a socio-constructivist perspective, learning design is a socially mediated process of knowledge construction in which educators negotiate pedagogical, narrative, and technological decisions [4]. Within this perspective, co-design practices [5] and authoring environments can function as pedagogical scaffolds [6], supporting designers in managing the complexity of instructional design activities [7, 9]. The present study investigates the collaborative design of NFC-enabled mobile Educational Escape Rooms using the TAITALE authoring platform and examines the

recurrent challenges emerging during collaborative design activities conducted across different European contexts.

2 Method

The TAITALE authoring platform supports a structured workflow guiding educators through narrative design, puzzle sequencing linked to NFC-tagged objects [8], multimedia feedback integration, and final resolution development. Rather than acting solely as a technical tool, the platform operationalises scaffolding principles by making key instructional design decisions explicit and supporting iterative co-design processes. Data were collected during co-design workshops and hackathons conducted in Spain, Italy, Greece, and Poland. A total of 116 participants—including in-service teachers, teacher educators, and pre-service teachers—collaboratively designed 30 Educational Escape Rooms. The analysis focused on identifying recurrent design patterns and challenges emerging across the different implementation contexts.

3 Results

Findings reveal a high degree of consistency across countries. While the platform was generally perceived as intuitive and well structured, occasional technical issues (e.g., device pairing and media compatibility) were reported. However, the predominant challenges were pedagogical rather than technical. Five recurrent themes emerged across the co-design activities: (1) aligning learning objectives with gameplay design; (2) ensuring coherence between narrative development and puzzle sequencing; (3) the time-intensive production of multimedia learning assets; (4) the value of collaborative design in distributing cognitive and creative workload; and (5) time constraints as a critical limiting factor.

4 Discussion

Overall, the findings suggest that the primary challenge in designing Educational Escape Rooms lies not in using authoring tools, but in managing the inherent complexity of integrating pedagogy, narrative, and gameplay into coherent learning experiences [10]. In this sense, TAITALE functions as a pedagogical scaffold by externalising and supporting key design decisions throughout the design process. The consistency of the findings across countries further suggests that these challenges are structural rather than context-dependent.

5 Conclusion

This exploratory study shows that the collaborative design of Educational Escape Rooms is primarily constrained by pedagogical rather than technical factors. Although minor technical issues emerged, participants consistently identified instructional design, narrative development, multimedia production, and time management as the

main challenges. The findings highlight the value of structured authoring environments such as TAITALE in supporting educators through complex game-based learning design processes and provide useful implications for the development of future authoring tools and professional development initiatives.

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Special Track 8

Pedagogy and participatory technologies in the post-digital era

Organizers:
Claudio Melacarne, University of Siena, Italy
Luca Agostinetto, University of Padova, Italy

Beyond Cognitive Delegation: Socio-Material Practices and Participatory Technologies for the Promotion of Agency in Higher Education

Daniela Cima
Università Cattolica del Sacro Cuore
Brescia - Italy
daniela.cima@unicatt.it

1 The "Onlife Agora": hybrid spaces and communicative proximity

In the post-digital context, where the boundary between the physical and the digital has become blurred and fluid [1], participatory technologies cease to be mere technical tools and become environments for the co-construction of knowledge and active citizenship; environments for the discussion and visualization of knowledge, taking on, in some respects, the form of an agora that becomes a hybrid "Onlife" space.
In the classical agora, citizens discussed on an equal footing, in the "Onlife agora". The organizational spaces are oriented toward psychological safety, where the value of an idea does not depend on who expresses it, but on the quality of the thought itself. The public square is, by definition, a place of transit, of encountering strangers, of commerce and barter, not only of goods, but of worldviews and becomes a perfect spatial metaphor for describing the transcendence of and openness to cultural complexity[2], as well as a space defined by relationships, where the dimensions of physical and communicative proximity take on new forms, no less effective than those in face-to-face interactions.

2 Socio-material practices: community of practice and skill development

Today, technology in the university is no longer merely an external tool, but rather an "integrated socio-material practice" [3], which enables students to create, modify, and share content; to collaborate and actively contribute; to construct, design, and produce artifacts and to visualize the complexity of knowledge, which takes on multidimensional and transdisciplinary forms. The relational space, which in the university context becomes a space for creation free from cultural superstructures [4], transforms students into participating co-producers in which knowledge is collectively constructed. The "Onlife"[5] space becomes a community of practice through forums, scientific social networking platforms and online learning environments when they are used for

dialogue, exchange, and creation. They take the form of a community that learns among and with people, thereby redefining traditional learning hierarchies.
Students experience autonomy within structured programs, but they also build relationships [6], often spontaneous and natural, precisely because the activity revolves around a topic and has a common goal, which allows them to overcome cultural barriers [7]and create new group and community cultures in which people experience unprecedented forms of encounter and knowledge. The physical dimension present in face-to-face interactions is absent in "Onlife", but the experience of participatory technologies allows for a more direct form of encounter with the Other through doing and acting, in which body and culture do not constitute barriers. The relational dimension can also be enhanced and pedagogically designed to be oriented toward building closeness and proximity as elements of the activity itself and of the relationship among students.
The integration of participatory technologies into education fosters, first and foremost, epistemic skills and the ability to manage complexity: co-constructing knowledge compels participants to negotiate the value of information, recognize biases, and verify the reliability of sources, integrating individual perspectives into a higher-level conceptual synthesis [8]. This process of organizing and sharing knowledge within the community of practice fosters the development of advanced information literacy. At the same time, interaction in such diverse contexts stimulates a deep relational sensitivity, which is indispensable for working in asynchronous teams characterized by fluid workflows, timelines, and roles; in these spaces, embracing disagreement and negotiating cognitive conflict serve as levers for collaborative growth [9]. Last but not least, digital citizenship skills emerge, which are necessary for engaging with the internet in an active, ethical, and informed manner. By developing the agency required to participate in public and academic discourse, students hone specific communication skills, learning to articulate complex concepts through multimodal formats and languages capable of transcending the physical boundaries of the university classroom [10].

3 Pedagogical design for an inclusive and sustainable digital agency

Activities in which participatory technologies are an integral part do not replace in-person activities, but complement them by offering the opportunity to develop other skills by leveraging certain unique characteristics and dimensions of the "Onlife" that facilitate encounters, relationships, interaction, and collaboration, as well as the absence of barriers of prejudice linked to cultural aspects[11, 12, 13,14]. "Onlife" does not preclude the opportunity to exercise social skills; rather, it develops different ones compared to in person contexts and, in some cases, enhances and amplifies already acquired soft skills by reshaping them.
This paper aims to analyze, through a theoretical reflection, how such contexts enable the development of advanced epistemic, relational, and digital citizenship skills, enhancing the management of complexity and the negotiation of cognitive conflict. In conclusion, it is emphasized that the task of contemporary pedagogy is to design learning pathways in which participatory technology is not the end goal of educational

activity, but rather a tool for acquiring cross-curricular skills, emerging as an inclusive "virtual training ground" for practices of humanity and sustainability.

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Empowerment Or Replacement Of Collaborative Learning? Artificial Intelligence, Student Agency, And The Social Construction Of Knowledge In Higher Education: A Systematic Literature Review

Farnaz Farahi[1[0000-0002-0473-4154]] and Simin Sasani[2[0000-0001-7712-8684]]

[1] eCampus University, Novedrate, Italy
[2] Southampton University, Southampton, UK
farnaz.farahi@uniecampus.it
s.sasani@soton.ac.uk

1 Introduction

In the contemporary post-digital ecosystem, technologies can no longer be considered external tools or simple supports for educational action, but rather socio-material devices that participate in the production of knowledge [4, 8, 9], in the configuration of educational relationships, and in the redefinition of students' agency. In this scenario, the growing diffusion of Artificial Intelligence, and in particular generative AI, in higher education raises a crucial pedagogical question. Do these technologies truly expand the possibilities for collaborative learning and students' cognitive empowerment, or do they risk progressively replacing peer interaction, the negotiation of meanings, and the processes of co-construction of knowledge?

The contribution presents a systematic review of the peer-reviewed scientific literature on the use of AI in higher education, with particular attention to the relationship between AI, collaborative learning, student agency, and the social construction of knowledge [3, 10]. The study is situated within socioconstructivist and sociocultural perspectives, taking Vygotsky, Bruner, and Dewey as theoretical references [11, 1, 2], for whom learning is configured as a situated, relational, and culturally mediated process. Alongside these perspectives, the study also draws on more recent contributions on the post-digital condition, sociomateriality, and artificial intelligence in education [6, 9, 8, 7, 12], which make it possible to interpret AI not as a neutral object, but as an actor entering networks of action, relationships, and decision-making.

The research question guiding the study is the following: in what ways does the integration of AI in higher education support or limit student agency, cognitive empowerment, and collaborative learning? More specifically, the review investigates whether AI promotes forms of scaffolding, reflexivity, autonomy, metacognition, and participation, or whether it produces effects of cognitive delegation, technological dependency, reduction of interaction, and displacement of epistemic authority from learners to algorithmic systems.

2 Methods

The systematic literature review identified 52 peer-reviewed scientific contributions referring to the context of higher education in the United Kingdom. Through the application of inclusion and exclusion criteria, defined according to the methodological protocol of the systematic review, 20 articles were selected and included in the final synthesis of the analysis [5]. The review followed the PRISMA reporting framework and searched the major databases accessible through the University of Southampton library (including Scopus, Web of Science, ERIC and PsycINFO).

Studies were selected through predefined search strings and explicit inclusion and exclusion criteria. The included studies are mainly concentrated in the three-year period 2024–2026 and primarily concern generative AI. The analytical categories adopted include: type of AI, pedagogical function, area of impact on learning, forms of interaction, dimensions of cognitive empowerment, indicators of collaborative learning, pedagogical risks, and the presence of the intercultural dimension. The research project explicitly assumes the problem of the alternative between empowerment and replacement of collaborative learning as the central issue of the investigation.

3 Results and Discussione

The first results reveal an ambivalent framework. On the one hand, AI can support learning processes through immediate feedback, personalization, cognitive scaffolding, support for reflection, facilitation of academic writing, and enhancement of participation within groups. In some studies, AI-mediated environments foster self-efficacy, motivation, the quality of problem solving, and the possibility of more frequent interactions. On the other hand, significant critical issues emerge: dependency on generated outputs, unreflective use, reduction of collective creativity, weakening of epistemic responsibility, risk of plagiarism, cultural biases, and loss of the dialogical dimension of learning. Particularly significant is the tension between AI as a "co-learner," cognitive partner, and form of shared agency between humans and intelligent systems, and AI as an inappropriate substitute for dialogical and collaborative interaction among students.

The review also highlights an important gap: the intercultural dimension is often absent or marginal. Only a few studies explicitly address the relationship between AI, cultural diversity, linguistic inclusion, and epistemic justice. This represents a significant limitation, since intelligent technologies do not operate in culturally neutral spaces: they incorporate linguistic models, implicit values, representations of knowledge, and possible forms of asymmetry. From this perspective, AI in higher education must also be examined from the standpoint of intercultural and postcolonial pedagogy, so that it does not reproduce cognitive hierarchies, symbolic exclusions, or forms of cultural standardization or epistemic injustice.

4 Conclusion

The contribution therefore argues for the need for a critical pedagogical approach to AI, capable of overcoming both technocentric enthusiasm and defensive rejection of technology. AI can become an educational resource only if it is embedded within intentional, reflective, and collaborative teaching arrangements, in which the teacher maintains a pedagogical steering function and students are educated toward a critical, dialogical, and responsible use of tools. The objective is not to delegate the task of learning to the machine, but to design contexts in which AI supports participation, reflexivity, cooperation, and the shared construction of meanings.

In conclusion, the review suggests that AI does not automatically determine either empowerment or replacement. Its effects depend on pedagogical frameworks, instructional design modalities, the forms of interaction promoted, and the capacity of higher education institutions to develop a critical culture of innovation. In this sense, AI can contribute to students' empowerment only if it does not interrupt the link between knowledge, relationships, and responsibility, but rather relaunches it within new collaborative ecologies of learning.

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Cultivating Human Worth or Optimising Employability? Meritocracy and the Datafied Governance of Italy's ITS Academy

Virginia Santa Capriotti[1][0000-0002-0114-938X]

[1] University of Bergamo, Department of Human and Social Sciences, Bergamo (Italy)
virginia.capriotti@unibg.it

1 Introduction and Aim

Across higher and tertiary education, data infrastructures have become an ordinary medium of governance, steering institutions and rendering learners legible through indicators and outcome metrics [1, 2]. The post-digital condition is marked less by new technologies than by their becoming mundane, embedded in the routines by which institutions are accredited and funded [3]; yet every indicator inscribes an idea of what education is for and of how worth is recognised [1]. This contribution takes Italy's reformed tertiary professional sector, the ITS Academy, as a revealing case, since its monitoring conditions accreditation, funding and rewards on measured results, up to employment [4, 5]. The question it pursues is which conception of merit such governance presupposes: the paper articulates a conceptual distinction – between meritocracy and *meritorietà* (meritoriousness) – and operationalises it through a pilot documentary analysis of the reform's normative and monitoring corpus.

2 Meritocracy and Meritoriousness (*meritorietà*)

A meritocratic logic treats talent as a scarce, rankable resource and education as competitive sorting, presenting the resulting inequality as deserved [6, 7]; digital metrics make this logic operative, recasting learning as quantified, comparable performance [1, 2]. Meritoriousness shifts the object of evaluation itself: it weighs formative processes, unequal starting conditions and the development of each learner's capabilities – talent as a potential to be realised, not a rank to be assigned – together with the institution's own responsibility for cultivating them [8, 9]. The two are distinct evaluative grammars requiring different data: comparable outputs in the first case, and traces of processes, conditions and recognition in the second. The distinction is especially consequential in professional education, whose dignity has long been weighed against the academic track rather than affirmed on its own terms [10]. Which grammar the ITS Academy's data infrastructures enact is therefore an empirical question.

3 The Case, the Corpus and the Coding Procedure

The corpus was delimited by three criteria – prescriptive force over the evaluation of institutions, national scope, currency (2022–2025) – and comprises seven documents: Law 99/2022; the decrees establishing the student registry and the national database (DM 227/2023), the national monitoring and evaluation system (DM 229/2023), the realisation and result indicators for fifth- and sixth-level EQF pathways (DM 228/2023, DM 235/2023) and the allocation of the national fund (DM 236/2023); and the INDIRE national monitoring report for 2025, with its indicator glossary [4].

The unit of analysis is the textual segment in which a criterion of value, an object of evaluation or a representation of the learner is stated or presupposed. Coding combines qualitative content analysis [11] with documentary analysis [12] and a problematisation-oriented reading of policy [13], asking what problem the measures represent themselves as solving. The frame is deductive, derived from the meritocracy–*meritorietà* distinction (Table 1), and open to inductive refinement. The procedure comprises four steps: an open reading supported by analytical memos; segment-level coding along the three axes; a second round after refinement of the codebook, attending to divergent segments; and the re-coding of about a third of the segments, drawn from all seven documents, two weeks after the first pass, with categories redefined wherever the two passes diverge. Interpretation weighs the position each segment occupies within the apparatus – prescriptive, monitoring or reporting – since a criterion tied to funding differs in force from a declaration of aims.

Table 1. The coding frame applied to the corpus.

Axis	Categories
Conception of success	employment; completion and regularity; performance; capability development
Subject of evaluation	institution; course; student; labour-market outcome
Image of the learner	output; human capital; developing person; professional subject

4 Preliminary Findings

The 2025 national monitoring assessed 450 pathways completed by 109 foundations: 8,588 students out of 11,834 obtained the diploma, 84% of them held an employment contract within twelve months, and 260 pathways (57.8%) qualified for *premialità*, the performance-based component through which 30% of the national contribution is allocated [4].

The preliminary analysis indicates a marked asymmetry between the two evaluative grammars. Employment, completion and regularity dominate the result indicators and acquire prescriptive force through their connection with funding and performance-based rewards. References to capability development and personal growth appear mainly in programmatic provisions and are only weakly translated into measurable indicators. The learner is consequently represented predominantly as a labour-market

outcome or as human capital, while the image of the developing person remains comparatively marginal. Employability is not thereby a poor educational aim: it can carry agency, inclusion and professional recognition. In this corpus, however, it tends to operate as the predominant criterion through which formative value is institutionally recognised, while processes, starting conditions and growth recede from view. The analysis remains open to disconfirmation: the corpus shows what the apparatus institutes, not what actors make of it.

5 Contribution and Next Steps

The contribution is threefold: a pedagogical critique of meritocracy applied to a sector usually read through employability alone; an analytical grid transferable to other datafied evaluation systems; and design principles for a *meritorietà*-oriented use of evaluative data – indicators registering formative processes and capability development, outcome measures paired with the conditions under which they were obtained, and participatory procedures in which students and teachers help define and interpret indicators [14, 15]. Two strands follow: interviews with coordinators, tutors and students on how indicators are enacted and reinterpreted in practice, and participatory workshops in which the same actors redesign a subset of indicators according to the criteria of *meritorietà*. Both converge on the question the paper submits to discussion: whether evaluation can recognise the singular worth of each learner rather than settle it at the point of employment.

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Between Resistance and Critical Integration: Teachers' Attitudes Toward Digital Technologies

Arianna Marras[1][0009-0006-2144-3822], Giovanni Bonaiuti[0000-0003-0219-3603] and Mirian Agus[0000-0001-6774-1530]

[1] University of Cagliari, Cagliari, Italy
{arianna.marras,g.bonaiuti,mirian.agus}@unica.it

1 Introduction and rationale

The increasing diffusion of digital technologies and generative artificial intelligence in schools is transforming instructional design, teacher mediation, and learning activities. Understanding teachers' attitudes toward technology therefore requires moving beyond a simple distinction between openness and resistance, and examining how they attribute pedagogical meaning to digital tools within professional practice. While technology acceptance models have traditionally explained adoption through perceived usefulness, ease of use, intention to use, and facilitating conditions [1], educational research shows that teachers' digital adoption also depends on attitudes, self-efficacy, technology-related anxiety, professional beliefs, and school characteristics [2]. Thus, the value of technologies cannot be assessed only in terms of frequency of use or willingness to adopt them, but must be related to instructional aims and to teachers' capacity to evaluate benefits, limitations, and implications. Studies on technology integration have further shown that digital adoption is shaped not only by first-order barriers, such as access and infrastructure, but also by second-order barriers, including beliefs, attitudes, and implicit instructional models [3,4]. This perspective is consistent with DigCompEdu, which frames educators' digital competence as a complex professional competence [5], with recent AI frameworks emphasizing ethical awareness, pedagogical integration, and teachers' professional agency [6], and with the TPACK model, according to which innovation derives from the integration of technological, pedagogical, and content knowledge rather than from technology itself [7].

2 Research questions and hypotheses

The study examines whether teachers' attitudes toward digital technologies reflect a linear acceptance–rejection continuum or, rather, a multidimensional structure. Specifically, it investigates whether distinct stances can be empirically identified - namely resistance/discomfort, uncritical technological confidence, and responsible pedagogical-didactic integration - which dimensions are central within teachers' belief systems, and whether they are associated with cognitive flexibility, age, and teaching experience. Consistent with research on technology acceptance, pedagogical beliefs, and instructional technology integration [1,2,3,4,7], a multidimensional structure was

hypothesized, with responsible pedagogical-didactic integration expected to constitute the theoretically most relevant component, as it reflects teachers' ability to subordinate technology use to instructional relevance, educational responsibility, and professional reflection.

3 Method

Participants were 355 teachers (age: m=49.7, sd=10.4; teaching experience: m=17, sd=11.3; 66.8% female) from primary school (20.6%), lower secondary school (19.7%), and upper secondary school (59.7%). A 15-item questionnaire, developed through expert-based theoretical reflection, assessed attitudes, beliefs, and professional orientations toward digital technologies in education on a 7-point Likert scale. The items addressed perceived risks and opportunities, resistance or discomfort, pedagogical and ethical reflection, and willingness to experiment. Socio-demographic and professional data were collected, and cognitive flexibility was measured through the Cognitive Flexibility Inventory [8]. Analyses combined network analysis to examine item relationships and centrality [9], exploratory factor analysis to identify latent dimensions, and correlations between the resulting factors, cognitive flexibility, age, and teaching experience.

4 Results

Network analysis revealed a moderately connected structure, with 15 nodes and 49 non-zero edges out of 105 possible connections (sparsity=.533). The network was mainly organized around two areas: responsible pedagogical-didactic integration, characterized by ethical reflection, assessment of benefits and risks, mindful use, and coherence with educational objectives; and resistance/discomfort toward digital technologies, associated with avoidance, preference for traditional practices, and perceived complexity or professional overload. Centrality measures showed that items concerning pedagogical and ethical reflection and the integration of technologies with educational objectives played a bridging role across the network, whereas items reflecting an uncritically positive view of technologies were not central, suggesting that the attitude system was not organized around a technocentric logic. Exploratory factor analysis confirmed data adequacy (KMO=.818; Bartlett's test $p<.001$) and identified a three-factor structure with good fit indices (CFI=.950; TLI=.915; RMSEA=.065; SRMR=.032). The first factor, "Resistance/discomfort toward digital technologies," included avoidance, perceived discomfort, and preference for traditional practices (α=.863). The second, "Responsible pedagogical-didactic integration," included ethical reflection, evaluation of risks and opportunities, and mindful technology use (α=.844). The third, "Technological confidence and willingness to experiment," included beliefs about the positive impact of technologies on learning, openness to experimentation, and lower risk perception, showing weaker but acceptable reliability (α=.643). Correlations between the identified factors and cognitive flexibility were not statistically significant, suggesting that this relationship may be mediated by variables not considered in the study, such as

technological self-efficacy, prior experience, specific training, professional identity, or resistance to change. Associations with age and years of teaching experience were also weak or absent.

5 Conclusions

The findings indicate that teachers' attitudes toward digital technologies constitute a multidimensional construct, not reducible to a binary opposition between acceptance and rejection. The key result is the emergence of responsible pedagogical-didactic integration as a distinct dimension, separate from both resistance/discomfort and insufficiently problematized technological confidence. Pedagogical and ethical reflection, assessment of benefits and critical issues, and coherence with educational objectives appear to be central elements of teachers' professional belief systems, suggesting that their relationship with technologies should be interpreted as different ways of attributing meaning to digital tools in teaching practice. Resistance may reflect integration difficulties, perceived overload, or uncertainty about instructional relevance, whereas technological confidence does not necessarily imply effective use without critical awareness. The proposed instrument may help identify attitudes and beliefs that orient technology integration and support more targeted professional development. In a context increasingly shaped by artificial intelligence and emerging technologies, these results highlight the need to strengthen not only technical competences, but also teachers' capacities for pedagogical evaluation, regulation, and decision-making.

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A Socio-Material Ethnography of Blended Learning Practices in Higher Education

Mario Giampaolo, PhD[1][0000-0001-8041-3902]

[1] University of Siena, Arezzo 52100, Italy

mario.giampaolo@unisi.it

1 Introduction

In the post-digital era, technologies are no longer distinct, external tools but normalized, integral components of the higher education ecosystem, co-producing knowledge, relational networks, and modes of participation. This paper presents an ethnographic study conducted at the University of Siena that investigates the implementation of a blended learning framework—the ECOBI model—across two Master's degree programs [1]. Moving away from purely technical or instructional evaluations, this research adopts a socio-material perspective to analyse how the digital transition is concretely negotiated as a situated organizational and cultural practice [2], [3], [4], [5].

2 Method

From April 2024 to June 2026 the study tracked forty-eight organizational actors, including faculty members, academic governance, instructional designers, and media producers. They compose the convenience sample of the study. The observed sample was divided into the following groups:

Two composed of faculty members from the degree programs involved in the pilot;

One comprising the project governance team, including the Rector, teaching delegates, and program chairs;

One consisting of technical-administrative staff and specialized support personnel, including instructional designers, media producers, and technical staff working in the laboratory supporting instructional design and production.

The primary empirical data analysed in this paper are derived from in-depth, video-recorded interviews conducted with the faculty members. The interviews explored the participants' professional experiences, the learning and unlearning processes triggered by the redesign, methodological adaptation practices, and the tensions that emerged during the transition to the blended learning model. In addition to the interviews, the study considered and integrated into the analysis information found in regulations and ministerial documents, minutes of faculty meetings, and of training courses.

The collected materials underwent qualitative thematic analysis following an interpretive and inductive approach, aimed at identifying recurring semantic clusters, interpretive patterns, tensions, and organizational compromises. The analysis highlights the processes of redefining teacher identity, the transformations in teaching-learning practices, and the forms of negotiation that developed among all organizational actors during the processes observed in the university context [6], [7], [8].

3 Findings

The analysis highlights three primary socio-material dynamics and institutional tensions:

Collaborative architecture: The introduction of "Educational Clusters" shifted teaching from an isolated, individual practice to a shared planning process, challenging traditional academic autonomy and rendering implicit design criteria visible.

Altered temporalities and exposure: The production of modular asynchronous video content altered academic workflows by shifting preparation timelines forward by months, while simultaneously generating professional anxiety due to the permanent, reproducible nature of the recorded digital body.

Assessment and automation tensions: The transition toward competency-based assessment models exposed a fundamental disconnection between institutional systems of individual grading and the collective nature of blended learning, intensified by faculty concerns regarding cognitive delegation to artificial intelligence tools.

4 Practical application

The study demonstrates that the integration of participatory technologies within hybrid university spaces is a non-neutral process of continuous mediation between innovation and academic tradition. By mapping these negotiations, the paper contributes to a critical understanding of how contemporary academic authority and professional identities are reconfigured within increasingly interconnected educational networks.

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Technologies and Learning in Higher Education: A Sociomaterial Study of a COIL Experience

Claudia Banchetti [0000-0001-6287-6719]

University of Siena, Siena, Italy
claudia.banchetti2@unisi.it

1 Introduction

In the post-digital era, technologies are intertwined with educational practices, redefining the modalities of collaboration and co-construction of knowledge. Indeed, the awareness of the role that technologies play in learning processes is not new, especially in higher education. Drawing on studies on sociomateriality, particularly third-generation Cultural-Historical Activity Theory (CHAT), this paper describes how the design of COILs can unleash the potential and contradictions of this perspective. A case study will be presented, in which a COIL program involved international students in topics related to environmental activism. This case provides the empirical context through which to explore the tensions and mediations that characterize the design and outcome of international collaborative programs mediated by participatory technologies.

2 Theoretical Framework

The contribution is placed within the framework of sociomateriality [1, 2], a perspective that overcomes the dichotomies between human and non-human to recognize how subjects, technologies, artefacts and contexts co-constitute each other in educational practices. Learning is understood as a situated process, inseparable from the social practices and tools that mediate it. Among the main sociomaterial orientations, the research adopts the third generation Cultural-Historical Activity Theory (CHAT) as a theoretical reference [3], which allows us to interpret higher education spaces as complex activity systems. From this perspective, rules, tools, division of labor, and community relations do not constitute a neutral backdrop, but actively participate in shaping educational practices. Human and nonhuman actors—material artifacts, technologies, objects—together contribute to shaping learning processes and the action possibilities of those involved [4].

3 The COIL Module Within the ELCRA Project

The contribution analyses a case study [5] relating to a Collaborative Online International Learning (COIL) experience developed within the three-year European

project ELCRA (Environmental Literacy in Higher Education Context for Preventing Violent Radicalization in Climate Activism), aimed at promoting environmental literacy in higher education with a view to preventing violent environmental radicalization. The project involved a consortium of five universities — Complutense of Madrid, Klaipėda, Jagiellonian University of Krakow, Coimbra and Siena, coordinator — each responsible for designing a COIL module. ELCRA was divided into successive phases: the first year was dedicated to a systematic analysis of the scientific literature on the topic of environmental radicalization, the second to the design of a MOOC, while the third year saw the creation of COIL, the subject of this contribution. There were five COIL modules in total, each coordinated by a partner university and involving approximately 50 international students. The University of Siena module lasted six hours over two weeks (April 17–May 1, 2026) and involved six students from partner universities, divided into two international groups of three. The groups were asked to design a counter-narrative aimed at adolescents on the prevention of environmental radicalization, working in English through alternating synchronous and asynchronous phases supported by a WhatsApp group and the Genially platform. Two intermediate synchronous monitoring sessions allowed for progress monitoring and feedback, while the program concluded with a plenary session for the presentation and collective discussion of the completed products. The empirical material consisted of the two counter-narratives and the collaborative interactions, analysed through thematic analysis [6].

4 Conclusions

CHAT guided the organizational choices of the COIL process, making every design element an object of sociomaterial investigation. The experience is analyzed by examining how digital tools, participation rules, peer relationships, and forms of coordination contributed to shaping a specific system of activities. The third-generation CHAT—subject, object, tools, rules, community, and division of labor—provided a process map for distributing roles, defining the counter-narrative task, and selecting the most appropriate digital artifacts to support international collaboration. From this perspective, from Genially to WhatsApp, from the synchronous/asynchronous structure to the international composition of the groups, no choice constitutes a neutral space: these are elements that actively shape the students' possibilities for action and collaboration [7]. Participants' engagement emerges not as an individual characteristic, but as the result of a complex network of sociomaterial mediations involving material and immaterial artifacts and human actors. The case also highlights structural tensions typical of online and international environments, linked to the coordination of heterogeneous timescales, tools, and languages, which make visible the negotiation dynamics through which shared meanings are constructed [8]. Although limited to a single context, the case highlights the potential of international online pathways in promoting critical participation, intercultural collaboration and shared reflection on complex environmental challenges [9].

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Participation As A Foundational Pedagogical Category For Understanding Learning In The Age Of Generative AI

Farnaz Farahi[1][[0000-0002-0473-4154]] and Lisa Bugno[2][0000-0002-6136-0806]

[1] eCampus University, Novedrate, Italy
[2] Università degli Studi di Padova, Padova, Italy
farnaz.farahi@uniecampus.it
lisa.bugno@unipd.it

1 Introduction

Contemporary educational contexts are characterised by sociocultural interdependence and digital hybridisation [6]. Technology, consequently, can no longer be regarded as separate from higher education but rather as integral to it. In particular, generative Artificial Intelligence (AI), in the post-digital era, constitutes a socio-material element that actively participates in the construction of knowledge [14] [9]. It is therefore necessary for education to consider generative AI not as something extraneous, but as a tool naturally present in students' lives—one with which and through which new possibilities can be developed. For this to occur, however, the integration of education and AI must be approached critically. Technological hybridisation, in other words, must not diminish but rather expand students' space of agency, co-responsibility, and co-construction of meaning [6] [10] [11]. In this sense, participation can be understood as a pedagogical and epistemological category [5] [7] [12] that should be preserved in order to interpret the transformations introduced by AI in educational and socio-educational contexts [3].

Within this scenario, the present contribution offers a theoretical-critical re-reading of participation as a pedagogical category through which to interpret the transformations introduced by AI in educational settings..

2 Methods

This contribution explores the topic from multiple methodological perspectives.
First, a theoretical examination of participation as a pedagogical category is undertaken.
Second, relevant research studies on the topic are reported.

In the first strand, drawing on the methodology presented by Ghirotto [8], the results of a systematic review examining 52 articles from the scientific literature—retrieved from the University of Southampton databases—are presented. A second line of inquiry concerns the TEACH-AI action-research project, developed by the CREDDI at eCampus University [1] [2].

3 Results and Discussion

Upon initial analysis, the review findings present an ambivalent picture.

On the one hand, generative AI is capable of developing forms of scaffolding and fostering participatory processes [4], enabling access to more complex information. On the other hand, from an intercultural and intersectional perspective, participation—understood as the promotion of agency and active citizenship—risks being weakened. If the pedagogical category of participation is not maintained, the risk is that dependence on generated outputs may, in the long term, lead to a loss of epistemic responsibility, an impoverishment of social interaction, and a reduction in the co-construction of meaning within knowledge processes

4 Conclusion

The analysis presented demonstrates that considering participation as a pedagogical category would help prevent the generation of univocal knowledge processes, thereby preserving the agency of higher education students. Indeed, it can foster empowerment, reflexivity, and new forms of collaboration. Conversely, there is a risk of promoting processes of cognitive delegation, technological dependence, and a reduction in active participation [15] [13]. There is thus a need to move beyond purely technocratic readings of the subject, as well as exclusively defensive stances toward digital innovation, by promoting intercultural and intersectional pedagogical approaches that are more oriented toward communities of practice and the co-design of human-centred environments[1][2].

Further analytical perspectives could be developed for the Italian context through more in-depth research studies.

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Digital Pedagogies on Social Media: Analysis of Edu-Influencers' Digital Teacher Identity, Engagement and Pedagogical Impact on Followers

Juan Ignacio Marti-Garcia[1][0009-0004-3510-9994]

[1] Universitat de Barcelona, Barcelona, Spain
jmartiga209@alumnes.ub.edu

1 Research Objectives and Questions

1.1 General Research Objectives

This thesis has two complementary objectives, each focused on one actor in the digital educational ecosystem (affinity space): edu-influencers and edu-followers.

O1: On edu-influencers. To analyse Spanish edu-tiktokers/instagramers: influence, digital identity, and pedagogical conceptions/learning theories in discourse/content.
O2: On edu-followers. To analyse motivations, choice criteria, and influence of edu-influencers' pedagogical conceptions/learning theories.

1.2 Specific Objectives

OE1.1. To analyse Spanish edu-influencers' influence/reach via engagement/datification metrics, along with their profile/trajectory, digital identity (self-perception, construction/modification via affordances), identity management/projection, and platform management as affinity spaces.
OE1.2. To identify/analyse pedagogical conceptions/learning theories in Spanish edu-influencers' TikTok/Instagram discourse, content and resources.
OE2.1. To investigate in-service teachers' motivations for using TikTok/Instagram in professional development and the pedagogical/personal criteria guiding their selection of edu-influencers.
OE2.2. To analyse the impact of edu-influencers' pedagogical conceptions/learning theories on their followers.

1.3 Research Questions

PI1.1. What is the influence of Spanish edu-influencers on the social media platforms TikTok and Instagram, according to updated engagement and datification metrics?
PI1.2. What is the profile/background of Spanish TikTok/Instagram edu-influencers, how do they self-perceive, construct, manage and project their digital teacher identity, and how do platforms influence its construction?

PI1.3. What pedagogical conceptions/learning theories underpin Spanish edu-influencers' discourse and how are they reflected in their TikTok/Instagram content/resources?
PI2.1. What motivations lead in-service teachers to use TikTok and Instagram for their continuous learning and professional development?
PI2.2. What pedagogical and personal criteria guide edu-followers' decision to follow certain edu-influencers on the TikTok and Instagram platforms?
PI2.3. To what extent do edu-influencers' pedagogical conceptions/learning theories influence their followers' educational practices/conceptions on TikTok/Instagram?

2 Context and motivation

The rise of edu-influencers on TikTok and Instagram as informal teacher training spaces lacks academic analysis regarding their digital identity construction, pedagogical conceptions, and impact on followers' professional development.

3 State of the art

Instagram [1] and TikTok [2] are teacher training spaces, though motivations remain unknown [3]. Edu-influencers [4] inspire others via pedagogical conceptions, yet it is unclear why some attract more followers or why teachers follow specific profiles. This requires urgent analysis [5].

4 Methodological approach

This mixed-methods study follows an explanatory sequential model [6]: digital ethnography; sampling (influencers: quota; followers: intentional) via Buzzsumo/Fanpage Karma; data collection (metrics, posts, interviews, questionnaires, focus groups); and analysis integrating quantitative metrics and qualitative thematic analysis (ATLAS.ti).

5 Expected outcomes

This study will characterise Spanish edu-influencers (profiles, pedagogical conceptions, influence) and followers' motivations/impact, providing a theoretical model and practical recommendations for teacher training in digital ecosystems.

6 Preliminary results

Not applicable (research in initial phase).

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Playing in the Post-Digital. Rethinking early childhood, intercultural perspective, embodied learning and community technologies as a challenge for higher education

Michele Marangi[1 [0000-0003-2013-5079]], Farnaz Farahi[1 [0000-0002-0473-4154]], Roberta Franceschetti[2 [0009-0003-5880-4124]] and Cristiano Zappa[1 [0009-0000-7567-4649]]

[1] eCampus University (Italy), [2] Associazione Mamamò (Italy)
michele.marangi@uniecampus.it farnaz.farahi@uniecampus.it
roberta@mamamo.it cristiano.zappa@studenti.uniecampus.it

1. Framework

The post-digital is often theorised from the vantage point of adult, institutionalised, and text centric educational practices. This paper proposes a deliberate methodological and theoretical displacement: it argues that rethinking the post-digital from early childhood reveals dimensions that remain structurally underexposed in current pedagogical discourse; namely, the primacy of embodied knowledge, the constitutive role of play, and the irreducibly relational character of learning environments. Rather than presenting empirical data or a systematic literature review, the paper advances a research perspective and a methodological proposal organised around four axes and held together by a shared question for higher education: what kind of professional formation is required to sustain this approach?

2. Early childhood in the post-digital

The first axis rethinks the post-digital starting from early childhood. Children aged 0–6 are born into conditions where connectivity, datafication, and platform logics already structure the domestic and educational environments [1]. This irreducible embeddedness makes early childhood as a privileged site for theorising the post-digital not as a transition but as a condition, one in which the digital/non-digital distinction was never stabilised to begin with. Where existing literature describes a cultural shift away from prior separations [2-3], the 0–6 age range reveals that no such separation need be assumed: entanglement was constitutive from the outset. AI operates here as invisible infrastructure, orienting relational pathways before children have conscious access to the devices involved [4], while datafication shape the very conditions of childhood rather than merely accompanying it [5]. Drawing on sociomaterial perspectives [6], this axis proposes an ontological reframing: participatory technologies in early childhood are constitutive elements of those practices from the outset.

3. Intercultural perspective

The second axis places the intercultural perspective at the center of the analysis, not as a dimension exclusively related to geographical origin or migratory status, but as an educational possibility of encounter, dialogue, mutual recognition, and shared construction of meanings. Culture is understood as a relational and dynamic space in which subjects negotiate languages, belongings, and worldviews [7-9]. The intercultural approach allows us

to critically examine how participatory technologies may foster listening, management of dissent, and dialogical participation within post-digital contexts. The central issue concerns not only access to technological tools, but the construction of relational environments in which differences may become opportunities for reciprocal learning and co-construction of knowledge [10-12].

4. Community technologies

The third axis develops the concept of community technologies, in which digital tools and infrastructures are designed and used with an explicit community orientation [13], fostering educational processes and social inclusion [14]. Within the network society, where digital technologies shape interconnected social, cultural, and economic environments [15], the unit of analysis shifts from the child–technology relationship to communities of practice. In this context, media education is framed as a cultural practice extending beyond technical literacy [16], drawing on media ecology [17], the social construction of technology [18], situated learning [19], and participatory cultures [20]. Digital competence thus becomes a collective capability through which communities actively reshape their socio-technical environments.

5. Bodies and playfulness

The fourth axis places play and the body at the centre of inquiry. Grounding the argument in embodied cognition [21-22] and physical literacy frameworks [23-24], this axis contends that play is a primary epistemological mode, one that technologies must be designed to extend rather than replace. The body is not the medium through which digital content is accessed; it is the site where knowledge is constituted, and any pedagogical approach that subordinates somatic experience to symbolic-digital interaction entails a loss that theory must account for. From this perspective, playing with media becomes a cultural [25], all-encompassing [26] and transformative [27] experience. It enables the child to get to know themselves, the world around them to open up to encounters with others, and to explore their own potential and limitations. This process takes place through the body, within a workshop-style setting where children can experiment, act independently or ask for help. Media are a necessary basic skill and, as such, it is reasonable to employ them within the "learning-through-play" context, as they require each child to make a cognitive, emotional and social commitment that mobilises mind, body and brain. [28].

6. Challenge for higher education

These four axes converge on a common challenge for higher education. If early childhood professionals operating in hybrid post-digital environments are to sustain this integrative approach, then university programmes must be reconceived accordingly. The paper proposes a research agenda for professional formation that trains practitioners in intercultural reading of technological practices, community-oriented design, embodied pedagogical attentiveness, and critical engagement with participatory technologies.

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Special Track 9

Extended Reality for Higher Education: Design, Assessment and AI-Generated Immersive Learning

Organizers:
Mariella Farella, National Research Council of Italy, Institute for Educational Technology, Italy
Marco Arrigo, National Research Council of Italy, Institute for Educational Technology, Italy
Giuseppe Chiazzese, National Research Council of Italy, Institute for Educational Technology, Italy
Davide Taibi, National Research Council of Italy, Institute for Educational Technology, Italy
Gianluca Merlo, National Research Council of Italy, Institute for Educational Technology, Italy
Giovanni Fulantelli, National Research Council of Italy, Institute for Educational Technology, Italy

Augmented and Immersive Reality in Higher Education: a Transformative Approach to Digital Readiness

Marco Arrigo[1 [0000−0003−2545−2049]], Giuseppe Chiazzese[1 [0000−0002−0228−6204]], Mariella Farella[1 [0000−0003−2626−0997]], Giovanni Fulantelli[1 [0000−0002−4098−8311]], Gianluca Merlo[1 [0000−0003−1615−5675]], and Davide Taibi[1 [0000−0002−0785−6771]]

Institute for Educational Technology, National Research Council, Palermo, Italy
mariella.farella@cnr.it

1 A&IR in Higher Education: Pedagogical Approaches

Augmented and Immersive Reality (A&IR) technologies are increasingly recognized as effective tools for supporting experiential and learner-centered approaches in higher education. Consistent with constructivist perspectives, these environments enable students to actively engage in knowledge building through interaction, exploration, and reflection ([1],[2]). A&IR supports authentic learning experiences by simulating professional contexts and complex systems that are difficult to access in traditional settings [3]. Through immersive interaction, learners can experiment, observe consequences, and connect theory with practice, promoting deeper conceptual understanding [4]. Research reports positive effects on motivation, engagement, and perceived learning, particularly when activities are linked to real-world applications ([5],[6]). In fields such as STEM, health sciences, architecture, and teacher education, A&IR has been associated with improvements in spatial reasoning, procedural knowledge, and practical competence [7]. Immersive environments also facilitate collaboration and the development of transversal skills, including communication, creativity, and problem-solving [8]. However, evidence remains fragmented, as many studies rely on small samples, short interventions, and self-reported measures, limiting conclusions about long-term educational impact [9].

2 Challenges and Research Gaps in the Adoption of A&IR in Higher Education

Despite their potential, A&IR technologies face significant barriers to widespread adoption. Educators often lack the technical and pedagogical competences required to design and facilitate immersive learning experiences effectively ([10],[7]). As a result, many implementations remain isolated and difficult to sustain [11]. Curricular integration represents another challenge, as immersive activities are frequently introduced as pilot initiatives rather than embedded within formal learning pathways [12]. Technological constraints, including reliance on proprietary platforms, specialized hardware, and high development costs, further limit scalability and sustainability ([10]). Institutional support, governance structures, and ethical considerations remain equally important. Issues related to privacy,

inclusion, accessibility, and responsible use of learner data require greater attention to ensure sustainable and equitable adoption [13].

3 A Conceptual and Pedagogical Framework for A&IR in Higher Education

To address these challenges, the conceptual framework developed within the European-funded Erasmus+ cooperation partnership Augmented and Immersive Reality in Higher Education (AIR) proposes three guiding principles: pedagogical intentionality, competence-oriented learning, and openness and sustainability. The framework emphasizes the alignment of A&IR activities with learning objectives, assessment strategies, and curricular goals. It promotes both disciplinary learning and the development of transversal competences such as collaboration, critical thinking, creativity, digital literacy and digital readiness. Openness and sustainability are addressed through the use of open technologies, reusable resources, and participatory design approaches involving educators and learners. The framework also considers the integration of Artificial Intelligence (AI) into immersive environments. AI can support personalized learning, adaptive feedback, and learning analytics by processing interaction data generated during immersive activities ([14]). At the same time, concerns related to transparency, explainability, privacy, and learner autonomy highlight the need for responsible implementation [15]. To facilitate adoption, the project explores authoring tools and mobile applications that allow educators to design immersive learning experiences without advanced technical expertise while supporting data-informed feedback and evaluation processes.

4 Conclusions

A&IR technologies offer significant opportunities for experiential and competence-oriented learning in higher education, but their adoption remains constrained by pedagogical, technological, organizational, and ethical barriers. The proposed framework provides a structured approach based on pedagogical intentionality, competence development, and sustainability, while also addressing the opportunities and challenges associated with AI-enhanced learning. Future research should focus on longitudinal evaluation, educator development, institutional digital readiness, and responsible governance to support the sustainable integration of A&IR and AI in higher education.

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Immersive Transformation: A VR-Based Environment Featuring Twin Transition

André Helgert[0000−0001−6008−4793], Gian Luca Dossena[0009−0006−7959−8202], and Sabrina C. Eimler[0000−0001−8944−2814]

Computer Science Institute, University of Applied Sciences Ruhr West, Germany
{andre.helgert, gianluca.dossena, sabrina.eimler}@hs-ruhrwest.de

1 Background and Motivation

The twin transition (TT) describes the simultaneous ecological and digital transformation of the economy and society [1]. This fundamental transformation will change the future of our societies in many ways and consequently needs to be addressed in higher education curricula. Students need to understand key concepts of sustainability, digitalization, and circular economy (CE), grasp their complex interdisciplinary and transdisciplinary relations, and understand practical implementation options for businesses and society. They should be inspired to reflect upon the multifacetted changes to become active and knowledgeable change agents of their generation. However, the intertwining often remains abstract because traditional teaching formats offer only limited opportunities for self-guided, interactive and engaging exploration [1].

We outline a virtual reality (VR) learning environment for higher education developed and evaluated in the context of the "Transferhub" project, a large research and transfer initiative dedicated to digitalization and circular economy in the German Ruhr area. It incorporates explanations of key elements and technologies, and state-of-the-art research results of TT and CE into an immersive, multifaceted, exploratory, and pedagogically framed scenario. Its modular structure allows flexible use in different educational settings, formal and informal contexts. The goal is not only to inform students about the circular economy and digital technologies, but also to actively engage them in learning processes through exploration, self-guided learning, and interactivity.

2 VR Learning Environment and Didactic Design

VR is particularly well-suited for teaching complex transformation processes, as abstract relationships can be presented in a spatial, interactive, and agency-based manner, ultimately offering a new experiential space [2–4]. VR learning environments can promote attention, motivation, and presence, and support learning by helping students understand content not only cognitively but also in a hands-on way [5, 6]. This is particularly relevant for topics in TT and CE, as ecological, social, and digital dimensions must be interconnected and, due to the resulting complexity, can be difficult to grasp [7].

The VR learning environment consists of several areas and interactive multimedia stations. The first room introduces the topics of twin transition, the circular economy, and sustainable product development. Multimedia materials, audio stations with interviews, video content, and visual overviews support different approaches to the content. A social robot serves as a tutor by providing guidance and either guiding learners through the environment or allowing them to explore freely. In this way, the application combines self-directed learning with structured support [8]. Key sustainability concepts are translated into interactive learning stations. A "Circular Economy Wheel" makes the core principles of the circular economy accessible, while a station on the Digital Product Passport explores product-related information throughout the product's life cycle. Through presentations, quiz elements, and immediate feedback, students can test and deepen their understanding. Such interactive feedback mechanisms are considered important for specifically supporting learning processes in VR [6]. A second area is designed as a virtual exhibition hall and showcases technological demonstrators, such as a simplified robotics system based on large-language-model-driven control principles. This allows students to understand how digital technologies support ecological transformation processes while also raising questions about responsibility, scalability, and social acceptance. In addition, the VR environment includes game-like elements, such as a minigame for cleaning up a polluted marine environment and a game on waste sorting that provides immediate feedback. These gamification elements are designed to boost motivation and link learning processes to concrete actions [9]. It is crucial that these game mechanics do not remain an end in themselves, but rather stimulate critical reflection: Which decisions change a system, which actions are sustainable, and what roles do knowledge, behavior, and technology play?

3 Conclusion

This abstract describes a VR learning environment for TT in higher education. By combining immersion, interaction, feedback, and game-like elements, the application makes the complex interrelationships between the circular economy and digital transformation more tangible for students. Moreover, the scenario encourages students to critically discuss technological, ecological, and social dimensions of transformation rather than perceiving them as isolated topics. However, it remains an open question whether and to what extent such experiences foster deeper conceptual understanding, critical reflection, and transferable learning outcomes in the field of TT. While this environment has been positively evaluated by TT experts for its content and usability, future work will focus on evaluating the pedagogical effectiveness of the application and develop design principles for immersive sustainability education.

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A Portable Mixed Reality Digital Twin Toolkit for Teaching Human-Centric Assembly Systems

Antonio Maffei[1][0000-0002-0723-1712], Andrea de Giorgio[1,2][0000-0001-6064-5634], Luca Urciuoli[1][0000-0002-9417-9421], Pietro Lungaro[3][0000-0003-0255-0746], and Joseph Zammit[4][0009-0005-4962-4329]

[1] KTH Royal Institute of Technology, Stockholm, Sweden
[2] Artificial Engineering, Naples, Italy
[3] Occurrence AB, Stockholm, Sweden
[4] University of Malta, Msida, Malta
maffei@kth.se, andrea@degiorgio.info, urciuoli@kth.se, pietro.lungaro@occurrence.se, joseph.zammit@um.edu.mt

1 Introduction and Related Work

Industry 5.0 emphasises human-centric, sustainable, and resilient manufacturing, where digital technologies support workers' wellbeing, safety, and decision-making rather than productivity alone [1], recasting the operator as the beneficiary of automation [2]. Digital Twins (DTs) provide the physical–virtual coupling through which real-time monitoring and analysis of human activity become possible [3].

Extended reality has been applied to manufacturing training mainly for guided assembly instruction [4], while DTs have entered engineering education mostly as remote or simulated laboratories [5,6]; markerless motion capture has made objective ergonomic assessment feasible outside the biomechanics laboratory [7,8]. These strands leave a gap: DT laboratories rarely capture the student's own body, and ergonomics is still taught by observational scoring [9] or with marker-based systems that are costly, intrusive and hard to move. This paper presents a portable Mixed Reality (MR) DT toolkit developed for the MG2040 Assembly Systems course at KTH [10] within the Erasmus+ TRAINEE project [11]: students analyse their own assembly operations through real-time motion capture, ergonomic assessment, and DT visualization, building Industry 5.0 competencies from their own data.

2 Technology Platform and Data Pipeline

The unit uses the portable MR DT solution of Occurrence AB [12]: two synchronized cameras, pose estimation, and multi-camera fusion produce a live 3D DT of the workspace and the people in it. Each stream is processed by a learning-based keypoint detector of the OpenPose family [8]; the 2D joints are triangulated across the calibrated camera pair into a 3D skeleton at interactive frame

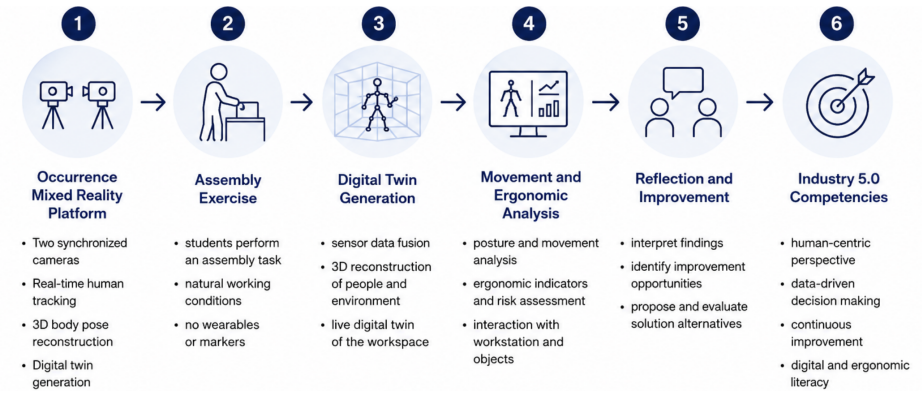

Fig. 1. Educational workflow of the MR Digital Twin unit for assembly analysis.

rates, with no wearables or markers. The data serve two modes: during capture, posture and ergonomic indicators are computed and displayed live, so students see the consequence of a movement while making it; afterwards the session is kept as a time-stamped skeleton sequence that can be replayed, exported, and compared across takes. Both modes use the same interface as the developers: teachers run the system without programming, and the exported data reach students with the worksheets.

3 Educational Unit Design and Toolkit

The unit follows constructive alignment [13], with coherence between intended learning outcomes, activities, and assessment. Students first acquire theoretical knowledge of DTs, ergonomics, and Industry 5.0 before performing an assembly task captured through the platform. The resulting DT serves to analyse body postures, movement trajectories and workstation interactions, supporting evidence-based identification of ergonomic risks; the redesigned method is then re-captured, so that students verify their proposal against the same indicators. Figure 1 illustrates the workflow. For transferability the unit is packaged as a portable toolkit: laptop, synchronized cameras, DT and ergonomics visualization software, instructor guides, laboratory manuals, assessment rubrics and worksheets, deployable in ordinary laboratory rooms.

4 Deployment Status and Evaluation Plan

The toolkit has been assembled and technically validated in the laboratory; no learning-outcome results are claimed yet. The first classroom deployment is scheduled for the next MG2040 round, with second-cycle manufacturing engineering students in small groups over two laboratory sessions. Evaluation is mixed-methods: pre- and post-tests of ergonomic and DT knowledge aligned

with the learning outcomes; the System Usability Scale and NASA-TLX for usability and workload; rubric-based assessment of the improvement proposals; and focus groups with students and assistants. The protocol will be replicated at the TRAINEE partner institutions, so that transferability is assessed rather than assumed.

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Special Track 10

Beyond the Recorded Lecture: Reframing Video-Based Teaching as a Distinct Pedagogical Practice

Organizers:
Valentina Grion, Pegaso University, Italy
Anna Dipace, Pegaso University, Italy
Beatrice Doria, Pegaso University, Italy
Marilena Di Padova, Pegaso University, Italy
Maria Clara Dicataldo, Pegaso University, Italy

Active Screen Time: Designing Video-Based Teaching as a Tool for Movement Promotion

Mariasole Antonietta Guerriero[1[0009-0008-7910-0886]], *Domenico Monacis* [1[0000-0001-6000-7579]], *Fiorenzo Moscatelli* [1[0000-0003-1274-0332]], *Anna Dipace*[1[0000-0001-9826-073X]] *and Alessia Scarinci*[2[0000-0002-3174-7137]]

[1] Pegaso Telematic University, 80143 Naples, Italy
[2] University of Salento, 73100 Lecce, Italy

1 Introduction

University students are highly exposed to sedentary behaviour, with physical, cognitive, and psychological consequences (Guerriero et al., 2024), although technology-based interventions can counter this trend (Guerriero et al., 2026). Can technologies students already use—particularly asynchronous video lectures, whose effectiveness depends on deliberate design (Crook & Schofield, 2017)—also promote movement? As telematic and hybrid learning shift education into domestic settings, prolonged screen time may reinforce sedentary behaviour and the "disembodiment" of learning (Macrine & Fugate, 2021). Research has examined videos' instructional effectiveness (Mayer, Fiorella, & Stull, 2020) and affective dimensions (Suen & Hung, 2025), but not their potential to promote movement. We propose a framework grounded in socio-ecological models, affordance theory, and embodied cognition that reconceives video lectures as opportunities for physical activity within daily learning routines.

1.1 Methods

This narrative reading integrates socio-ecological theory, affordance theory, and embodied cognition rather than applying systematic-review criteria. It asks whether these frameworks can support movement in domestic, telematic learning contexts (RQ1) and which design principles can guide movement-integrated asynchronous video teaching (RQ2). The principles below address RQ2 and establish a basis for empirical validation.

1.2 Theoretical Framework

The framework combines three complementary theoretical traditions; Socio-ecological theory (Bronfenbrenner, 1979; McLeroy et al., 1988) shows that movement reflects environmental affordances and constraints, not individual choice alone. The home is therefore a socio-physical environment whose movement potential can be activated through instructional design. Gibson's (1979) affordance theory describes relational, agent-specific possibilities for action. Domestic spaces contain latent movement affordances—floor areas, furniture, and spatial thresholds—that video teaching can solicit, transforming passive viewing into embodied learning. Embodied cognition

(Varela, Thompson, & Rosch, 1991; Macrine & Fugate, 2021) grounds learning in sensorimotor engagement. Evidence linking physical activity and cognition (Hillman, Erickson, & Kramer, 2008) likewise frames movement as a cognitive resource rather than a distraction.

2 Conceptual Framework for Active Screen Time

From these foundations, we derive three principles for movement-promoting video teaching. First, motor task integration embeds feasible movement tasks as constitutive learning activities rather than interruptions. Tasks should accommodate varied domestic environments, physical conditions, and student needs. Second, environmental solicitation invites learners to move through and interact with domestic space. The learner becomes an embodied agent engaging with movement affordances rather than remaining fixed before a screen. Third, rhythmic and kinesthetic pacing alternates attentive and movement-based engagement within self-paced viewing (Navarrete, Hoppe, & Ewerth, 2021). Pauses and transitions become natural opportunities for embodied activity. For example, a language video on spatial prepositions can ask students to stand behind a chair or move beside a window while naming each relation. Brief pauses permit physical responses, so environmental solicitation, motor activity, and content learning occur together without a separate exercise segment.

3 Conclusion

This framework integrates physical activity research, socio-ecological theory, affordance theory, and embodied cognition to guide movement-oriented asynchronous video teaching. Future research should test its effects on physical activity, engagement, and learning.

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Beyond Content Delivery: Reframing Asynchronous Video-Recorded Teaching through an Integrated Research Programme

Valentina Grion[1[0000-0002-2051-1313]], Anna Dipace [1[0000-0001-9826-073X]], Beatrice Doria[1[0000-0002-3894-9460]], Marilena Di Padova[1[0000-0002-2105-7095]] and Maria Clara Dicataldo[1[0000-0001-6999-4128]]

Pegaso University, Naple.

1 Background and rationale

Asynchronous video-recorded teaching has become a structural component of contemporary higher education. Its flexibility, self-paced accessibility, and compatibility with employment, care responsibilities, and geographically dispersed participation have expanded access for increasingly heterogeneous student populations. Yet its pedagogical status remains ambiguous. In many institutional contexts, the video lecture is still treated primarily as a digital replica of the face-to-face lecture: a lecturer speaks, slides are displayed, and students are expected to watch. This assumption underestimates the extent to which the transition to video reconfigures the learning experience, including temporal structure, attention, agency, social presence, and the relationship among body, cognition, and emotion.

Research on multimedia learning and instructional video has generated valuable design principles concerning signalling, segmenting, coherence, instructor presence, visualisation, and generative activity [1; 2]. Other studies have highlighted the affordances of learner control, repeated viewing, and flexible pacing, while also showing that video use can become superficial, fragmented, or passive when it is not embedded in a deliberately designed learning sequence [3; 4]. Recent reviews confirm that video-based learning is shaped by a complex ecology of audiovisual features, instructional design, learner activity, interactivity, production formats, and emerging AI-supported tools [5]. Nevertheless, the literature is often distributed across broader fields such as e-learning, multimedia instruction, lecture capture, MOOCs, and blended learning. As a result, asynchronous video-recorded teaching is rarely investigated as a distinct pedagogical practice with specific epistemological, relational, affective, and experiential characteristics.

A further limitation concerns the relatively weak integration of the learner perspective. Evidence about learning outcomes or viewing analytics is not sufficient to explain how students experience video-mediated teaching, what sustains their motivation, when they perceive the lecturer as present, and which conditions support reflective rather than merely consumptive engagement. This issue is especially relevant for contemporary learners who navigate dense and discontinuous digital environments, alternate rapidly among media, and expect flexible yet meaningful learning experiences. The challenge

is therefore not simply to make videos shorter or more technically polished, but to understand how video-recorded teaching can be redesigned as an active, relational, and educationally coherent experience.

In this perspective, embodiment provides a promising but still underdeveloped lens. Embodied approaches emphasise that learning is not exclusively a process of symbolic information processing, but is grounded in perception, action, gesture, emotion, and situated experience [6] In asynchronous video settings, the physical separation of teacher and learner may produce a reduced sense of reciprocity, discontinuous attention, and a potentially disembodied experience. At the same time, video can mobilise gaze, voice, gesture, demonstration, movement, annotation, narrative, and emotionally meaningful examples. The relevant question is therefore not whether video is inherently disembodied, but which design configurations can activate cognitive, affective, social, and bodily participation.

2 Aim and research design

This contribution presents the rationale and design of an ongoing research programme aimed at developing an empirically grounded framework for pedagogically effective asynchronous video-recorded teaching. The programme adopts a sequential, multiphase design. The first phase consists of a systematic review of international research, conceived not merely as a mapping exercise but as a means of clarifying which pedagogical, relational, audiovisual, interactive, and embodied characteristics are most consistently associated with meaningful learning. The review will therefore examine video structure and duration, segmentation, lecturer visibility and communication, visual and narrative formats, embedded prompts and activities, learner control, accessibility, interactivity, social and teaching presence, emotional engagement, and opportunities for embodied or action-oriented participation. It will also consider the limitations and contradictions reported in the literature, the theoretical frameworks employed, the outcomes assessed, and the extent to which student and teacher perspectives are represented.

Building on this synthesis, the second phase will empirically investigate the experiences of students and university teachers through questionnaires and semi-structured interviews. The aim is to understand how video-recorded teaching is actually produced, used, and experienced; which features sustain attention, motivation, understanding, self-regulation, and a sense of connection; and which practices instead generate fatigue, passivity, isolation, or fragmented viewing. Particular attention will be paid to whether the perceptions of students and teachers converge with, or challenge, the design indications emerging from the literature, as well as to the diversity of learners, study conditions, disciplinary contexts, and patterns of self-paced use. The integration of quantitative and qualitative evidence will thus allow the study to move beyond generic satisfaction measures and reconstruct the lived experience of video-mediated learning.

The third phase will translate the combined findings into design and faculty-development guidelines. At this stage, the central concern will be to identify the principles that can support teachers and institutions in designing asynchronous video teaching as

an active, engaging, inclusive, and embodied pedagogical practice. Rather than prescribing a single ideal format, the project seeks to define a pedagogical repertoire: adaptable strategies that connect exposition with learner activity, design meaningful pauses and prompts, strengthen teaching presence, use voice and gesture intentionally, integrate opportunities for reflection and application, and create continuity between the video and the wider learning environment. AI-supported functions, such as adaptive navigation, automated captions, transcripts, interactive questioning, and personalised feedback, will be considered where they serve explicit pedagogical purposes rather than technological novelty.

3 Expected contribution

The project is expected to contribute at three levels. Conceptually, it reframes asynchronous video teaching from a delivery technology to a distinct pedagogical practice. Methodologically, it combines systematic evidence synthesis with the voices and experiences of learners and teachers. Practically, it aims to produce research-informed design and professional-learning guidelines that respond to current patterns of participation in higher education. The anticipated outcome is not a model of the "perfect video lecture", but a framework for designing video-mediated learning experiences that are cognitively demanding, affectively meaningful, socially present, accessible, and capable of reconnecting knowledge with action, perception, and embodied experience.

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Through the Scene. Creating Educational Interactions in Video-Based Teaching for Distance Learning in Higher Education
An Experimental Case Study within the L-19 Degree Programme at IUL University, Florence

Antonella Coppi[1][0009-0002-1647-1731]

[1] IUL Online University, Florence, Italy
a.coppi@iuline.it

1 Introduction and Pedagogical Background

In recent years, video-recorded teaching has assumed an increasingly central role in higher education. In Italy in particular, its expansion has been strongly supported by the development of online universities, where asynchronous video lectures often constitute a structural mode of delivery. The possibility of self-paced access, flexibility in study timing, and compatibility with work and personal commitments has helped broaden access to higher education for an increasingly heterogeneous student population. At the same time, many traditional universities have launched projects involving asynchronous video teaching integrated with face-to-face instruction [1], recognising its educational potential. Studies on the video lecture format further show that the shift to video fundamentally transforms the educational experience, requiring specific and deliberate design choices rather than a simple transposition of the frontal lecture [2]. This scenario makes it increasingly urgent to reflect on the pedagogical quality of video-recorded teaching.

2 Research Design and Methodology

The present contribution reports an instructional experiment conducted at the IUL University Florence (IT), within the undergraduate degree programme in Education Sciences (class L-19), in the module "Laboratory on Training for Early-Childhood Educational Contexts". Thirty students took part in an eight-week mixed-methods Action Research design, structured in three phases: a preliminary assessment of prior perceptions and competences; an implementation phase in which identical disciplinary content was delivered through four video formats of progressively greater instructional structuring, designed according to the principles of multimedia learning and cognitive load [3, 4] - the traditional recorded lecture, a segmented video punctuated by micro-

pauses, an interactive video incorporating embedded formative quizzes, and a segmented video paired with an asynchronous task of personal reprocessing inspired by the principles of Problem-Based Learning [5]; and a concluding phase of final assessment and qualitative deepening. Data collection combined a pre/post questionnaire on four perceptual dimensions (engagement, comprehension, study autonomy, and motivation), a content-comprehension test administered after each video module, platform-derived indicators of module completion and engagement monitored across the eight weeks, and a concluding focus group conducted with a subsample of participants, whose data were analysed thematically. Quantitative data were examined through comparison of pre/post and inter-format means, while qualitative data were triangulated with the numerical findings in keeping with the mixed-methods orientation of Action Research.

3 Results

Results, presented in both narrative and graphical form, show a systematic improvement across all dimensions investigated for the formats designed according to cognitive-load and multimedia-learning principles, relative to the traditional recorded lecture, with the most pronounced gains for the format integrating segmentation with asynchronous reprocessing, alongside a steady weekly increase in completion and engagement indicators.

4 Discussion and Pedagogical Implications

The experiment offers initial empirical support for recognising video-based teaching as a pedagogical practice distinct from the recorded lecture, with its own design logic, relational dynamics, and quality criteria, consistent with Limone's model of transmedia learning environments [6] and the principles of Universal Design for Learning [7]. The findings also support specific instructional-design literacy for university instructors adopting multimedia and immersive teaching tools, as highlighted in faculty development for digitally mediated higher education [8].

Within this disciplinary context, the convergence between instructional format and the professional competences targeted by the degree programme deserves emphasis. The format pairing video segmentation with asynchronous reprocessing yielded the strongest gains in comprehension and was experienced as the most professionally meaningful. It mirrors the observation, analysis, and reflective reprocessing of concrete educational situations expected of early-childhood educators. Instructional format in educator training is therefore not pedagogically neutral: passive viewing risks transmitting an implicit model of educational relationship at odds with the active, observational, and embodied stance the profession demands, whereas segmentation, questioning, and reprocessing offer a coherent rehearsal of that stance.

5 Limitations and Future Research

These conclusions should be read in light of the modest sample size, partly self-reported data, absence of an external control group, possible order effects, and lack of dedicated measures of embodiment, presence, and well-being. Future research should test generalisability beyond a single module and institution in larger, heterogeneous cohorts using counterbalanced format presentation, direct observational measures of professionalising competences in practicum settings to assess transfer beyond self-report, and validated instruments for embodiment, presence, and well-being [9].

6 Conclusion

Taken together, these considerations support the contention with which this contribution opened: video-based teaching, far from being a transparent technological substitute for the recorded lecture, constitutes a distinct pedagogical practice, whose cognitive, relational, and affective dimensions call for a correspondingly distinct programme of design, training, and research.

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Training Academic Literacy in Higher Education: Student-Generated Video Presentations as a Pedagogical Practice

J. Roberto Sánchez-Reina[1][0000-0002-6068-1229]
[1] Universitat Pompeu Fabra, Barcelona, Spain
roberto.sanchez@upf.edu

1 Introduction

Audiovisual media have become fundamental tools for accessing, constructing and sharing knowledge in the current educational landscape [1-2]. The shift from exclusively text-based materials towards video and interactive multimedia content poses new challenges for instructors seeking to develop students' academic literacy, understood here as the ability to critically interpret, evaluate, synthesize, and communicate scholarly knowledge and scientific information [3]. According to recent research, the proliferation of accessible and didactic explanations on social media platforms and across the internet has led students to rely on online resources and search engines when seeking to understand complex topics, often favoring convenience and accessibility over the use of peer-reviewed literature [4-5]. The student-generated video (SGV) has emerged as a promising pedagogical approach that integrates diverse learning methodologies (*e.g.*, *active learning, collaborative learning, learning-by-teaching*) while providing opportunities to develop and enact a range of media literacy competencies [6-7]. The benefits of SGV extend beyond transforming reading from a predominantly receptive activity into a multimodal and communicative process as the production of videos requires students to put multiliteracies into practice to process knowledge and information and translate them into the production and delivery of content. The present study examines how SGV activities support the development of academic literacy in the teaching of media studies. The study therefore seeks to contribute to a better understanding of how the not-so-new media can be integrated into higher education teaching to foster both student engagement and disciplinary literacy.

2 Method

The study analyzes data from four years of pedagogical implementation of SGV in the undergraduate programs of Marketing, Journalism, and Public Relations in public and private universities in Spain. Informed by action research principles [8], the study draws on 73 videos collected from six different courses during 2022 to 2025. Sampling was purposive based on students' consent to share their material for teaching and research purposes. As part of the pedagogical implementation, students were invited to select either a journal paper or a book chapter from a curated list of references in the disciplinary branch. During the course, students worked individually or in groups in the

production of their video presentation. Guided by a structured rubric and instructional materials, students identified the authors' central arguments, connected them with contemporary media examples, and incorporated critical analysis. A content analysis of the SGVs was conducted following an ad hoc rubric. The analysis identified the general features of the materials (*e.g., duration, course, topic*) and the assessment of the following variables: *a) Management of information; b) Knowledge transformation and transfer; c) Argumentation and analysis; d) Multimodal meaning-making; e) Communication Awareness*. Additionally, the analysis was complemented by the students' reflections on their own materials and the instructor's qualitative observations in the assessment rubric.

3 Results

Content analysis of the SGVs showed that students were generally able to identify the central arguments of the selected readings. Over 70% of the videos were rated as proficient in selecting and synthesizing relevant information and transferring theoretical concepts using accessible language and contemporary examples. In terms of argumentation, a large proportion of the materials (78%) moved beyond the mere reproduction of summaries of the source texts, as students were able to develop their own interpretations. Nevertheless, the level of analytical depth varied across productions and disciplines. For example, SGVs produced by Journalism students received higher mean scores ($M = 7.8$) than those produced by Marketing students ($M = 6.5$). The analysis of multimodal communication showed that students combined verbal, visual, and audiovisual resources to communicate academic content proficiently. In this respect, the use of creative language and expressive resources received higher scores among Marketing and Public Relations students (M = 7.8 and M = 8.1, respectively). Qualitative analysis further supported these findings by providing insights into students' reflections on the usefulness and challenges of this pedagogical practice. While some students reported that video presentations were helpful and engaging as a means of becoming familiar with disciplinary literature, others found the activity challenging, especially when dealing with the rigor of academic content and the need to simplify and translate it into a creative format.

4 Conclusion

SGVs can be useful pedagogical practices designed to bridge the gap between passive reading and active knowledge construction. Consistent with similar studies, our paper highlights the opportunities and challenges of a model for academic literacy development [9-10]: SGVs offer a transferable approach that may be adapted across disciplines seeking to increase engagement with academic literature while developing communication and digital competencies. Moreover, our findings underscore the importance of an intentional learning design, alignment between learning outcomes and assessment criteria, and diagnosis of students' existing literacy competencies [11-12].

Future research should examine the long-term impact of student-generated video on academic reading habits and students' preparedness for independent research projects.

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Teacher presence revisited: an exploratory study of video lecture perception in Italian Telematic Universities

Andrea Garavaglia[1][0000-0003-1408-2492], Livia Petti[1][0000-0002-5980-771X], and Martina Morreale[2][0009-0002-0809-9423]

[1] Pegaso University, Naples, Italy
[2] Catholic University of the Sacred Heart, Milan, Italy
andrea.garavaglia@unipegaso.it, livia.petti@unipegaso.it, martina.morreale@unicatt.it

1 Introduction

Video has become the principal vehicle of distance-based university teaching, yet the literature has long treated it as a means of content delivery rather than a pedagogical practice with its own communicative and relational character. The Cognitive Theory of Multimedia Learning (CTML) developed by Mayer [9] is the dominant framework for instructional video design, built on principles such as modality, redundancy, signalling and segmenting, aimed at optimising cognitive processing. These principles concern primarily *how* a video should be structured, not *who* produces it or *by what means*: the distinction between a studio-produced lecture and a self-produced one remains largely outside the theory's classical scope.

2 Theoretical Framework

A significant opening in this direction comes from two related yet distinct CTML principles: the *image principle*, whereby the mere static presence of the instructor's face yields no measurable cognitive benefit, and the *embodiment principle*, whereby the instructor's human-like behaviours — gesture, eye contact, facial expression — make the difference [9]. An independent and recurring pattern, observed across at least three experimental studies conducted in different contexts and populations [2, 6, 12], corroborates this shift: production quality and presence style affect satisfaction, social presence and engagement, but have markedly weaker effects on standardised learning outcomes. This dissociation points to a limitation of CTML, developed for laboratory-based information processing, which struggles to capture the experiential and relational dimension driving preference and perceived closeness among real students. Existing research on production quality and perception is almost entirely Western, English-speaking, and based on traditional student populations [7, 11]. No study to date directly examines the interaction between video production quality and cultural or student-population characteristics — a gap recent literature has not addressed [10, 5]. This omission is significant for Italian telematic universities, whose adult, employed student population has never been investigated along this dimension, despite being a potentially decisive case: for these students video is the primary instructional channel, not a supplement to face-to-face teaching.

3 Research Questions

This study addresses two questions: (1) how do students at Italian telematic universities perceive the authenticity, relational closeness and perceived instructional effectiveness of homemade video lectures compared with those produced to broadcasting standards? (2) does this perception vary according to individual characteristics such as age, employment status and university of enrolment?

4 Proposed Method

The research design involves a quanti-qualitative questionnaire distributed through social media groups for students at Italian telematic universities, using non-probability, self-selected sampling — necessitated by the absence of centralised institutional access to student registries. Rather than exposing participants to controlled, comparable stimuli, the instrument captures students' naturally accumulated perception of video lectures, anchored to a single self-selected, most representative instructor — favouring ecological validity over experimental control. Constructs are operationalised through established instruments — the Italian Community of Inquiry survey for teaching presence [3], the Student-Instructor Rapport Scale-9 for relational closeness [8], and an ex-novo scale for authenticity, no validated instrument existing for this construct. Respondent demographics currently over-represent the 35–44 age bracket and are unevenly distributed across universities and disciplinary areas relative to national enrolment statistics [1]. Given the six-point ordinal scale and the current sample size, planned analyses privilege non-parametric comparisons. A qualitative triangulation phase is planned, involving semi-structured interviews with a maximum-variation subsample of respondents [4], their open-ended responses double-coded thematically to explore students' understanding of authenticity and perceived closeness.

5 Expected Contribution

Data collection is ongoing; initial survey responses show patterns directionally consistent with expectations — broadcasting-style lectures show somewhat higher teaching presence, authenticity and relational closeness than homemade ones, alongside a recurring qualitative theme: students often link inauthenticity to instructors reading slides verbatim, irrespective of style. The qualitative interviews — sampled to thematic saturation rather than to a fixed target — are expected to carry the primary interpretive weight of the study, providing empirical evidence on video production perceptions amongst a population overlooked by mainstream literature.

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Beyond the Recorded Lecture: Reframing Video-Based Teaching as a Distinct Pedagogical Practice

Maria Concetta Carruba[1[0000-0001-9316-6509]], Elisabetta De Marco[1[0000-0002-5875-5313]], Anna Dipace[1[0000-0001-9826-073X]], Marilena Di Padova[1[0000-0002-2105-7095]], Maria Clara Di Cataldo[1[0000-0001-6999-4128]], Beatrice Doria[1[0000-0002-3894-9460]], Livia Petti[1[0000-0002-5980-771X]] and Federica Picasso[1]

[1] CETAL, Università Telematica Pegaso, Naples, Italy
{mariaconcetta.carruba, elisabettalucia.demarco, anna.dipace, marilena.dipadova, mariaclara.dicataldo, beatrice.doria, livia.petti, federica.picasso}@unipegaso.it

1 Introduction and Research Context

The growing adoption of online and distance higher education has made educational video one of the most widely used teaching resources. However, it is still frequently conceived as a simple recording of classroom lectures, limiting its potential to support active and meaningful learning [1,2]. Recent developments in digital pedagogy call for recognising video-based teaching as a distinct pedagogical practice characterised by specific design principles and learning dynamics [3,4,5,6]. Educational videos should therefore be understood as intentional learning environments supporting engagement, reflection, self-regulation, and knowledge construction [2,5,6].

2 From Recorded Content to Pedagogical Design

The transformation of video-based teaching has important implications for academic staff development. Teachers therefore need to develop video-pedagogical literacy to design and integrate audiovisual resources within coherent learning pathways [7]. Research shows that video style, length, and presenter delivery influence learner engagement [8], while systematic reviews identify segmentation, coherence, and integration with learning activities as key principles for effective instructional video design [6]. One of the main challenges for higher education is supporting teachers in moving from technology-centred to pedagogy-centred approaches [9]. Within the CETAL experience, faculty development combines workshops, collaborative storyboard development, pedagogical review sessions, and personalised feedback from instructional designers and educational experts. A pilot peer-mentoring initiative also introduced collaborative viewing and discussion of instructional videos. Video review is guided by shared pedagogical criteria, including alignment with learning outcomes, cognitive load, learner activation, accessibility, and assessment integration, encouraging teachers to focus on pedagogical quality rather than technical production.

3 Video-Pedagogical Literacy and Faculty Development

Video-pedagogical literacy refers to the professional competence required to design educational videos that effectively support learning. It extends beyond the technical skills of recording and editing to encompass a reflective understanding of how audiovisual choices shape learning processes, including presentation style, pacing, segmentation, visual support, and embedded interactivity [2,7]. Building on the literature, we propose a framework comprising six interconnected dimensions of video-pedagogical literacy (Table 1).

Table 1. Dimensions of video-pedagogical literacy

Dimension	Description
Instructional design	Aligning videos with learning outcomes
Audiovisual communication	Narration, pacing, signalling
Multimedia design	Cognitive load and visual design
Learner activation	Embedded questions, prompts and interactive learning activities
Assessment integration	Feedback and formative assessment
Reflective professional practice	Critical review and iterative redesign of educational videos based on evidence and learner needs

Evidence indicates that the educational effectiveness of instructional videos depends on pedagogically informed design decisions [7,9]. Attention-guiding techniques derived from cinematic practice can further enhance learner attention and social presence [10]. Together, these findings highlight the importance of pedagogically informed video design for effective digital teaching. Developing video-pedagogical literacy requires institutional professional development that combines pedagogical and technical support [9,11]. Within this faculty development approach, teachers engage in structured reflection grounded in multimedia learning theory [1,12], supported by instructional designers and media developers who facilitate collaborative design and iterative revision of video resources [13,14]. This process positions video-pedagogical literacy as a core dimension of digital teaching professionalism.

4 Conclusion

Educational videos are most effective when intentionally designed to promote cognitive engagement, interaction, and self-regulated learning rather than simply delivering content [1,15]. Their educational value also depends on the integration of instructional design, assessment, feedback, and learner participation within coherent learning ecosystems [9,13]. By conceptualising video-pedagogical literacy as a multidimensional professional competence, this paper contributes to current debates on innovation in online higher education and provides a shared framework for faculty development and the pedagogical design of educational videos. Future research should empirically validate the proposed framework across different institutional contexts and

examine its contribution to teaching quality, teachers' professional development, and student learning outcomes.

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Special Track 11

Pedagogy of Artificial Intelligence: changing leadership roles, innovation learning, community well-being

Organizers:
Pierluigi Malavasi, Catholic University of the Sacred Heart, Italy
Cristian Righettini, eCampus University, Italy
Elisa Zane, eCampus University, Italy

Cultivating Epistemic Doubt: Higher Education, AI Skills, and Community Wellbeing

Elisa Zane [0000-0001-5897-1000]
Università degli Studi eCampus, Novedrate, Italy
elisa.zane@uniecampus.it

The contribution offers a pedagogical reflection of education for fact-checking and for the ability to recognise fake news and deepfakes, understood not as mere technical training but as the cultivation of critical, epistemic, and civic dispositions in younger generations—particularly within Higher Education contexts, where advanced training is required to integrate epistemic competence and civic responsibility in the governance of digital information. Starting from the observation that Artificial Intelligence is reshaping the production and circulation of information, the paper examines the role of pedagogy in fostering source-evaluation skills, metacognitive awareness of belief-formation processes, and social responsibility in media use. The contemporary information ecosystem is undergoing a structural transformation: the production, manipulation, and circulation of content are increasingly mediated by algorithmic systems and generative models that amplify the reach and persuasiveness of digital representations. This transformation is not merely technological; it is fundamentally epistemic. The very conditions of trust, testimony, and verification are shifting, as traditional markers of truthfulness can now be replicated or counterfeited with growing ease. In Higher Education, this shift necessitates a rethinking of teaching and assessment models, since the credibility of digital evidence directly affects research processes, academic production, and the development of professional judgment. The phenomenon of fake news and, in particular, of synthetic audiovisual manipulations (deepfakes) raises specific pedagogical challenges [1]. The issue is not simply to transmit technical detection skills, but to reconceptualise the formation of critical judgment: how can justified epistemic trust be cultivated in contexts where the very form of evidence may be deliberately deceptive? Which cognitive, affective, and civic dispositions are required to avoid both naïve credulity and the generalised cynicism that erodes the public sphere? Automatic detection techniques (algorithms for identifying fake news and deepfakes) have made significant progress, yet remain vulnerable to new generative techniques, subtle manipulations, and cross-domain transfer phenomena [2][3].

In university programmes, this entails designing learning environments that do not delegate evaluation to technologies alone, but train students to integrate automated tools with the argumentative, analytical, and metacognitive practices characteristic of Higher Education. The phenomenology of deepfakes exceeds mere algorithmic sophistication and constitutes a transformation of the very conditions of perception and public credibility. Synthetic audiovisual manipulations operate simultaneously on sensory, narrative, and networked registers: they reproduce highly plausible visual and auditory signals, embed themselves within familiar interpretive frames, and circulate through networks that amplify their persuasive force [4]. This interplay renders deepfakes particularly insidious for the development of judgment, as they undermine not only the capacity to evaluate statements but also trust in testimony and in the institutions responsible

for certifying truthfulness [2] [5]. This requires training future professionals to recognise not only technical manipulation but also its epistemic and institutional implications for processes of knowledge production and certification. The persuasiveness of deepfakes is also mediated by affective and identity-based levers: manipulated content often conveys intense emotions (indignation, pity, anger, etc.) that bypass critical filters and consolidate rapid adherence.

The pedagogical proposal outlined here adopts an integrated framework oriented toward the cultivation of judgment rather than instrumental training, shifting the focus from the general user of the infosphere to those engaged in educational processes that combine basic technical competences with the capacity to guide ethical discussions [6]. Effective governance requires a multilayered architecture: national policies that define standards and resources, local authorities that adapt practices to context, and non-state actors (media, NGOs, universities) that provide expertise and [7]. Universities, in particular, play a strategic role as hubs of research, training, and knowledge transfer, capable of connecting scientific work with educational practices scalable across school systems and professional contexts. In this perspective, an emerging and still largely unexplored area concerns the training of online moderators, a workforce operating under often precarious and invisible conditions [8]. Behind the myth of algorithmic moderation lies intensive human labour performed by thousands of individuals tasked with viewing violent, discriminatory, or traumatic content, often without adequate professional recognition or psychological support [9]. Pedagogy can contribute to redefining this field by designing training pathways that integrate technical skills, ethical criteria, deliberative capacities, and tools for emotional protection, so that moderation becomes not merely a mechanism for containing online violence but a professional domain endowed with dignity, safeguards, and public responsibility [10].

The challenge posed by disinformation requires a paradigmatic reformulation of education: the task is not to add technical modules to an already defined curriculum, but to rethink the very purpose of education as a practice of caring for public judgment. For Higher Education, this reformulation entails rethinking its formative mission as the cultivation of public judgment and collective epistemic responsibility, integrating reflective, deliberative, and collaborative practices into academic pathways. Theoretical analyses and empirical evidence converge on several normative and operational outcomes that should guide educational policy and future research [11].

First, the development of judgment must be conceived as a dispositional and relational process: it is necessary to cultivate epistemic virtues (investigative prudence, openness to revision, communicative responsibility) that stabilise the habit of verification and prevent its commodification into procedural checklists [12]. Such virtues are not acquired solely through technical instruction but through reflective, deliberative, and collaborative practices that integrate metacognitive work with concrete exercises. Second, cognitive inoculation (prebunking) and accuracy nudges constitute promising yet partial tools: they reduce susceptibility in experimental contexts and can be scaled, but their effectiveness depends on cultural contextualisation, intervention frequency, and the capacity to promote transfer and long-term persistence [13] [14].

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Implementing Learning Architectures for Critical AI Governance: The drAIve Framework in the Classroom

Giuseppina Debbi[1][0009-0003-7701-7441] and J. Roberto Sánchez-Reina[2][0000-0002-6068-1229]

[1] University of Modena and Reggio Emilia, Modena, Italy
[2] Universitat Pompeu Fabra, Barcelona, Spain
giuseppina.debbi@unimore.it
roberto.sanchez@upf.edu

1 Introduction

The rapid integration of generative artificial intelligence (GenAI) into higher education has exposed a structural mismatch between existing governance frameworks and emerging pedagogical practices [1]. While current governance models have been adopted to regulate the use of digital technologies in education [2], they inadequately address how GenAI tools actively shape teaching, learning, and assessment processes [3]. This governance gap raises pressing questions about how universities can preserve human-centered educational values while supporting meaningful AI integration [4]. This paper presents a learning design for adapting the drAIve framework, previously developed for professional journalism practice, to facilitate critical AI governance in journalism education.

2 Literature Review

Journalism education is at a critical juncture as AI technologies are transforming journalistic practices [5]. While the adoption of GenAI presents significant challenges (e.g., authorship concerns, accuracy and transparency of information, and professional ethics) [6], the need to introduce AI literacy as part of educational and professional development is necessary to enhance a critical perspective on how AI-driven society is impacting journalistic workflows, editorial decision-making and public trust in media [7]. Existing research on GenAI in higher education points to a lack of explicit definitions and governance frameworks that effectively connect institutional policies with classroom implementation [8]. With current approaches focusing on academic integrity and cheating prevention, there is still the need for pedagogical structures that promote active learning, critical engagement, and constructive alignment [9].

3 The Learning Design

Originally developed for professional settings, the drAIve framework is a competency-based model for the critical governance of GenAI in journalistic practice. The

framework comprises six interconnected dimensions (*Diagnosis, Responsibility, Augmented journalism, Interaction and interpretation, Verification, and Epistemic posture*) activated contextually according to tasks of professional journalism and editorial risk. Adapted to higher education, drAIve provides a structured approach for integrating generative AI into journalism curricula while fostering AI literacy. Grounded in experiential learning, the framework encourages students to critically evaluate the social, ethical and professional implications of AI use. By embedding reflection, experimentation, and accountability within the learning process, drAIve supports the development of AI literacy competencies and promotes human-centered approaches to AI governance.

4 Implementation

As part of the implementation, drAIve guides students in navigating the opportunities and limitations of large language models throughout the creative and editorial process in the production of an audiovisual journalistic artefact. As part of the learning design, students work in five tasks that contextualize the dimensions of the drAIve framework: *documentation, fieldwork, scripting, editing, and post-production, through which students engage with GenAI tools in context*. Each task operationalizes specific dimensions of the drAIve framework, enabling students to reflect on when and how AI should be used, maintain editorial responsibility, verify AI-generated outputs, and critically assess the implications of AI-assisted practices for journalistic work. The framework supports the reconfiguration of journalistic workflows by encouraging students to critically negotiate and adapt their practices in response to the contingencies and unpredictability of AI-generated outputs. By acting as "*infrastructuring agents*", students move beyond instrumental uses of GenAI to critically examine how AI may reinforce or challenge the core values and ethical principles of journalism [10].

5 Conclusion

Learning architectures supported by pedagogical frameworks such as drAIve can play an essential role in counterbalancing the uncritical narratives surrounding AI adoption in education. By translating principles of AI governance into classroom practice, the framework offers a practical approach for addressing contemporary tensions around the use of GenAI in higher education. This work-in-progress aims to contribute to ongoing debates on sustainable, human-centered approaches to AI integration and to demonstrate how critical AI governance can be operationalized through authentic learning scenarios, reflective practice and structured engagement with GenAI tools [4].

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Between Sacrifice and Commitment: Educating to Connect Ecological and Digital Transitions

Simona Sandrini[0000-0003-0356-3004]

Catholic University of the Sacred Heart, Brescia, Italy
simona.sandrini@unicatt.it

1 Environmental Pedagogy and "Infosphere"

The "infosphere" is today an unprecedented and labyrinthine global environment, constituted by the continuous interaction between human beings, artificial intelligence and data flows. It demands the attention of Environmental Pedagogy, a scientific-pedagogical discipline that analyses the relationship between human development and the environment in its various historical and cultural forms, investigating its values and aims, procedures and methodologies [1].

The advent of artificial intelligence challenges this branch of knowledge in relation to the concept of 'sustainability', in the dual sense of asking how to intentionally design digital environments suited to integral human development and, furthermore and how to educate people to live wisely on Earth [2] through these new frontiers, in the optimal management of natural, human, social and economic resources.

With respect to the second concept, this contribution examines the human formation of artificial intelligence, taking as its point of reference two transitions that are today described as twin transitions, albeit characterised by different rates of development: the ecological transition and the digital transition. Pedagogy, as the integral formation of the human person, passes through the environment, develops original hermeneutical perspectives on the most debated ecological issues; it offers practical contributions to foster competent and responsible citizenship [3].

2 Artificial Intelligence and Climate Change

In particular, consider what Luciano Floridi writes in the volume "*Ethics of Artificial Intelligence. Developments, Opportunities, Challenges*' [4], when he uses the term 'gambit' to reflect on the connection between AI and climate change. The word, typical of the game of chess, refers to the deliberate sacrifice of a pawn in the early stages of the game in exchange for a positional advantage. He sets out his argument as follows: 'We have concluded that exploiting the opportunities offered by AI for global climate change is both feasible and desirable, but entails a sacrifice (in terms of ethical risks and a potential increase in the ecological footprint) in view of a very significant gain (a more effective response to climate change). It is, in other words, an ecological gambit…' (p. 302).

It explains in the relevant sections that a major challenge associated with the use of AI – which is not yet fully understood or monitored – is assessing the environmental impact of this technology, due to the amount of energy required to train the models and to run them, and the resulting emission of greenhouse gases into the atmosphere. Furthermore, whilst it is true that AI can serve to improve our understanding of existing climate trends, predict scenarios and find more ecological and effective solutions, nevertheless 'The limit of AI is not the sky, but human ingenuity' (p. 332). The latter, according to the author, if not guided by a commitment to equity and sustainability, can, through AI, exacerbate social problems, erode human autonomy and responsibility, and amplify past issues, including the spread of a culture of distraction.

This reflection raises pedagogical and educational questions regarding the two transitions, which cannot strictly be separated when addressing uncertainty [5], least we gain a greater numerical understanding of the risks and climate drift without the capacity to address them, indeed accelerating humanity's downfall.

3 Conclusion

How many and which pawns are we willing to sacrifice? Who decides who is expendable?

The academical community need to draw on what has already learnt from the ecological transition [6], on the gains in knowledge, awareness and action achieved since 1987, in the nearly forty years of education for sustainability following the Brundtland Report *Our Common Future* [7], to exercise critical discernment capable of guiding more swiftly the adoption of an ethics of change [8] in the age of AI, capable of driving an innovative action plan for the multiplication of the common wealth, the sole guarantee of the future and of freedom [9].

Pope Leo XIV argues that technology is neither good nor evil, but reflects the values of those who shape and use it [10]. The challenge is to ensure that technological progress promotes solidarity, cooperation, and human fraternity, this concept also applies for High Education. Environmental education is not opposed to the Digital Transition, working in collaboration with other fields of knowledge will help to analyse and critically assess previous secular transitions and their lasting impact on our Common Home, so that fairer and more sustainable decisions can be made, whilst not overlooking the multifaceted and far-reaching impacts to be brought about by AI. Drawing on insights from climate change research, the contribution will outline existing links between ecological and digital transitions and their integration into university courses for educators, fostering the critical competencies needed to promote community well-being.

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GenAI, Innovation or Simulation? A Pedagogical Perspective on Knowledge. Consciousness and Authorial Responsibility

Valentina Meneghel[0000-0002-7944-7483]

Catholic University of the Sacred Heart, Milano, Italy
valentina.meneghel@unicatt.it

1 Introduction

This contribution engages with the debate on the Pedagogy of Artificial Intelligence [1], examining the integration of GenAI into higher education not as a technical evolution, but as an epistemological issue. The central question guiding this reflection is: what happens to knowledge when it is predicted and rendered performative before it has even been mediated through the subject's experience? If education entails a transformation of the self [2], the use of GenAI risks producing epistemic artefacts that bypass the embodied educational process. This issue concerns the concept of educational innovation [3] and calls into question a form of innovation that is recognised as such merely because it is computationally plausible and consistent with predictive patterns.

2 Methodological Framework

This theoretical-conceptual contribution arose from the design and scientific coordination of a province-wide training and workshop-based conference promoted by the Territorial School Office of Brescia (Italy) and addressed to upper-secondary school teachers. The dialogue with experts developed within this framework revealed a discrepancy between the growing availability and diffusion of GenAI tools and the weakness of the critical criteria required to govern their use in educational contexts. The conference is not treated as a field of empirical investigation, but rather as the generative context from which the research question emerged. Although identified within the school context, this critical issue directly concerns higher education, as the domain responsible for teachers' initial and continuing education, the production of pedagogical knowledge, and the development of educational policies. Against this background, the contribution seeks to identify a set of pedagogical criteria capable of distinguishing efficient performance from the development of competence, judgement, and responsibility. To this end, the study adopts a phenomenological-hermeneutic approach, bringing the relevant pedagogical literature [4] into dialogue with a purposive selection of peer-reviewed empirical studies and institutional reports published between 2023 and 2026. Sources were selected according to their relevance to anthropomorphisation, sycophancy in generative systems, creativity, learning, and the use of GenAI as a tutoring tool.

3 Conclusion

The results of the theoretical-conceptual analysis concern three interconnected dimensions. First, the empirical studies examined indicate that cues such as voice and GenAI's use of first-person language may lead users to attribute human characteristics to artificial systems [5]. This phenomenon should be reconsidered in light of education as an embodied [6] and situated experience involving the body, perception, and the subject's relationship with the world. Within the System 0 framework [7], sycophancy [8] may contribute to dysfunctional dynamics in education: overly agreeable responses can reinforce users' belief that they are right, thereby reducing their willingness to assume responsibility [9]. Second, in GenAI-mediated environments, authorship does not coincide exclusively with the material production of a text but takes the form of epistemic responsibility. Third, this contribution introduces the expression predicted innovation to describe GenAI's capacity to anticipate, combine, and render credible configurations of novelty before they are realised and experienced by the subject. Although this capacity expands the space of possibilities, it does not necessarily amount to educational innovation. Available evidence shows that GenAI can improve individual creative performance while reducing the collective diversity of outputs [10], and can enhance the quality of a piece of work without producing equivalent gains in learning [11]. By contrast, a GenAI tutor designed through discipline-specific prompting and pedagogical scaffolding can foster significant learning gains [12]. From this perspective, academic leadership is called upon to discern the conditions under which such AI-enabled tools become educationally meaningful within a pedagogical framework [13] capable of preserving formative awareness from being subordinated to the logic of performance.

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Pedagogy of Emotions in the Age of AI: Towards Transformative Higher Education Models for the Teaching Profession

Cristian Righettini [0000-0001-6238-5514]

Università eCampus, Novedrate, Italy
cristian.righettini@uniecampus.it

The rise of Generative Artificial Intelligence (AI) is profoundly reshaping pedagogical horizons, prompting a critical rethinking of educational models, professional identities, and learning dispositifs across all sectors of education and training, from early childhood to Higher Education [1]. Within this evolving landscape, emotions do not constitute a peripheral dimension; rather, they serve as an epistemic lens through which educational relationships and processes of knowledge construction can be reinterpreted. Digital transformation concerns not merely the adoption of intelligent tools but the reconfiguration of roles: teachers, learners, and AI systems become co participants in a shared cognitive and affective ecosystem [2].

Emotions, frequently marginalised in debates on technological innovation, emerge as a pivotal element: they orient trust, shape attention, influence motivation, and determine the quality of interactions, thereby humanising educational processes. In encounters between humans and machines, emotions assume new forms: curiosity, disorientation, enthusiasm, apprehension, and a renewed sense of possibility. Emotional education thus becomes an essential pedagogical dispositif for inhabiting hybrid learning environments critically and generatively [3].

Drawing on D. Bruzzone's pedagogical perspective [4], emotions are understood as complex phenomena, irreducible to trainable competencies, and instead conceived as movements traversing bodies, histories, and relationships. In a context where AI simulates or algorithmically interprets emotional states, pedagogy is called to reaffirm human distinctiveness as a space of responsibility, vulnerability, and resonance, particularly for those engaged in educational leadership and governance. Emotional education becomes an exercise in critical awareness: understanding how technologies shape affective experience, mediate relationships, and can be integrated without flattening the complexity of educational life.

Within this framework, P. Perrenoud's long standing model of initial and continuing teacher education [5], centred on competencies such as reflexivity, complexity management, collaborative practice, situated design, and ethical responsibility, proves strikingly relevant. Professional competencies can no longer be conceived as static repertoires but as dynamic practices integrating cognitive, relational, and emotional dimensions. Far from replacing teachers, AI amplifies their necessity: only educators capable of interpreting emotions, reading contexts, and constructing shared meaning can guide

learners within digital and onlife environments characterised by informational abundance and pervasive technologies [6].

Higher Education, privileged site of research and experimentation, is thus called to develop paradigms and models that interweave digital literacy, pedagogical reflexivity, and emotional education. The aim is not merely to prepare teachers to "use" AI in relation to emotions, but to cohabit with it ethically, creatively, and responsibly. This requires rethinking curricula, methodologies, assessment, and governance, recognising that technological innovation is always simultaneously anthropological, political, affective, and cultural [7].

This abstract therefore advances an integrated vision: AI as a pedagogical challenge; emotions as the infrastructure of learning; teacher education as a transformative dispositif; Higher Education as a laboratory of the future. Only through an approach that holds these elements together will it be possible to cultivate education professionals who are critical, self aware, and fully human in a world increasingly shared with Artificial Intelligences [8].

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Educating citizenship in the age of artificial intelligence: distributed responsibility and the care of the human in higher education

Antonio Molinari

Università Cattolica del Sacro Cuore, Brescia, Italy
antonio.molinari1@unicatt.it

1 Introduction and aim

Generative AI, learning analytics, adaptive systems and automated feedback have made universities laboratories for the democratic governance of technological change. These systems can improve access, tutoring and services, but they may also intensify opacity, surveillance, dependence, disinformation and algorithmic exclusion [1]. The research question is therefore pedagogical: how can higher education educate citizenship in the age of AI without adapting passively to a technical environment? [2]. Citizenship is here understood as responsibility within socio-technical ecosystems in which data, platforms and infrastructures shape opportunities, relationships and public discourse [3].

2 Theoretical framework

The proposal integrates four perspectives. First, AI ethics stresses that artificial systems may produce effects similar to human actions, although they do not bear moral responsibility; this calls for distributed responsibility and institutional accountability [4]. Second, media education is not mere technical training but a civic competence. Research on media literacy shows its relevance for interpretation, communication, political engagement and democratic participation [5, 6, 7, 8]. Third, studies on faculty development and e-tutoring show that digital transformation affects teaching cultures, professional identities and organizational forms [9,10]. Fourth, the economics of education highlights that investment in cognitive, social and relational skills has long-term effects on life opportunities and social cohesion [11]. In dialogue with Beccalli's view of an economy centered on personhood, trust and cooperation [12], AI literacy can be read as human and civic capital rather than as an episodic technical update.

3 Pedagogical governance and academic leadership

Pedagogical governance of AI designates the educational capacity to transform technological adoption into a shared process of discernment [13]. Regulations and risk assessments are necessary, but they remain insufficient

without a community able to ask educational questions: what purposes does AI serve? Who benefits from its use? Which exclusions can it generate? Which responsibilities cannot be delegated? Academic leadership should therefore become distributed, participatory and reflective. Teachers, tutors, administrators and students should be considered co-responsible actors in the construction of learning ecosystems [14]. AI-aware leadership entails ethical judgement, critical literacy, assessment of social impact and the protection of academic freedom.

4 Conclusion

The expected result is a theoretical-operational model based on five principles: human agency, pedagogical intentionality, distributed responsibility, institutional accountability and the common good. These principles can guide universities in evaluating AI-enabled practices not only by performance, scalability or efficiency, but also by autonomy, inclusion, justice, trust and community well-being [15]. The model is consistent with a pedagogy of care that treats digital transformation as an anthropological and social question [16, 17] and resonates with human dignity, solidarity, subsidiarity and social justice [18]. The originality of the contribution lies in shifting the focus from AI as educational support to AI as an object of citizenship education and democratic governance. In this perspective, the Pedagogy of Artificial Intelligence becomes a strategic field for reimagining the university as a democratic, inclusive and generative community [19].

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Compassionate Academic Leadership in the Age of AI. Cultivating Collective Well-Being in Higher Education Through Human-Centered Artificial Intelligence

Giampaolo Sabino[1] [0000-0002-5650-7076]

[1] University of Brescia, Brescia, Italy – 25121, IT
giampaolo.sabino@unibs.it

1 Introduction

The advent of Artificial Intelligence (AI) represents a significant challenge for contemporary educational studies. Beyond its opportunities and critical issues in teaching and learning [1, 2], its rapid diffusion in higher education raises fundamental questions regarding leadership roles, ethical governance, and community well-being [3, 4]. Indeed, AI integration is profoundly transforming leadership forms, decision-making processes, pedagogical practices, and participation in academic life [5].

AI can contribute to forming competent and aware citizens in the digital age and may promote a reconfigured humanism, where technology serves human growth without replacing relational care and ethical judgment [6, 7]. University leadership cannot be limited to managing technical adoption of digital tools but must orient AI use towards equity, well-being, and community cohesion [8, 3]. Leadership must become a morally oriented practice aligning technological innovation with values of care, justice, and inclusion.

Consequently, AI should be conceptualized not as a replacement for human agency but as a socio-technical partner that requires pedagogical mediation and ethical framing. However, this creates a fundamental paradox: compassionate leadership is grounded in human relationality, empathy, and mutual care, while AI operates as a non-human, algorithmic system that cannot feel, understand, or respond to suffering. How can a leadership practice rooted in human compassion govern a technology that is fundamentally non-human by design?

2 Compassionate Leadership as a Framework for AI Governance

New models of ethical governance are needed, oriented towards transparency and accountability. Drawing on the Marie Skłodowska Curie Action COMPASS-H project – COMpassionate leadership Pathways for Skills and Systemic impact in Healthcare – , this paper extends the compassionate leadership framework to higher education, arguing that principles of relational trust, systemic resilience, and ethical innovation apply to academic leadership in the age of AI. COMPASS-H provides the theoretical

basis to examine how AI can enhance rather than replace the human dimension within compassionate academic leadership, rethinking leadership as a relational, ethical, and distributed practice grounded in social justice [9]. Compassion – the sensitivity to one's own and others' suffering combined with the motivation to prevent or alleviate it [10] – is not innate but can be cultivated through structured training, reflective practice, and supportive organizational cultures [11, 12]. Compassionate academic leadership is now a crucial and core concern in tertiary education, requiring leaders to embody compassion in their leadership practice as carriers of culture [13]. Compassion is a strategic capacity for promoting relational trust, systemic resilience, and ethical innovation [14]. In higher education, compassionate leadership integrates attention, understanding, empathy, and action into institutional routines, transforming care from an individual virtue into an organizational capacity.

However, the prevailing "human-centered" approach to AI governance remains insufficient: it treats humanity as an additive value to technology rather than addressing how human and algorithmic agency coexist and co-constitute each other. This paper proposes compassionate leadership as a framework for navigating the human-algorithmic paradox.

This paper proposes three theoretical contributions. First, AI adoption shifts academic leadership from hierarchical control to distributed governance, requiring new competencies in ethical decision-making and participatory processes. Second, Compassionate leadership provides a framework for faculty professional development that integrates AI-aware skills with pedagogical reflexivity and peer mentoring. Third, AI governance grounded in compassionate leadership principles strengthens psychosocial well-being, inclusivity, and community cohesion in academic institutions.

These principles should be operationalized through concrete policies, ethical committees, and participatory mechanisms ensuring continuous evaluation of AI impact on well-being and equity. The framework requires empirical validation through case studies and comparative analyses across institutional contexts.

3 Conclusion

This paper argues that compassionate academic leadership in the age of AI is not about opposing humanism and technology but about ensuring that technological innovation remains aligned with care, justice, and inclusion. In this perspective, compassionate AI leadership becomes a political and pedagogical practice for governing the relationship between human and algorithmic agency in higher education.

The proposed framework offers a basis for future empirical research on compassionate AI leadership and suggests that academic institutions should develop AI governance policies grounded in transparent decision-making, faculty development, and psychosocial well-being. However, the framework still requires empirical validation through case studies and comparative analyses across institutional contexts.

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Pedagogical Professions and University Education in the Age of AI

Serena Mazzoli[1][0000-0002-6049-7640]

[1] eCampus University, Novedrate, Italy
serena.mazzoli@uniecampus.it

1 Introduction

Pedagogical professions are traversed by the changes affecting education in contemporary society, finding themselves confronted with new educational challenges and a significant evolution of professional competences [3,4,5]. To train education professionals today means developing the capacity to interpret educational problems critically within contexts profoundly transformed by the digital transition, with particular reference to the role of artificial intelligence in decision-making, organisational and relational processes.

From this perspective, human formation engages with the challenges of the contemporary world [11], across the diverse contexts in which education takes shape and throughout the entire course of life, responding to the demand for new competences generated by the evolution of socio-technological systems [2].

2 University, Pedagogical Professions, Artificial Intelligence

The transformations underway directly and inescapably challenge universities, which are called upon to rethink in depth the educational pathways addressed to future professionals of education and training, both teaching and non-teaching [5]. In this direction, the capacity to grasp the systemic questions that characterise our time, understanding how algorithmic systems bear upon decision-making processes, organisational practices and the educational relationship, assumes a central role in the construction of professional competences. In parallel, the acquisition of robust AI literacy competences [1,12,13], not reducible to the mere ability to use artificial intelligence tools but extended to the capacity to recognise critically their ethical, pedagogical and social implications, becomes an indispensable element. The aim is to train professionals capable of integrating AI into educational work while keeping firm the pedagogical oversight that orients the choices, practices and purposes of formative action.

The principal international organisations converge in pointing to the need to develop AI literacy competences within the pathways of initial and continuing education intended for the pedagogical professions. In particular, UNESCO [13] stresses the urgency of promoting an ethical and responsible use of artificial intelligence in every professional sector; the OECD [12] emphasises the centrality of the capacity to steer innovation within educational contexts; the EUA [8] highlights the role of universities in ensuring quality, transparency and accountability in the adoption of AI; and the

European Commission [6,7], finally, recognises AI literacy as a key competence for future professionals of education and training, indicating the need to strengthen a critical and informed preparedness for the use of artificial intelligence within university pathways. At the same time, the growing integration of AI into educational ecosystems requires a critical reflection on the risks of algorithmic opacity, the tensions between automation and pedagogical judgement, and the need to preserve the interpretive and relational complexity of professional practice.

3 Conclusions

The contribution highlights how artificial intelligence does not amount to a set of tools to be integrated into educational services, but rather to a transformative factor capable of redrawing the very conditions in which the educational relationship takes shape [9, 10]. The educational relationship, while not replaceable by generative systems in its interpretive, affective and situated dimension, is profoundly shaped by the organisational and decision-making environment that AI is today helping to reconfigure. International studies confirm this tendency [12]: the educational activities most exposed to automation concern documentation, data management and administrative and design-related processes, domains that cannot be reduced to mere bureaucracy, since they constitute structural components of professional practice.

For those preparing for roles of pedagogical coordination, the crucial question therefore does not concern the possibility that AI might replace the relationship, but rather the capacity to govern the environment within which that relationship unfolds: an environment made of criteria, responsibilities, documents, timeframes, spaces and practices that AI is progressively redefining.

It is in this direction that the pedagogical leadership of the future is delineated, and that the responsibility of the university is affirmed in preparing professionals able to act in an active, critical and informed manner within an educational ecosystem transformed by artificial intelligence.

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Artificial Intelligence as a Subject of Study in Higher Education: Global Standards and the Paradox of Ukrainian Educational Programmes

Olha Hulai[0000-0002-1120-6165], Oleksii Prykhodko[0000-0001-8496-1295], Tetiana Furs[0000-0002-4786-9980], Pavlo Savaryn[0000-0001-7140-7068] and Andrii Lobatskyi [0009-0009-1497-4977]

Lutsk National Technical University, Lvivska, 75, Lutsk, Ukraine
o.hulai@lntu.edu.ua,o.prykhodko@lutsk-ntu.com.ua,
t.furs@lntu.edu.ua,savaryn.pasha@lntu.edu.ua,
a.lobatskyi@lntu.edu.ua

1 Introduction

Researchers identify five key areas of application for AI tools in higher education: (1) Assessment/Evaluation, (2) Predicting, (3) AI Assistant, (4) Intelligent Tutoring System (ITS), and (5) Managing Student Learning [1-3]. Modern higher education faces an unprecedented challenge, which can be described as the 'educational paradox of artificial intelligence' (AI). The essence of the paradox lies in a sharp conflict of speeds: AI is the discipline with the fastest-evolving toolset, whilst the university remains one of the most inertial systems for updating educational programmes [4]. The discourse on the integration of AI into higher education highlights a growing global gap between curricula and the practical skills required by industry [5].

To gain a comprehensive understanding of this issue, it is important to consider artificial intelligence in two dimensions: as a separate academic discipline and as a holistic educational programme (EP), as well as to compare global practices with local Ukrainian realities [6]. In the Ukrainian context, this paradox is compounded by the fact that current higher education standards for IT specialisms (mostly approved in 2020–2024, i.e. prior to the global boom in generative AI) do not include AI as a mandatory component. The aim of this study is to analyse how Ukrainian higher education institutions (HEIs) are adapting their educational programmes (EPs) to industry requirements amidst strict regulatory constraints, and to identify ways to overcome the identified educational paradox.

2 Methods and results

The study sample comprised the total population of accredited bachelor's degree programmes (240 ECTS credits) at six leading technical universities in Ukraine (including Lutsk National Technical University) the titles of which explicitly include the term 'Artificial Intelligence'. The programmes were divided into two groups according to their core specialisations: F1 'Applied Mathematics' and F3 'Computer Science'. All subjects were semantically grouped into blocks, after which their average proportion was calculated. The data were compared with the recommendations of the international standard ACM/IEEE Computer Science Curricula 2023 (CS2023) [7]. As

CS2023 does not specify fixed percentages for subject blocks, but instead adopts a competence-based approach and flexible curriculum design, the table provides an indicative breakdown, summarised on the basis of the Knowledge Areas structure and recommendations for AI integration.

The results of the analysis of the distribution of ECTS credits across subject areas are presented in Table 1. As the empirical data show, the approach to AI education in Ukraine depends entirely on the underlying degree programme (a maths-driven approach in programme F1 versus an engineering-driven approach in programme F3). However, common to both groups is a critically low percentage of disciplines that directly study AI (Machine Learning, neural networks, Data Mining) – on average around 13–15% of the total volume.

Table 1. A comparative analysis of the structure of AI education programmes in Ukraine and global recommendations

Subject module	F1 'Applied Mathematics'	F3 'Computer Science'	Recommendations ACM/IEEE CS2023 [7]
1. Humanitarian / Soft Skills	~ 10 %	~ 12 %	~10–15% (ethics, communication, teamwork, social aspects of IT)
2. Fundamental (Mathematics)	~ 32 %	~ 18 %	~15–20 % (discrete mathematics, statistics, linear algebra for AI and data analysis)
3. Basic IT (Programming)	~ 25 %	~ 42 %	~35–40% (programming, algorithms, systems architecture, software development)
4. Specialised (Proprietary AI)	~ 15 %	~ 13 %	~20–25% (AI, ML, Data Science, intelligent systems, integrated into various courses)
5. Practical Experience / Projects	~ 18 %	~ 15 %	15–20% (project-based learning, team projects, development and implementation of AI solutions)

According to the ACM/IEEE CS2023 document, AI (Knowledge Areas: AL-AI and AL-ML) has attained the status of a fundamental discipline that should be integrated across the curriculum, accounting for up to a quarter of the core curriculum [7]. In Ukraine, however, AI is largely treated as an isolated 'add-on' in the final years of study.

3 Conclusion

The low proportion of specialist AI subjects clearly illustrates the bureaucratic aspect of the Ukrainian education paradox. As higher education standards for the 2022–2024 period do not include AI competencies, higher education institutions are forced to devote up to 85% of their curriculum to meeting regulatory requirements, learning outcomes and core subjects [8]. Universities simply do not have 'free credits' to introduce a sufficient number of modern courses.

Furthermore, the rapid development of generative AI (such as ChatGPT) calls for an immediate response regarding academic integrity and changes to teaching approaches [9–10]. As one solution to overcoming this barrier within the framework of current

standards, a shift towards the creation of hybrid specialised disciplines is proposed. Instead of mechanically adding separate AI courses, higher education institutions should integrate AI into existing core subjects (for example, transforming a traditional discipline into 'Probability Theory in Machine Learning Tasks' or 'Designing Information Systems using LLM'). This will simultaneously meet the requirements of the national standard and provide students with up-to-date skills.

The modernisation of traditional disciplines through the cross-cutting implementation of AI technologies (in line with the ACM/IEEE CS2023 vision) is the most viable adaptation strategy for universities until the official update of state standards for higher education.

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Financial Literacy and Artificial Intelligence in Higher Education: Personalized Learning, Well-being and Educational Innovation

Teresa Giovanazzi[1][0000-0002-8466-7050]

[1] Free University of Bozen, Brixen, Italy
teresa.giovanazzi@unibz.it

1 Introduction

The acceleration of digitalisation processes and the growing diffusion of artificial intelligence (AI) represent one of the most radical transformations in the history of human civilisation, profoundly redefining the contexts of higher education and the modalities of teaching, learning and skills development. Artificial intelligence, understood as a set of technological devices capable of simulating human cognitive processes — from learning to reasoning through to problem-solving — opens up unprecedented scenarios for education [1], calling for a critical reflection on the operational modalities, formative purposes and value frameworks that orient higher education. It is a reality capable of profoundly altering our relationship with knowledge, time and otherness, introducing forms of algorithmic rationality increasingly integrated into decision-making, ethical, communicative and educational processes [2].

Educational innovation is not limited to considering the introduction of new digital devices, but implies above all a re-reading of the forms of thinking and acting, a problematisation of the concepts of education and training, and the necessity of promoting a culture of artificial intelligence [3]. The need emerges to combine a critical perspective with an openness to change, without losing sight of the meaning of an integral human formation, capable of guiding new generations in an increasingly complex and interconnected world.

2 Financial Literacy, Artificial Intelligence and Personalized Learning

In this scenario, financial education represents a particularly significant domain for observing the transformative potential of artificial intelligence. The growing complexity of the economic decisions that students are called upon to face makes it necessary to develop educational pathways capable of combining financial competencies, critical thinking and digital literacy. Being able to navigate social changes and market

evolutions means forming citizens equipped with the competencies necessary to deeply understand economic and social dynamics, analyse and evaluate risks and opportunities, and make conscious and informed decisions [4].

This contribution, without any claim to exhaustiveness, aims to reflect on the potential of artificial intelligence in fostering innovative pathways of financial education in higher education, with particular attention to the processes of personalised learning [5] and student well-being. The integration of financial education and artificial intelligence makes it possible to overcome standardised approaches to teaching, fostering the construction of adaptive learning ecosystems in which content, tools and feedback are shaped according to the cognitive, behavioural and motivational characteristics of students, democratising access to knowledge and enhancing individual talents in an inclusive and equitable perspective.

3 Pedagogical Perspective

Artificial intelligence does not merely support the acquisition of financial knowledge, but contributes to the development of a greater awareness in economic choices and in the management of personal resources. This perspective is situated within the pedagogical debate on the opportunities offered by artificial intelligence for educational innovation [6], highlighting how the personalisation of learning can contribute not only to the improvement of financial competencies, but also to the development of individual and collective well-being. A greater awareness in the management of economic resources can positively influence the reduction of financial stress, the strengthening of self-efficacy and the capacity of students to plan their own future with responsibility [7].

Rethinking education in the light of new technologies means rediscovering the ethical task of higher education: preparing students to live with awareness in a complex world, providing them with the tools to act as free individuals and citizens capable of imagining and building a better future, facing the challenges of an increasingly digitalised society.

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Human Horizon, Artificial Intelligence. Supporting Educational Professions to Promote Community Well-Being

Sara Scioli[0000-0002-8676-1550]

Catholic University of the Sacred Heart, Milano, Italy
sara.scioli@unicatt.it

1 Artificial Intelligence: Potential and Vulnerabilities. Unresolved Issues

Artificial intelligence (AI) represents one of the major milestones in the technological innovation in recent years. It is one of the most significant topics and one of the most controversial. On the one hand, it holds enormous potential but also raises ethical, social, and educational issues of considerable complexity: "The challenge is primarily ethical, not technological" [1]. As part of an increasingly rapid digital transition, AI is redesigning various aspects of human existence across the board, from social, cultural and in both personal and work life: this urges the educational community to engage in a multidimensional and cross-sectoral critical reflection. The aim of this paper is to underline some issues linked to the raise of the AI. AI is used in a wide variety of contexts—almost in every field of knowledge and practice—in ways that are fully aligned with the culture of immediacy that so distinctly characterizes our era. Without denying the potential of AI, there is a risk that cognitive and emotional effort will be replaced by algorithmic efficiency: fragility and limitation risk no longer being conceived as integral parts of the human condition, but as obstacles to be removed.

As Pope Leo XIV underlines in his first encyclical, Magnifica Humanitas, signed on May 15, 2026, "we must remember that humanity flourishes not *despite* limitations, but often *through* them" [2]. It is important to reverse the tide, for "fragility is not what technology must correct: it is the place where life becomes truer" [3]. While AI can serve as an integrative backdrop within interdisciplinary approaches, as is already happening, it is legitimate to ask whether it is truly capable of promoting "a *diălogos*, a deal between different worlds, languages, and forms of knowledge, […] a 'long-term perspective' that holds together and explains the different points of view" [4].

Based on the ideas of E. Morin [5], how is AI able to avoid the compartmentalization of disciplines, the fragmentation of problems, and the reduction of the complex to the simple? How does AI promote - or, conversely, hinder and act as an obstacle to - curiosity and the inquiring mindset which, as the author notes, can only be inspired by an "educational enthusiasm"?

Various scientific studies, as well as national and international documents, underline the need to educate and train younger generations in critical thinking, problem-solving, and adaptability—so they can become informed, engaged, and active citizens: how does the use of AI foster these transferable skills, or does it instead inhibit them?

2 Educational Professions, Community Well-Being: the Human Dimension as a Source of Meaning

This paper is based, without any claim of exhaustiveness, on the university research project, currently underway at the Catholic University of the Sacred Heart [6] that is of particular transdisciplinary significance: *RECOGNISE. Skills builders for the community well-being.* This research aims to examine pedagogical professions—specifically about skills building and team development—to foster their social, economic, cultural and identity recognition to pursue the community well-being and to support universities in training the next generation of pedagogical professionals in the digital age.

In this regard, it raises emblematic educational and training issues that disclose further questions. What attitude must the educational sciences adopt in the age of artificial intelligence? What training programs are needed today to support educational professionals so they can guide individuals, organizations, and communities toward a critical, responsible, and informed use of AI? How can universities balance the use of artificial intelligence with the holistic development of the person, in order to promote inclusive learning environments and professional communities focused on well-being?

In its latest Report, UNESCO [7] emphasizes that education is called to assume a leading role in the digital transformation of society in order to promote a meaningful use of technology—to "act upon" science rather than be subject to it.

The digital transition also underlines the need of a pedagogical approach aimed at guiding innovation by enhancing and promoting human activities, rather than reducing them for technology.

As L. Floridi notes:

> We must shape and guide the future of AI and stop improvising as we go, limiting ourselves to chasing innovation instead of guiding it. It is time to work on an innovative project for a better infosphere. There are encouraging signs, and all of this is achievable through the improvement and expansion of human activities [8].

3 Conclusion

Artificial intelligence currently lives between risks and benefits; it lies between progress and potential setbacks; it toggles between the allure of its potential and the inevitable focus on ethical considerations; it stands between the potential to serve as a strategic tool for integrating different disciplines and the risk of deepening the fragmentation of knowledge and social inequalities.

This challenges the field of educational sciences to ensure that the flourishing of human dignity remains the guiding principle toward which a pedagogical approach to artificial intelligence should aim, balancing fragility, educational planning, and the well-being of communities.

Supporting educational professions to promote community well-being in the age of artificial intelligence.

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Developing AI Literacy in Higher Education: Formative Assessment, Educational Feedback and Pedagogical Leadership

Cristiana Gnutti

University of Valle d'Aosta, Via Monte Vodice, 11100 Aosta, Italy
c.gnutti@univda.it

1 AI-Aware Professional Competencies in Higher Education

In recent years, Artificial Intelligence has emerged as a driving force of transformation, affecting people's personal, professional, social, and educational lives. As argued by Jacques et al. [1], AI has brought about radical changes on a global scale, including in higher education, redefining teaching tools, the ways in which knowledge and competencies are constructed, and the ways in which educational responsibilities are assumed. In light of this scenario, this theoretical-conceptual contribution is situated within the field of AI pedagogy in higher education and is based on a critical reading of selected international frameworks and recent educational literature. It focuses on the development of AI-aware competencies among current and future teachers, with particular attention to formative assessment, educational feedback, and pedagogical leadership, understood as integrated dimensions in the development of the teaching profession. Its central claim is that professional education on AI cannot be reduced to technical training in the use of tools, but must integrate digital, ethical, assessment-related, design, and reflective competencies while keeping pedagogical judgment central.

International literature underlines how the adoption of AI in education requires moving beyond merely technical and operational competence, integrating it with ethical awareness, critical capacity, and personal reflexivity. UNESCO's AI Competency Framework for Teachers proposes a broad vision of teacher competence articulated around five dimensions: a human-centred approach, AI ethics, foundations and applications of AI, AI pedagogy, and AI for professional development [2]. The framework emphasizes a humanistic approach, the protection of human rights, and human control in human-machine collaboration. In the same way, the European Commission's guidelines on the use of AI and data in educational processes recall the need to educate teachers capable of acting according to criteria of transparency, responsibility, equity, security, and data protection [3]. Coluzzi et al. [4] show how, in European universities, the integration of intelligent technologies requires a balance between digital competencies and soft skills, such as emotional intelligence, communication, critical thinking, leadership, and teamwork. In this direction, Malavasi [5] invites us to consider the pedagogy of AI as a possibility for questioning the responsibilities of human choices, the limits of machines, and the conditions for an education that is fully human.

2 Formative Assessment, Educational Feedback and Pedagogical Leadership

A particularly significant area for observing this transformation is that of formative assessment and educational feedback. AI can support certain phases of assessment and feedback, for example through learning analytics, the identification of patterns, and the generation of comments or personalised suggestions. However, such outputs must always be critically interpreted by the teacher and cannot be assumed automatically. By its nature, formative assessment is not reduced to the collection of data or the measurement of performance, but implies the construction of criteria, the interpretation of processes, and support for the development of competent action [6]. In the same way, feedback does not coincide with an automatic response, but represents a complex professional practice founded on pedagogical intentionality, clarity, dialogue, and orientation towards improvement [7]. For this reason, formative assessment and educational feedback should be explicit priorities in the development of professional competencies on AI. Initial and continuing teacher education should include activities aimed at developing Teacher Feedback Literacy, understood as the knowledge, competencies, and dispositions needed to design meaningful and pedagogically sustainable feedback pathways [8]. For example, teachers could compare AI-generated feedback with feedback produced by educators, evaluate its accuracy, clarity, fairness, and pedagogical usefulness, and identify errors or biases in automated comments. The development of these competencies also requires pedagogical leadership capable of orienting technological innovation within ethical, participatory, and professionalising frameworks. Innovation is not an end in itself or the simple introduction of new tools, but a process of positive change to which pedagogy must give direction, meaning, and value [9]. In this direction, Marrandino [10] interprets AI as a cognitive 'teammate' in educational design, highlighting the need for competencies of questioning, contextualisation, critical supervision, and decision-making responsibility.

3 Conclusion

In conclusion, the contribution argues that the development of professional competencies on AI cannot be reduced to technical modules on the use of tools, but requires training pathways capable of integrating digital, ethical, assessment-related, design, and reflective competencies. University and teacher education pathways can thus foster critical awareness, criteria of judgment, and professional responsibility, especially in formative assessment and educational feedback. In this perspective, pedagogical leadership is decisive in promoting shared criteria and responsible AI practices in higher education.

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Magnificent Humanity, Artificial Intelligence, Pedagogy. Recognise Open Questions

Pierluigi Malavasi[0000-0001-8178-967X]

Catholic University of the Sacred Heart, Milano, Italy
pierluigi.malavasi@unicatt.it

1 Where are we going? Pedagogy, AI, and Care for Our Common Home

The reflection developed in the Encyclical Letter *Magnifica Humanitas. On Safeguarding the Human Person* in the Time of Artificial Intelligence is especially relevant in this context: "First, any statement regarding AI risks becoming quickly outdated, given the remarkable pace at which these systems are developing. Second, all of us, including those who design them, possess only a limited understanding of their actual functioning. Indeed, current AI systems are more 'cultivated' than 'built', for developers do not directly design every detail, but instead create a framework within which the intelligence 'grows'. As a result, fundamental scientific aspects - such as the internal representations and computational processes of these systems - remain, at present, unknown. There thus emerges an urgent need for a twofold commitment: on the one hand, a deepening of scientific research; on the other, the exercise of moral and spiritual discernment" [1].

Christopher Olah's participation in the Vatican presentation of the Encyclical attracted considerable public attention. Olah is a co-founder of Anthropic, a leading company in the field of artificial intelligence. He stressed the need for a deeper understanding of how language models such as Claude AI function, including their internal structures, so that technical interventions can mitigate risks and safeguard human oversight. He also called for agreement on a form of "plurilateral disarmament" or moratorium in response to rapid and insufficiently coordinated technological development. From this perspective, developers should consider temporarily suspending the release of the most advanced AI models. Developments in recursive self-improvement are particularly concerning, as they may enable an AI system to design and develop future versions of itself autonomously. Beyond stereotypes and rhetorical simplifications, several questions remain open: the role of human agency in "cultivating" AI resources; the irreducible distinction between the human person and any technological artefact; and the need to educate for discernment and understanding when addressing radical innovations in both processes and products. These questions should be considered from the perspective of the common good, with particular attention to educational needs, social vulnerabilities, inequalities and poverty. They require joint reflection by scholars [2], business leaders, system developers and public decision-makers [3].

2 Methodological Notes

This contribution develops a specific thematic focus within the ongoing transdisciplinary research project *Recognise. Skills builders for the community well-being.* The project investigates non-teaching pedagogical, educational and training professions [4] and seeks to identify their contribution to personal and community well-being [5]. This thematic strand adopts an exploratory approach to examine the transformations introduced by artificial intelligence (AI) in educational care professions [6]. The study is guided by two research questions. How is AI reshaping the practices, competences and responsibilities of those working in non-teaching pedagogical, educational and training professions? What educational, organisational and ethical conditions enable these systems to support rather than replace caring relationships, while preserving the centrality of educational experience, the quality of professional judgement, and the promotion of personal and community well-being? The theoretical framework is phenomenological and hermeneutic. It examines pedagogy's ontological engagement with radical technologies and considers professional experience as a site of meaning in which the relationship between educability, technology and responsibility emerges and is redefined.

3 Conclusion

A pedagogy of artificial intelligence is conceived as a practical science whose empirical and eidetic research horizons are integrated within the ethical and educational dimension that characterises the interpretation and design orientation of pedagogical knowledge [7]. At stake is an emancipatory pedagogy that, in order to educate for quality of life, must address the ambiguities and paradoxes inherent in the concept of artificial intelligence. From the perspective outlined in the magisterial document *Magnifica Humanitas*, treating efficiency not as one measure among others but as the exclusive criterion of value weakens the constitutive relational and communal dimensions of the human person. This entails the risk that the development of personal and collective well-being may be delegated to merely functional automated processes.

In this context, reconsidering the role of educational care professionals acquires particular significance. Their role can be expressed through pedagogical design aimed at the critical and strategic implementation of artificial intelligence systems within human experience. Pedagogical design, as an expression of professional competence and dedication to the care of our common home [8], combines action and reflection within the framework of social responsibility. Its purpose is to shape people's lived experience and contribute to the development of civilisation through practices grounded in care and hope [9]. Recognising pedagogists in this context means conceiving a fraternal leadership for change capable of individual and collective, intra- and intergenerational ethical discernment, so that AI remains a support, rather than a substitute, for human dignity.

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Beyond Technical Supervision: Teacher-in-the-Loop for Responsible GenAI Integration

Elisa Saraceni[1][0009−0004−6602−327X], Benedetta Petroselli[2], Lorenzo Stacchio[2][0000−0002−9341−7651], and Emanuele Frontoni[2][0000−0002−8893−9244]

[1] Law Department, Università degli Studi di Macerata, Macerata, Italy
e.saraceni1@unimc.it

[2] Department of Political Science, Communication and International Relations, Università degli Studi di Macerata, Macerata, Italy
b.petroselli1@unimc.it, lorenzo.stacchio@unimc.it, emanuele.frontoni@unimc.it

1 Introduction

The widespread adoption of Large Language Models (LLMs) is reshaping educational systems, positioning Generative AI (GenAI) as a cognitive infrastructure rather than a merely experimental tool [2,10]. International and European policy frameworks call for human-centered adoption models that preserve teacher agency, safeguard fundamental rights, and translate AI literacy into educational practice [6,8,3]. However, structured competency frameworks and operational models for school-level implementation remain limited, including in Italy, where recent ministerial guidelines represent an initial institutional step but leave pedagogical translation unresolved [9,5]. PAIDEiA (https://paideia.study/) addresses this gap through a scalable, human-centered framework for the responsible integration of GenAI in schools. Developed and piloted in the Marche Region, it is grounded in the Teacher-in-the-Loop paradigm, understood as pedagogical and epistemic leadership: teachers act as designers, mediators, and validators of AI-supported learning environments [4,7,1]. The framework is operationalised through PaolaGen.AI (https://paolagen.ai/), a custom LLM-driven platform that constrains AI generation through a curriculum-oriented Retrieval-Augmented Generation (RAG) pipeline. Its specialised vertical tutors are aligned with school levels, disciplines, and professional roles, enabling educators to configure didactic modules, validation steps, and interaction rules within a controlled environment. PAIDEiA thus translates AI literacy into institutional practice by supporting effective GenAI use, critical evaluation of its outputs and limitations, and awareness of the ethical responsibilities associated with algorithmic mediation [3,8].

2 Methodology

PAIDEiA is organised into six sequential and interdependent phases: (1) Baseline Analysis and Research; (2) Training of Trainers; (3) Family Information

and Awareness; (4) Classroom Experimentation; (5) Implementation and Scale-Up; and (6) Monitoring, Evaluation, and Reporting. This contribution focuses on Phase 2, which is designed to bridge teacher readiness and student agency through the co-design of Learning Units (UDA) within cross-school working groups. The co-design process positioned teachers as pedagogical orchestrators of GenAI supported learning environments. Working groups developed structured activities in which students are required to compare GenAI outputs with validated sources, discuss alternative interpretations, identify deliberate errors, revise prompts, and produce shared artefacts. In this sense, the UDA do not treat GenAI as a generic conversational tool, but as a set of situated pedagogical agents embedded in specific disciplinary tasks and learning goals. Critical engagement with GenAI is therefore framed as a core learning practice rather than as an auxiliary digital skill. Each UDA also functioned as a generative environment for the development of specialised conversational agents to be integrated into PaolaGen.AI. The most pedagogically relevant agents — including a Socratic tutor, reflective error-analysis bots, a fact-checking agent, and tools for visual literacy and metacognitive reasoning — were selected and configured through teacher-defined objectives, validation procedures, and structured dialogue rules. This process allowed the project to translate co-designed classroom scenarios into operational GenAI mediated learning environments, while maintaining teacher control over pedagogical purposes, interaction constraints, and epistemic validation criteria [11].

3 Conclusions

PAIDEiA contributes to the debate on the responsible integration of LLMs in education by proposing a scalable model based on teacher governance, institutional accountability, and learning environments that are controlled and supported by GenAI. Early findings suggest that the responsible adoption of GenAI requires far more than mere access to generative tools: it depends on pedagogical orchestration, teacher professional development, and classroom design that transforms GenAI outputs into objects of critical inquiry. The framework also redefines educational innovation as a process aimed at strengthening human agency. Teachers are positioned as epistemic leaders who define objectives, validation procedures, and rules of interaction, while students are engaged as active agents in the validation of knowledge. By linking teacher mediation, student action, and critical AI literacy, PAIDEiA offers a concrete model for aligning technological innovation with equity and the responsible use of GenAI in the educational context.

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Can the Pedagogist Act as an Epistemic Mediator in the AI University?

Luca Lanfranchi[0009-0000-4706-515X]

Catholic University of the Sacred Heart, Largo Gemelli 1, Milano, Italy
luca.lanfranchi@unicatt.it

1 Generative AI and Popper's Three Worlds

Generative artificial intelligence acts on the conditions through which university knowledge is produced, selected, ordered, transmitted, and assessed. Higher education is a decisive site for observing this transformation because knowledge, professional skills, ethical responsibility, and organisational practices are being redefined. A pedagogy of artificial intelligence [1] can interpret AI as a formative, epistemological, and institutional issue. Popper's theory of the Three Worlds [2] offers a useful framework: World 1 concerns physical bodies and material infrastructures; World 2 concerns subjective experiences and intentional processes; World 3 concerns objectified products of the human mind, including languages, theories, stories, symbolic systems, and scientific works. Generative AI operates through the interaction of these worlds: it depends on material, energy, and computational infrastructures; it receives direction from human questions and expectations; and it reorganises the cultural products of World 3. Gnoli's concept of the *mentefact* [3] clarifies that AI works on abstract cultural configurations, such as theories, narratives, moral codes, argumentative structures, and conceptual images. Its outputs therefore express a particular organisation of World 3, shaped by material, linguistic, economic, and cultural conditions.

2 The Pedagogist as an Epistemic Mediator

Within this framework, the pedagogist can be understood as an *epistemic mediator*. Their task is to make visible the epistemological assumptions guiding the selections and exclusions produced by AI systems. In the university, this mediation involves teachers, students, administrators, teaching coordinators, and academic leaders. The pedagogist can cultivate an *ars interrogandi* through which AI outputs are read not as neutral answers, but as effects of an order of knowledge: privileged sources, dominant languages, available datasets, training criteria, alignment procedures, institutional regulations, and cultural imaginaries. AI in higher education is often represented as an inevitable force of change [4], while educators still occupy a limited role in the relevant research [5]. This strengthens the need for academic leadership able to govern AI critically and responsibly. Bias can emerge throughout the life cycle of large language models [6]; generative AI can reproduce epistemic injustice [7], and even knowledge-

enhanced models remain dependent on situated and unequal forms of knowledge [8]. These dynamics are connected to broader processes of data colonialism [9] and to the colonial matrix of power reproduced through AI [10]. AI literacy [11, 12] therefore becomes fully pedagogical when it forms people able to understand how AI classifies, selects, hierarchises, and returns knowledge.

3 Conclusion: Towards an Epistemically Responsible Pedagogy of AI

The pedagogist-epistemic mediator works on a liminal threshold [13]: the space between access to information and the formation of judgement. University education should enable students and institutions to inhabit consciously the interaction among Popper's three worlds. Four criteria can translate this role into academic governance. *Epistemic localization* requires leaders to accompany the adoption and use of AI with explicit consideration of data provenance, model limitations, and contexts of validity. *Linguistic and cultural plurality* requires multilingual testing, comparison of outputs across languages, and attention to minoritised and situated forms of knowledge [14]. *Interpretative slowness* introduces structured pauses for source verification, collegial discussion, and human review before AI outputs inform teaching, assessment, or institutional decisions. *Formative excess* protects dimensions of education – dialogue, embodiment, care, creativity, and judgement – that cannot be reduced to prediction, standardisation, or efficiency. These criteria can orient professional development, course design, procurement protocols, and institutional policies. A pedagogy of AI thus forms academic communities capable not only of using technology, but also of understanding its conditions, recognising its exclusions, and orienting it towards epistemic justice [15] and the common good.

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Special Track 12

AI-augmented E-learning for Mathematics Education at University Level

Organizers:
Antonella Montone, University of Bari Aldo Moro, Italy
Giovannina Albano, University of Salerno, Italy
Michele Fiorentino, University of Bari Aldo Moro, Italy

Collaborative AI Prompting as a Driver of Metacognitive Awareness and Epistemic Agency in Higher Education

Fabrizio Barpi[1[0000-0001-8371-5690]], Annamaria Miranda[2[0000-0003-3210-7964]], Loredana Saliceto[2[0009-0009-1601-3870]], Alessandro Ciasullo[3[0000-0001-6271-2554]], Gabriella Casalino[4[0000-0003-0713-2260]] and Davide Taibi [5[0000-0002-0785-6771]]

[1] Politecnico di Torino, Turin, Italy, fabrizio.barpi@polito.it
[2] University of Salerno, Fisciano, SA, Italy, amiranda, lsaliceto)@unisa.it
[3] University of Naples, Federico II, Naples, Italy, alessandro.ciasullo@unina.it
[4] University of Bari Aldo Moro, Bari, Italy, gabriella.casalino@uniba.it
[5]CNR-Institute for Educational Technology, Palermo, Italy, davide.taibi@cnr.it

1 Introduction and Theoretical Framework

The growing diffusion of generative AI in higher education has shifted attention toward learners' capacity to formulate, evaluate, and refine their interactions with AI systems [1, 2]. From a Knowledge Building perspective [3], AI functions as a mediating artefact for collaborative knowledge construction, provided learners exercise epistemic agency, the capacity to identify problems, set inquiry goals, and advance knowledge [4], both individually and collectively [5]. Equally central is metacognitive regulation: planning, monitoring, and evaluating one's own cognitive processes [6–9] becomes critical when students must assess AI outputs against authoritative sources and revise strategies accordingly. Given limited research on this intersection, the study asks: *How do metacognitive regulation and collective epistemic agency emerge during collaborative prompt formulation, evaluation, and revision in AI-supported higher education?*

2 Methodology

Undergraduates from different Italian institutions joined a shared AI-guided activity across disciplines. The underlying premise was that AI should not replace human reasoning but serve as a tool for critical discussion, deepening understanding of course content and facilitating exam preparation. Working in teams, students used Google NotebookLM to deepen a lesson using course materials, including slides, excerpts, exercises, and videos, as well as self-identified resources, documenting the process in a collaborative logbook. A pre/post Metacognitive Awareness Inventory, MAI-C [8,9], adapted for the project, tracked changes in metacognitive awareness across the activity.

The activity followed a structured iterative cycle. Each student first completed the MAI-C individually and then independently formulated a prompt for the AI, specifying the question, the expected response type, and the strategy they would use to verify the answer. Teams then compared their individual prompts, negotiated a shared version, submitted it to NotebookLM, and critically evaluated the response against course

materials, discussing clarity, completeness, and relevance. Based on this evaluation, they refined and resubmitted the prompt, recording both the revised prompt and the improved response. The cycle closed with individual reflection on any shifts in AI use strategy and a final MAI-C administration. Preliminary analysis examined Salerno students' logbooks, using each group's prompt selection, AI-response evaluation, and revision cycle as the unit of analysis. Researchers iteratively coded the data using Knowledge Building [3] and shared epistemic agency concepts.

3 Preliminary Findings

Episodes showing groups' shared control of the inquiry were coded as collective epistemic agency. Three patterns emerged from the Salerno logbooks. The first concerns metacognitive planning: before querying the AI, teams discussed and evaluated alternative prompts, anticipating learning goals and establishing criteria for assessing responses, engaging in planning and goal-setting regarding the direction of inquiry. One group explained: "We chose this question because it was the most general of the three and would help us gain a better understanding of the other two topics as well."

The second pattern involves monitoring and regulation: after reviewing NotebookLM's output, students identified omissions, insufficient explanations, and missing connections with the content, then revised their prompts, using prompt refinement as a mechanism for monitoring understanding and regulating subsequent learning actions.

The third pattern concerns critical evaluation of AI-generated information: several students shifted from immediate trust toward a more critical stance, progressively treating AI outputs as resources requiring validation against disciplinary knowledge and external references. One student noted: "Before, I used to trust the answers immediately; now I pay much more attention to the quality of the information".

4 Conclusions

Preliminary findings indicate that educational value resides not in AI-generated responses per se but in the collaborative processes of prompt negotiation, evaluation, and revision. Students collectively set learning goals, assessed knowledge claims, identified limitations, and progressively reoriented their inquiry, treating prompts as shared epistemic objects around which knowledge-building processes were organised. Consistent with [1], these findings link collaborative AI questioning to engaged, agentic learning and highlight prompt evaluation and revision as collective mechanisms for validating knowledge and redirecting inquiry. In this sense, the activity generated forms of collaborative prompting that combined metacognitive awareness with collective epistemic agency: rather than consuming AI-generated information passively, students actively negotiated the direction of inquiry and assumed responsibility for evaluating its outcomes. These results position collaborative AI prompting as a promising pedagogical approach, with future analyses set to deepen these findings by integrating logbook evidence with MAI-C data, comparing contexts, and assessing whether changes persist.

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Deconstructing AI Outputs: A Blueprint for Secondary Mathematics

Annarosa Serpe [0000-0003-4820-1760]

Department of Mathematics and Computer Science,
University of Calabria, 87036 Rende (CS), ITALY
annarosa.serpe@unical.it

1 Introduction

The current transition towards Artificial Intelligence (AI)-supported education tends to privilege technological availability over intentional pedagogical transposition.
As observed by [1], contemporary literature suffers from a saturation of descriptive taxonomies at the expense of operational frameworks to guide their orchestration within classroom dynamics. This marked deficiency constitutes a substantial critical gap: it not only isolates the practitioner within a praxis devoid of methodological benchmarks but also obstructs the transition from technological affordances to the genuine restructuring of knowledge.

Consequently, there is a risk that AI is perceived as a superficial addition rather than a resource capable of reconfiguring the cognitive ecology of the learning environment. In the mathematical domain, research has extensively documented the manifold functions of AI—as tutor, assistant, or cognitive partner—highlighting its capacity to catalyse the personalisation of learning [2].

However, the shift from theoretical perspectives to daily practice necessitates particular attention to the ecological validity of interventions. It is therefore imperative to substantiate research with substantive contributions that translate theoretical principles into tangible didactic actions, providing teachers with operational and readily deployable approaches.

In view of the above, the present study aims to promote formal rigour and critical thinking through the construct of productive failure (PF) [3, 4], a perspective that elevates error to an epistemic resource to trigger reflective processes and metacognitive agency. The selection of this model addresses the difficulty of calibrating tasks that induce a productive struggle (PS) while simultaneously maintaining pedagogical accessibility. To overcome such complexities and counteract the "haste to conclude" [5], AI is employed here as a "creative assistant" to generate mathematical arguments that are formally coherent yet logically fallacious.

The activity, mediated by ChatGPT [6], engages learners in the deconstruction of these outputs to distinguish syntactic verisimilitude from genuine logical cogency. Through this scaffolding, the student abandons passive epistemic delegation to assume the role of a critical evaluator and co-designer of their own learning trajectory.

1.1 Research Question

Against this backdrop, the present study intends to investigate, in the first instance, to what extent the systematic analysis of fallacious mathematical proofs —when appropriately mediated by the productive failure paradigm—can effectively consolidate learners' logical-formal rigour, offering a more incisive alternative to traditional error-correction practices.

Parallelly, the investigation aims to examine how the active deconstruction of algorithmic output influences the perception of AI's epistemic authority. Specifically, it seeks to verify whether this process can facilitate a conscious transition from the mere delegation of tasks to the tool towards a critical interaction that leverages its function as a cognitive partner.

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A Metacognitive and Instrumental Analysis of Agency and Educational Contract Shifts in AI-Mediated Calculus II Study

Maria Antonietta Lepellere[1][0000-0002-0216-4135]

[1] University of Udine, Udine, Italy

maria.lepellere@uniud.it

1 Introduction and Theoretical Framework

The rapid, pervasive integration of Large Language Models (LLMs) into undergraduate independent study routines has fundamentally challenged traditional instructional boundaries [1]. Within University Mathematics Education, contemporary quantitative research heavily focuses on macro-level student performance shifts: while current data confirms that AI scaffolding improves routine procedural fluency, it frequently warns against an impending "illusion of competence" when students encounter multi-step structural logic [2; 3]. A significant gap persists in literature regarding granular, longitudinal, qualitative data, tracking how individual STEM students deploy metacognitive monitoring to manage their educational agency (deciding when to rely on the professor, when to delegate to the AI, and when to look for institutional human support) across a Calculus II course. This longitudinal case study addresses this gap by analyzing the daily learning log of an engineering student during a multivariable integration module, answering the following research question: In what ways do metacognitive monitoring and instrumental genesis interact when advanced calculus students use GenAI as a scaffold, and how does this interaction drive shifts in their educational agency? Advanced calculus represents a severe cognitive bottleneck in University Mathematics Education, particularly during fast paced instructional deliveries and high-dimensional vector modelling [4]. Drawing on Rabardel's Instrumental Approach [5], Schoenfeld's Metacognitive Framework [6], and Zimmerman's Self-Regulated Learning cycles [7], a qualitative thematic analysis [8] was performed on the student's daily learning log. The findings reframe the current "conceptual-procedural divide" by capturing a dynamic shift in the human-AI educational contract [2; 3]. Initially, the student successfully instrumentalized the AI as a real-time classroom scaffold to mitigate lecture-induced cognitive overload. Asynchronous afternoon study sessions transformed the artifact into a conceptual text-expander. However, when faced with complex 3D vector theorems and multivariate integration domains, the AI's lack of genuine spatial grounding generates disruptive computational hallucinations, failure modes widely documented in advanced calculus cognitive frameworks [9]. Driven by high metacognitive monitoring, the student rejected the faulty digital feedback and strategically returned to human

institutional tutoring [10; 1], highlighting the irreplaceable nature of human educational safety nets in contemporary higher education.

2 Methodology and Results

This qualitative single-case study design [11] tracked "Elena", a high-achieving first-year Management Engineering student at an Italian university. Over a 4-week, 24-hour module on multivariable integration (chronologically divided into Line Integrals, Double Integrals with Gauss-Green Formula, Surface Integrals with Stokes Theorem, and Triple Integrals with Divergence Theorem), Elena maintained a daily, semi-structured learning log. She documented the morning lecture topics and pacing alongside qualitative accounts of her afternoon independent study sessions with the GenAI platform Gemini. The textual corpus was analyzed via inductive Thematic Analysis [8] cross-referencing codes of instrumental genesis and metacognitive monitoring loops.

The thematic analysis of Elena's log reveals a sophisticated, three-stage instrumental trajectory driven by active self-regulation. 1. Real-Time In-Class Scaffolding: On Lesson 5, faced with a rapid classroom lecture on changing variables in double integrals, Elena experienced immediate cognitive overload. Fearing she would "lose the thread of the explanation", she activated Gemini inside the classroom in real time. Rather than requesting direct exercise solutions, a disruptive trajectory warned about in literature [3], she instrumentalized the tool to generate a step-by-step procedural schema for Jacobian determinant transformations. By cross-referencing Gemini's algorithmic text with the professor's live writing, she synchronized her notes. The AI successfully functioned as a real-time operational scaffold, protecting her from pacing-induced alienation. 2. Conceptual Filtering and Semiotic Translation: Elena deployed consistent cognitive awareness regarding her comprehension boundaries. When abstract properties of vector fields "mixed up in my head" (Lesson 3), she drew summary schemas and triggered an asynchronous inquiry with Gemini, filtering its text to construct functional "rules of thumb" regarding simply connected domains in R^2 and R^3. Furthermore, on Lesson 4, she actively monitored the pedagogical delivery, evaluating the professor's definition of a "normal domain" as over-complicated. Elena independently executed a semiotic conversion, rewriting the abstract theory into an operational engineering process (variable x between constants, variable y between functions), using the AI purely to cross-check local algebraic treatments. 3. The Threshold of AI Failure and Metacognitive Decoupling: As the instructional pacing accelerated toward 3D vector fields and skipped foundational steps (Lesson 9), Elena experienced a breakdown in independent home study. She committed severe calculation errors by inserting a scale factor of ρ instead of $\rho^2\sin(\vartheta)$ in spherical coordinates and felt too far behind to approach the instructor directly. On Lesson 12, she turned to Gemini to identify integration boundaries for the Divergence Theorem. Here, the AI reached its limit, outputting contradictory, confusing spatial noise due to its probabilistic token nature. Elena's metacognitive evaluation of the tool was immediate: noting that Gemini's answers "did nothing but confuse my ideas further", she halted the interaction. Avoiding an illusion of

competence, Elena executed a mature self-regulation shift: she rejected the artifact's spatial hallucinations, protected her cognitive agency, and returned to human tutoring.

3 Conclusion

Elena's diary redefines the role of GenAI in higher education, shifting the perspective from a plagiarism threat to a personalized asynchronous pacing regulator. Considering that students spontaneously deploy LLMs to survive rapid lectures, rather than restricting AI use in classes, it is much more valid to implement it in a controlled way. Professors should provide structural "prompt templates" alongside slide decks to ensure students generate accurate, synchronized scaffolding text during class [3]. Furthermore, because LLMs seamlessly perform routine procedural computations [2], exams should precisely target structural friction points such as those highlighted by Elena log.

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Generative AI and Advanced Computing Environments in Mathematical Modelling: Evidence from Scenario-Based Learning in Higher Education

Alice Barana[1[0000-0001-9947-5580]], Giulia Boetti[1[0000-0001-5329-3378]], Cecilia Fissore[1[0000-0001-8398-265X]], Marina Marchisio Conte[1[0000-0003-1007-5404]], Fabio Roman[1[0000-0002-6021-0275]]

[1] Dipartimento di Biotecnologie Molecolari e Scienze per la Salute, Università di Torino, Turin, Italy
{alice.barana, giulia.boetti, cecilia.fissore, marina.marchisio, fabio.roman}@unito.it

1 Introduction and Theoretical Framework

Mathematical modelling can be defined as the process of analysing a real-world situation, constructing a mathematical representation, working mathematically on the resulting model, interpreting the results, validating them against reality, and communicating conclusions. The study adopts the modelling cycle proposed by Blum and Borromeo Ferri [1] that consists of seven phases: Construction, Simplification, Mathematisation, Mathematical Work, Interpretation, Validation, and Communication. Mathematical modelling is considered a key competency in higher education, as it enables students to connect mathematical knowledge with real-world situations and decision-making processes [2]. Advanced Computing Environments (ACEs) and Generative Artificial Intelligence (GenAI) offer new opportunities to support this process. ACEs facilitate symbolic computation, visualisation, simulation, and parameter exploration, enabling students to investigate mathematical models efficiently [3, 4]. However, they often require specific technical skills and provide limited support for conceptual explanations and argumentation. Conversely, GenAI systems can support the understanding of problem contexts, clarify mathematical concepts, assist mathematisation, and facilitate argumentation [5, 6, 7], but their outputs may contain inaccuracies or unreliable information. Building on previous research on AI-enhanced mathematical problem-solving [8], this study extends the investigation to mathematical modelling in an authentic university context, analysing, phase by phase, how GenAI and an ACE support students throughout the mathematical modelling cycle. The study addresses the following research question: How does the integration of an ACE and GenAI support the different phases of mathematical modelling in university-level scenario-based learning?

2 Educational Context and Methodology

The study was conducted within the Mathematical Modelling for Security and Defence module offered in the Master's Degree Programme in Strategic and Military Sciences

at the University of Turin. The course adopted a Scenario-Based Learning approach [9, 10] in which mathematical models emerge from the analysis of realistic operational situations. A total of 82 students, organised into 17 groups, worked collaboratively on six modelling scenarios addressing epidemic models, dynamic systems, logistics, cryptography, combinatorics, and 3D Analytic Geometry. Students were encouraged to use the ACE Maple [11] alongside a GenAI tool of their choice throughout the modelling activities. Data were collected through a final questionnaire administered at the end of the course. The quantitative section included 24 parallel Likert-scale items investigating the perceived contribution of Maple and GenAI to the processes involved across the seven phases of the modelling cycle. The qualitative section included three open-ended questions concerning the combined use of Maple and GenAI, the contributions of the two technologies to solving the scenarios, and the ways students used, verified, or modified AI-generated outputs. The quantitative analysis aggregates questionnaire items across the seven modelling phases and compares students' perceptions of the contributions of Maple and GenAI. The qualitative analysis adopts a thematic approach. Students' responses are coded according to the modelling phase involved, the type of support provided (ACE, GenAI, or combined use), and additional emergent categories describing specific forms of interaction with the technologies.

3 Results and Conclusions

The quantitative results reveal distinct patterns of perceived usefulness for ACE and GenAI across the modelling cycle. Students perceived GenAI as particularly useful during the initial phases of modelling, including understanding the real-world situation, clarifying mathematical concepts, identifying relevant variables, and supporting the transition from contextual descriptions to mathematical representations. It was also considered helpful for explaining modelling choices and communicating results. In contrast, the ACE was perceived as more useful for mathematical work on the model, particularly for manipulating representations, performing complex calculations, simulating alternative scenarios, exploring parameter variations, and validating results. Students also highlighted ACE's role in analysing model behaviour and assessing the plausibility of solutions. The findings suggest that the complementary roles of GenAI and ACEs are not generic but phase-specific, with each technology supporting different cognitive demands throughout the modelling cycle. While GenAI appears to support conceptual, linguistic, and communicative aspects of modelling, ACE is primarily associated with computational, exploratory, and validation activities. Preliminary examination of the open-ended responses further suggests iterative workflows in which outputs generated through one tool are refined, verified, or extended through the other. From a pedagogical perspective, the findings suggest that AI-enhanced mathematical modelling activities should intentionally integrate GenAI and ACEs, leveraging their complementary strengths rather than treating them as alternative technologies. This may support the design of digital learning environments that preserve students' active role throughout the modelling cycle. Future work will combine questionnaire data with

assessments of students' modelling solutions to explore the relationship between technology use and modelling performance.

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Students' Interactions with ChatGPT in the Search for a Satisfactory Mathematical Solution

Giovannina Albano[1][0000-0002-5119-5413], Anna Pierri[2][0000-0002-9612-7879] and Agnese Ilaria Telloni[3][0000-0001-8159-8144]

[1] Università degli Studi di Salerno, via Giovanni Paolo II, 132, 84084, Fisciano (SA), Italy
[2] Università Giustino Fortunato, viale Raffaele Delcogliano, 12, 82100 Benevento, Italy
[3] Università degli Studi di Macerata, Contrada Vallebona, 1, 62100 Macerata, Italy
galbano@unisa.it,apierri@unifortunato.eu,agnese.telloni@unimc.it

1 Introduction and Theoretical Framework

The increasing integration of generative Artificial Intelligence (AI) tools into university mathematics education is transforming the ways students access explanations, solve problems, and evaluate mathematical arguments [1]. Recent studies have explored various uses of generative AI in mathematics education, including students' perceptions of AI-generated explanations, the mathematical accuracy of chatbot responses, and the role of AI as a support for problem solving and formative assessment [2]. Although these studies provide important evidence regarding the quality of AI outputs and students' evaluations of them, much less is known about how students interact with AI systems as they construct and refine mathematical solutions. This paper is set within broader research exploring the use of ChatGPT in first-year Linear Algebra courses. In a previous study, we analysed engineering freshmen evaluations of a ChatGPT-generated solution to a mathematical task: students were generally able to identify procedural weaknesses and missing theoretical references, whereas only a small minority recognised subtle logical inconsistencies involving implications and quantifiers [3]. These results raised further questions about the potential role of interactions with AI in supporting or hindering the development of mathematical reasoning and awareness. The present study focuses on students' interactions with ChatGPT to improve an initial solution provided by the chatbot to a Linear Algebra task. The framework is a theoretical model based on the Anthropological Theory of the Didactic (ATD) [4]. Particular attention is devoted to the logical chain, understood as the sequence of inferences connecting statements and conclusions. This perspective enabled us to analyse not only the mathematical content of students' interactions with ChatGPT, but also the evolution of their reasoning and their management of logical relationships throughout the dialogue with the AI system.

2 Experimental Design and Methodology

The experimental activity, involving 60 engineering freshmen enrolled in Linear Algebra courses at two Italian universities, consisted of three consecutive phases. First,

students individually analysed a ChatGPT-generated solution to a Linear Algebra task and identified its strengths and weaknesses. Second, they were asked to interact with ChatGPT by posing questions, requesting explanations, challenging arguments, or asking for alternative approaches to improve the proposed solution. Students individually interacted with ChatGPT without predefined prompts, allowing them to freely decide both the sequence of questions and when the solution could be considered satisfactory. Once they were satisfied with the solution, they submitted both the complete interaction log and the final accepted solution for analysis. The interaction logs were analysed through an inductive thematic analysis. The coding process focused on identifying recurrent interaction patterns, types of requests addressed to ChatGPT (e.g., clarification, validation, theoretical justification, alternative strategies), the modifications introduced into the proposed solutions, and the criteria adopted by the students to judge a solution as satisfactory. The coding scheme was progressively refined through iterative cycles of individual reading and analysis by each researcher, followed by team discussions. The emerging categories were then interpreted through the perspective of the extended ATD theoretical framework, focusing on the evolution of the logical chain. In particular, the analysis examined how students progressively reconstructed the logical chain through successive interactions with ChatGPT.

3 Preliminary Findings

Preliminary findings suggest the existence of different interaction profiles. Some students adopted a validation-oriented approach, using ChatGPT mainly to confirm their own reasoning. Others relied on the AI tool as an explanatory resource, requesting clarifications, theoretical references, or alternative methods. A third group engaged in a more critical dialogue, explicitly questioning arguments, challenging logical inferences, and prompting revisions of the solution. The interactions with ChatGPT often led to improvements in the explicitness of theoretical justifications and in the organisation of the solving process. However, difficulties related to logical implication and deductive reasoning frequently persist, even after multiple exchanges with ChatGPT. Across the three interaction profiles, differences also emerged in the way students managed the logical chain. Critical-dialogue students were more likely to question inferential steps and request explicit justifications, whereas validation-oriented students tended to accept logical inferences without further examination. Explanation-seeking students used ChatGPT to make the logical chain more explicit, rather than to critically evaluate it. The study aims to contribute to discussions on the educational role of generative AI by shifting attention from the evaluation of AI outputs to the analysis of student interactions with AI tools [5, 6]. It highlights how the search for a satisfactory solution emerges as a negotiated process in which mathematical knowledge, evaluative criteria, and AI-generated explanations mutually influence one another. The findings provide insights into the opportunities and limitations of AI-supported formative assessment and raise further questions about the extent to which interactions with AI tools may shape students' mathematical reasoning practices and their approaches to justification and proof.

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Designing AI-Based Digital Tutors for Mathematics Learning: From Didactic Purpose to AI-Enhanced Activities

Cecilia Fissore[1[0000-0001-8398-265X]], Francesco Floris[1[0000-0003-0856-2422]], Marina Marchisio Conte[1[0000-0003-1007-5404]]

[1] Dipartimento di Biotecnologie Molecolari e Scienze per la Salute, Università di Torino, Turin, Italy
{cecilia.fissore, francesco.floris, marina.marchisio}@unito.it

1 Introduction and Theoretical Framework

While LLMs are being adopted more widely in educational contexts, their role in supporting mathematical learning remains controversial [1]: for example, they can provide students with immediate feedback and generate solutions that students can critically examine and discuss [2], but they may also reduce students' engagement in key cognitive processes such as modelling, generalisation, argumentation, and validation [3]. UNESCO's guidance on generative AI in education and research [4] stresses the need for educational institutions to validate GenAI tools ethically and pedagogically. At the same time, the Italian National Strategy for Artificial Intelligence 2024 – 2026 identifies education and training, including higher education, as strategic areas for developing AI literacy [5]. In the Italian context, these orientations are also reflected in school-level national guidelines [6] and in the growing effort of universities to define institutional guidelines for the use of AI in teaching, learning, assessment, and research, in line with national and international recommendations [7]. This contribution proposes a design framework for integrating AI-based digital tutors into mathematics learning activities to support a more intentional, pedagogically controlled, and critically informed use of LLMs.

2 AI-Based Digital Tutors for Mathematics Learning

The CHAT-ACTS framework highlights the potential of personalised chatbots to support active learning and self-regulated learning through feedback, planning, and evaluation [8]. In mathematics education, recent studies suggest that chatbots can improve the pedagogical alignment of generated resources, especially when the design accounts for task characteristics, multiple mathematical representations, and the relationship between exploration and justification [9]. They can support problem solving, conceptual clarification, error analysis, and autonomous practice by providing feedback. However, because LLM-based tutors may generate incorrect responses and encourage cognitive delegation, teachers must prepare students to use them critically. We distinguish AI-based conversational tools at three levels: a generic chatbot provides

broad and often non-contextualised answers; a tutorbot can be guided by course materials; a Retrieval-Augmented Generation (RAG) system connects the model to a curated knowledge base to ground its answers [10]. The digital tutor considered in this contribution is situated between tutorbots and full RAG-based systems: it is a conversational system that uses an LLM to generate linguistically plausible answers, but whose behaviour is intentionally shaped by the teacher through a system prompt. This contribution is design-oriented: a digital tutor is presented as an illustrative prototype of the framework, while empirical validation with students will be addressed in future work.

3 Designing Digital Tutors for AI-Enhanced Mathematical Activities

The proposed framework adopts a two-level approach: it considers both the digital tutor and the AI-enhanced mathematical activity in which the tutor is embedded. At the tutor-design level, teachers are guided to define the mathematical topic, the target students, the learning difficulties the tutor should address, the course materials or examples it should rely on, the type of support it should provide, and the interaction rules it should follow. Particular attention is given to the tutor's pedagogical role, tone, boundaries, and feedback strategy. To illustrate the framework, we present "Tutor Radiomath", a prototype AI-based digital tutor designed for first-year Radiology students who need support in a basic mathematics course. The tutor addresses topics such as functions, plane geometry, proportions, numerical computation, percentages, and logarithms through contextualised problems. It offers hints, guiding questions, and related exercises, providing the complete solution only after repeated attempts and supporting active learning, autonomy, and critical thinking. The digital tutor is meaningful only within a carefully designed mathematical activity. The design process can be organised into seven phases: defining the cognitive objective of the activity; identifying the evidence of learning students will produce; clarifying the role of AI as an assistant to interact with; planning what students do before using AI; structuring how they interact with the tutor during the activity; specifying what they produce after the interaction; and defining evaluation criteria focused on students' added judgment beyond the AI output. In this way, students receive explicit guidance on what to provide to the AI, what they must take responsibility for, and what they need to verify, with particular attention to interpretation, revision, and mathematical justification.

4 Conclusion and Future Work

The framework contributes to the design of AI-enhanced mathematics activities by shifting the focus from the digital tutor as a tool to the pedagogical conditions under which it is used. Future work will present the mathematical activity in which Tutor

Radiomath will be tested with students, and will analyse its effects on learning processes, students' experiences, and mathematical reasoning.

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From Answer Generator to Feedback Partner: Exploring Generative AI for Formative Feedback in Mathematics Teacher Education

Michele G. Fiorentino[0000-0003-1557-4878] and Antonella Montone[0000-0002-4450-1590]

University of Bari Aldo Moro, Bari, Italy
{michele.fiorentino, antonella.montone}@uniba.it

1 Theoretical Background of Feedback Literacy in the Age of Generative AI

Feedback is widely recognised as one of the most influential factors affecting learning and achievement [1, 2]. Within the formative assessment paradigm, feedback is not conceived as a simple transmission of information about correctness, but as a process that supports learners in understanding their current performance, identifying possible improvements, and regulating subsequent learning actions [1]. Effective feedback therefore requires active learner engagement and the ability to interpret, evaluate, and use information productively.

Recent developments in the field of feedback literacy have further emphasised the role of learners as active agents in feedback processes. According to this perspective, students should develop the capacity to appreciate feedback, make judgements about information received, manage emotional responses, and translate suggestions into concrete actions for improvement [3]. Consequently, the effectiveness of feedback depends not only on its quality but also on learners' ability to critically engage with it.

The emergence of generative Artificial Intelligence introduces new possibilities and challenges within this framework. Large Language Models can provide immediate, personalised, and scalable feedback, potentially overcoming some of the limitations that characterise higher education contexts, such as large class sizes and limited opportunities for individual support [4]. However, recent studies have also highlighted risks related to inaccurate feedback, hallucinations, excessive reliance on AI-generated responses, and the tendency of students to accept suggestions uncritically [5, 6]. These issues are particularly relevant in mathematics education, where the quality of reasoning and argumentation is often more important than obtaining a correct answer.

From this perspective, AI-generated feedback should not be evaluated solely in terms of accuracy, but also in relation to the ways students interpret, negotiate, and use the information received. This shift places feedback literacy and AI literacy at the centre of the educational debate, especially within teacher education programmes, where future teachers are expected to critically evaluate both mathematical arguments and technological resources.

Against this background, the present study addresses the following research question: (RQ) How do pre-service teachers interpret and use AI-generated formative

feedback when solving an open-ended mathematical problem, and how does this interaction shape changes in the quality of their mathematical reasoning and argumentation?

The study was conducted within the Italian PRIN 2022 project Artificial Intelligence & Feedback for Effective Learning (AI&F) and involved 220 pre-service primary teachers enrolled in the Elements of Geometry course at the University of Bari Aldo Moro. Participants worked in pairs to solve an open-ended mathematical problem concerning the equi-extension of parts of a rectangle, interacted with ChatGPT through a structured prompt designed to elicit formative feedback rather than direct solutions, and subsequently revised their answers. The unit of analysis consisted of 110 interaction protocols, each including the initial solution, the shared dialogue with ChatGPT, and the revised response. Protocols were analysed by comparing changes in mathematical reasoning across these three phases, with particular attention to the breadth, completeness, and explicit justification of students' arguments. Preliminary findings indicate that AI-generated feedback often encouraged participants to reconsider their initial assumptions, refine their reasoning, and provide more explicit justifications. The richest improvements were observed in protocols characterised by iterative cycles of questioning, clarification, and revision, where students actively engaged with the AI-generated feedback, moving from empirical and local arguments towards broader and more explicitly justified solutions.

At the same time, several critical issues emerged. Some students encountered misleading suggestions, inaccurate representations, or excessively verbose outputs generated by the AI system. Rather than merely constituting limitations, these situations often became opportunities for reflection and discussion, particularly when students critically questioned the feedback provided by the AI. The findings suggest that the effectiveness of AI-generated feedback depends not only on the quality of the generated responses but also on learners' capacity to critically evaluate and reinterpret them.

2 Conclusion

The findings suggest that generative AI can represent a valuable resource for formative assessment in university mathematics education when embedded within carefully designed learning activities. Rather than positioning AI as an answer generator, the findings support its role as a dialogic feedback partner that promotes revision, mathematical argumentation, and critical reflection, while complementing rather than replacing the teacher's pedagogical role.

The study highlights the importance of fostering both feedback literacy and AI literacy within teacher education programmes, enabling future teachers to critically interpret, evaluate, and use AI-generated feedback while recognising both its potential and its limitations. These findings contribute to the emerging field of AI-augmented mathematics education and provide initial design implications for AI-augmented technology-enhanced learning environments that intentionally integrate human and artificial agents to support mathematical reasoning and learning.

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Enhancing Mathematical Argumentation Through AI Tutoring: A Study Using ChatGPT in Upper Secondary Education

Umberto Dello Iacono [0000-0003-0224-1046] and Marco Picariello [0000-0001-6679-0533]

Università degli Studi della Campania Luigi Vanvitelli
{umberto.delloiacono,marco.picariello}@unicampania.it

1 Introduction

Argumentative competence is recognized as a key dimension of mathematical proficiency because it enables students to formulate, justify, communicate, and critically evaluate mathematical ideas. The OECD PISA Mathematics Framework identifies mathematical reasoning as one of the fundamental processes underlying mathematical literacy. Students are expected to make conjectures, justify conclusions, evaluate arguments, and communicate mathematical reasoning in a coherent manner [2]. Consequently, fostering argumentation has become an important objective of mathematics education, as it contributes to students' capacity to participate meaningfully in mathematical practices and to use mathematics critically and reflectively in a variety of contexts.

Generative Artificial Intelligence (GenAI) is emerging as a promising tool for supporting the development of students' argumentative skills. Recent studies have documented the growing use of ChatGPT in mathematics education, highlighting its potential to support mathematical reasoning, problem solving, and classroom interaction [4, 8]. Unlike traditional digital technologies, GenAI systems can engage in interactive dialogue, generate explanations, pose questions, and provide feedback on students' reasoning processes. These features create new opportunities for learners to articulate, justify, and refine their arguments in a variety of educational contexts.

The present study focuses on the use of ChatGPT. It may act as a conversational partner that encourages students to explain their thinking, identify weaknesses in their arguments, and consider counterarguments [1, 9]. In this study, ChatGPT is configured as an educational tutor to support upper secondary students' argumentation during mathematical problem-solving. It operates, through a sequence of carefully designed and iteratively refined prompts, to guide learners in analyzing the problem, identifying relevant mathematical relationships, justifying their choices, and reflecting the validity of their reasoning. Such an approach is consistent with recent research showing that interaction with ChatGPT, including the discussion of AI-generated errors, can promote mathematical exploration and self-learning [5].

The research question is as follows: (RQ) To what extent does ChatGPT, when properly configured to serve as an educational tutor, support upper school students in developing argumentative competence while solving mathematical problems?

2 Theoretical Framework

This study uses Toulmin's argumentation model and linguistic cohesion as theoretical frameworks. According to Toulmin [7], an argument is composed of interconnected elements, including a claim, the data supporting the claim, and the warrant that justifies the connection between them. This framework has been widely used in mathematics education research because it provides a useful lens for examining how students construct, justify, and communicate mathematical arguments.

Although Toulmin's model [7] provides a useful framework for analyzing the structure of arguments, it does not explicitly address the linguistic features through which arguments are communicated. For this reason, the present study complements Toulmin's framework with a linguistic perspective focused on textual cohesion. According to Halliday and Hasan [3], cohesion refers to the linguistic resources that connect sentences and ideas, giving text unity and structure. While coherence is a cognitive process, cohesion is achieved through explicit linguistic devices that help readers follow the progression of an argument [6].

3 The Study

This is an exploratory study that adopts a pre–post intervention design aimed at exploring how interaction with ChatGPT, configured as an educational tutor, may support the development of argumentative competence during mathematical problem-solving activities. Participants were six students attending the third, fourth, and fifth year of an upper secondary school (Human Sciences and Music programs) in southern Italy. The intervention was conducted over four weeks, and it consisted of three phases. In the first phase, students individually completed a paper-based OECD-PISA mathematical task, selected because of its strong potential for eliciting mathematical argumentation. In the second phase, the students worked collaboratively in small groups, interacting with ChatGPT, which was configured through a structured prompting strategy based on the adopted theoretical framework to encourage students to explain their reasoning, justify their mathematical choices, consider alternative interpretations, and progressively refine their arguments. In the third phase, students tackled a second paper-based task similar to the one in the first phase, to explore any changes in their argumentative competence following the tutoring experience with ChatGPT.

The two authors jointly analyzed the students' written productions by identifying the main components of mathematical arguments according to Toulmin's model (claims, data, and warrants) and examining indicators of textual cohesion, including the use of connectives and lexical repetition, to evaluate the clarity and organization of students' written explanations. The results suggest that using ChatGPT as an educational tutor appears to have contributed to improvements in the quality of students' mathematical arguments: in the third phase, the students formulated clearer claims, provided more explicit justifications, and produced more cohesive written explanations than in the first phase, with more frequent use of connectives and lexical repetition than in the first phase, linking their conclusions to the underlying mathematical reasoning; the use of

connectives and lexical repetition contributed to the clarity and organization of their written explanations. Overall, the results seem to indicate that ChatGPT, when properly configured, can foster the development of argumentative and communicative skills in high school students. The integration of Toulmin's model with textual cohesion has provided a valuable perspective for the evaluation of mathematical argumentation. In this sense, it should be considered a theoretical contribution of this study. Since these findings are preliminary and based on a small sample, they should be interpreted as exploratory and will require further validation through larger-scale studies.

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Special Track 13

Gameful learning in higher education: experiences, methodologies and best practices.

Organizers:
Andrea Tinterri, Pegaso University, Italy
Massimiliano Andreoletti, Catholic University of the Sacred Heart, Italy

Casual Games and Soft Skills Development in Higher Education: An Exploratory Case Study on Keep Talking and Nobody Explodes

Angelo Mirra1[0009-0004-0398-2158] and Maria Cinque2[0000-0001-7526-7728]

[1 2] Lumsa University, Rome 00193, Italy
a.mirra@lumsastud.it
m.cinque@lumsa.it

1 Introduction

Over the past two decades, interest in the educational use of video games has grown substantially, particularly within game-based learning (GBL) research on disciplinary knowledge and transversal competences [1–4]. Digital games can function as complex learning environments in which players act and progressively construct meaning [5]. Empirical research has concentrated mainly on serious games designed explicitly for educational purposes, while commercial or casual games remain comparatively underexplored [6].

2 Study Context

In 2025, an exploratory pilot case study was conducted over one week in the School of Applied Psychology at University College Cork (UCC), Ireland. The participants were eight second-year students, organized into four pairs. The study formed part of the doctoral research undertaken within the PhD program in Learning Sciences and Digital Technologies (XXXVIII cycle) at LUMSA University. The educational setting was deliberately small-scale and intensive, enabling close observation of interaction during repeated cooperative gameplay.

3 Research Aim and Questions

A PRISMA-informed literature review on GBL, soft skills, and personal values in higher education indicated that most empirical studies concern serious games, leaving a gap regarding the structured educational use of commercial cooperative games [6,7]. We examined Keep Talking and Nobody Explodes, a cooperative game in which players must work together while assuming different roles. We investigated whether the game could provide a meaningful context for fostering the development of soft skills and associated personal values.

Two research questions (RQ) guided us:

RQ1. How are communication, active listening, teamwork, perspective-taking, decision-making, problem-solving, and related personal values manifested during cooperative gameplay with a commercial cooperative game?

RQ2. What descriptive changes in these behaviours and in participants' self-perceptions can be observed across repeated matches and role rotation?

4 Methodology

A mixed-methods design was adopted, combining quantitative self-report data with qualitative observation and interviews; to triangulate participants' perceptions with evidence of interaction during gameplay, drawing on an ethnographically informed approach [8]. Data collection was organized into three phases:

Phase 1 – Baseline. Participants completed the Soft Skills and Personal Values Questionnaire and took part in a semi-structured interview.

Phase 2 – Gameplay. Each pair played Keep Talking and Nobody Explodes, alternating in different game roles.

Phase 3 – Post-activity. The questionnaire and semi-structured interviews were used to examine participants' perceived changes and reflections on the experience; video recordings were analysed alongside the Cooperative Performance Metrics (CPM).

4.1 Quantitative data

- The Soft Skills and Personal Values Questionnaire. Previously used in a PhD research project on "Contemporary Humanism" within the European project "Virtual Service-Learning and Active Citizenship Skills," coordinated by the EIS School at LUMSA University [9].

4.2 Qualitative data

- The Cooperative Performance Metrics (CPM), developed by Seif El-Nasr et al. [10] and subsequently examined in cooperative gameplay research by Gorman and Linehan [11], provided a structured framework for coding cooperative behaviours during the sessions.
- Video recordings captured each pair's interaction and supported the CPM-based analysis.

5 Results and conclusion

Across repeated matches, the CPM-based observations indicated progressively more effective communication, teamwork, active listening, and perspective-taking. Performance appeared to be influenced by pre-existing familiarity between partners. Ques-

tionnaire responses and post-activity interviews also indicated more positive self-perceptions of the soft skills most directly activated by the game. These data suggest that the activity offered a meaningful setting in which such competences could be observed and discussed; they do not, however, demonstrate that the game independently caused improvement. The findings suggest that a commercial cooperative game can be educationally useful when embedded in an intentionally designed sequence. The principal limitations are the very small, non-random sample (four pairs), the short duration, the limited number of gameplay trials, the reliance on self-report measures, and the absence of a comparison group. The results are therefore not generalisable, but they support further research with larger samples, clearer pre/post measures, documented debriefing procedures, and more detailed reporting of quantitative and qualitative evidence.

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Promoting Engagement and Agency through Gamefulness: Lessons from UTOPIA, an Immersive Edu-LARP Methodology for Higher Education

Piera De Gironimo[1[0009-0007-5502-4519]], Alan Mattiassi[2[0000-0002-9996-0700]] and Martina Montenegro[3]

[1] University of Cassino and Southern Lazio, 03043 Cassino, Italy
[2] Game Science Research Center, 55100 Lucca, Italy
[3] Eryados ETS, 00123 Rome, Italy
piera.degironimo@unicas.it; alan.mattiassi@gmail.com; martina.montenegro21@gmail.com

1 Introduction

Gameful learning asks us a tough but essential question: how can we rethink educational environments to make learning more engaging and meaningful? [1, 2] The concept of introducing structure, rules, roles, negotiation of meaning, lusory goals and orchestrating them in a connected and functional system (a game) might indeed constitute the methodological answer to that question [3, 4]. This paper reflects on this hypothesis by analyzing UTOPIA, a participatory project aimed at Generation Z that leverages Educational Live Action Role-Playing (Edu-LARP) to build real-world skills [5, 6]. This integration of immersive simulation and civic education represents a highly innovative pedagogical approach within the Italian national educational landscape. While the project originally targeted upper secondary school students, the lessons we learned offer highly adaptable insights for other education contexts, both as results of applied experimentation and in bridging the gap between instructional design and applied research. Since the observed dynamics of negotiation, distributed leadership, and psychological safety depend on the systemic structure of the game rather than the participants' age, these findings are directly transferable and scalable to higher education contexts.

2 Context and Methodology

During the sessions carried out between February 2024 and April 2025, we involved over a hundred students aged 15 to 19. The project was facilitated by a multidisciplinary team of educators and Edu-LARP designers from Eryados ETS in collaboration with five upper secondary schools across Italy (IIS Carlo Matteucci, IIS Einstein-Bachelet, and Liceo Tito Lucrezio Caro of Rome, ITT Leonardo Da Vinci of Viterbo, ASLAM of Samarate, Varese).

Participants were immersed in a scenario inspired by William Golding's *Lord of the Flies*. Mirroring the novel's plot, the premise was simple yet daunting: society

has collapsed, and it is up to them to rebuild it entirely without adult rules. Our instructional design moved through several stages. We started with classroom debates on urgent issues like climate change and civic duty, moved into Edu-LARP workshops, and culminated in a 7-hour site-specific immersive simulation, followed by individual debriefing interviews. Taking on diverse roles—from rebels to artists and athletes—students had to navigate incredibly complex social dynamics, confronting both psychological factors and narrative developments [7, 8].

3 Results

To assess the development of the declared skills, data collection procedures involved qualitative online questionnaires and 110 individual post-simulation debriefing interviews exploring themes of civic duty and social responsibility. The results suggest that indeed gameful approaches, and specifically immersive approaches like this, shift the educational focus from mere knowledge transmission to tangible competence building. Crucially, the qualitative corpus reveals that the experience did not simply alter students' opinions, but fundamentally reshaped their cognitive frameworks, shifting them from simplistic, grade-driven academic compliance toward systemic, contextual reasoning.

A major impact on crucial soft skills, such as complex problem-solving, conflict negotiation, and collaborative leadership has been detected, echoing the necessity of practical improvisation in complex scenarios [9]. Specifically, qualitative data revealed that the simulation effectively pushed students to navigate real societal challenges: in-game challenges like unequal resource distribution and the inefficiency of the charismatic leaders they initially elected organically triggered spontaneous peer-to-peer negotiations and the assumption of civic responsibilities. Thematic analysis revealed an emergent shift toward distributed leadership and cooperative negotiation.

Furthermore, the fictional roles acted as psychological safety facilitators: by lowering the social cost of interaction, the playing frame allowed participants to experiment freely. This translated into an enhanced sense of personal agency, transitioning from passive critique to active positioning regarding civic duties. Finally, students articulated a sophisticated demand for adaptive scaffolding, showing that giving them the agency to be active protagonists visibly boosted their motivation, autonomy, and psychological well-being [10, 11].

4 Conclusions

By unpacking the impacts and the challenges of the UTOPIA experience, this contribution explores the transformative potential and the scalability of immersive gameful simulations. We argue that game-based strategies can effectively break down traditional institutional barriers, offering a practical, engaging model to foster active citizenship, transversal skills, and personal agency in higher and adult education contexts.

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Gamified Learning in Higher Education: A Mixed-Methods Experimental Study on Student Engagement, Motivation and Participation

Davide Di Palma[0000-0001-8224-5797], Fabiola Palmiero[0009-0003-1883-6295], Giovanna Scala[0009-0003-9277-8580] and Margarita Bogdanova[0000-0001-5603-9666]

Università degli Studi della Campania "Luigi Vanvitelli", Department of Psychology, Caserta, Italy
davide.dipalma@unicampania.it, fabiola.palmiero@unicampania.it, scala.nina001@gmail.com, margarita.bogdanova@unicampania.it

1 Introduction

Research on digital and blended teaching reports declining participation, weaker peer relations and a reduced sense of academic belonging [1, 2]. Gameful learning [3] is often proposed as an answer, yet its application has rested largely on points, badges and leaderboards, which risks reducing participation to reward-driven performance [4, 5]. Reviews confirm effects on engagement and motivation [6, 7, 8] but note a reliance on self-report and few mixed-methods designs [9].

Drawing on Self-Determination Theory [10] and socio-constructivist accounts of learning [11], this study asks whether an eight-week gameful intervention affects engagement, intrinsic motivation and academic belonging.

2 Method

2.1 Design and Participants. A quasi-experimental mixed-methods design [12] was applied in a pedagogy degree programme at an Italian university in 2024/25. Eighty-four second- and third-year students aged 19 to 27 (M = 22.4, SD = 2.1) formed an experimental group (n = 42) and a control group (n = 42) drawn from two pre-existing classes. Both covered identical content with the same lecturer and workload, differing only in teaching method; pre-test scores showed no significant difference.

2.2 Intervention. The experimental group worked for eight weeks in a blended gameful ecosystem. After an onboarding week, students formed teams of four or five and operated as educational design teams within a shared narrative frame. Weekly missions comprised collaborative case analysis, the design of teaching activities, shared production of digital content, micro-tasks and peer discussion, with difficulty rising in line with scaffolding principles [13]. Feedback was continuous, automated on the platform and qualitative from the lecturer, who acted as facilitator. Badges marked participation, collaboration and problem solving and were kept apart from rankings and rewards. The control group followed conventional lectures and guided discussion.

2.3 Instruments and Analysis. Engagement, intrinsic motivation and belonging were measured before and after with the Student Engagement Scale, the Intrinsic Motivation Inventory and the Psychological Sense of School Membership Scale, all seven-point, with Cronbach's alpha above .80. Data were processed in SPSS 28 with paired and independent samples t tests ($p < .05$). Qualitative material came from two focus groups of about ten participants, ten semi-structured interviews of 35 to 45 minutes and weekly reflective journals, transcribed in full and coded thematically [14] through open and then axial coding, with attention to divergent accounts.

3 Results

Post-test scores differed significantly on all three measures (Table 1).

Table 1. Post-test comparison between the two groups.

Variable	EG M (SD)	CG M (SD)	p
Engagement	4.31 (0.42)	3.42 (0.47)	< .001
Intrinsic motivation	4.45 (0.39)	3.57 (0.45)	< .001
Sense of belonging	4.22 (0.40)	3.48 (0.44)	< .001

Within the experimental group, emotional engagement rose most (3.14 to 4.42), followed by cognitive (3.09 to 4.37) and behavioural engagement (3.39 to 4.15), all at $p < .001$, while interest and enjoyment (3.28 to 4.58) and perceived competence (3.35 to 4.39) showed the clearest motivational change. The control group improved on none.

Six themes emerged, namely emotional engagement, continuity of study, peer collaboration, perception of learning, the role of the student and belonging. Students tied continuity of participation to the weekly structure rather than to assessment, one reporting weekly involvement driven by interest rather than by an approaching examination. Belonging was described as recognition within the group rather than attendance.

Some students nonetheless found the participation demanding, some preferred conventional lecturing, and groups differed in leadership and task distribution.

4 Discussion and Conclusion

The findings align with Self-Determination Theory [10], since the elements students tied to change, namely feedback, graded challenge and team work, correspond to autonomy, competence and relatedness. The gain on the relational measure suggests that such outcomes rest on how collaboration is designed rather than on game elements as such [5, 9].

Convenience sampling, the absence of randomisation and the short intervention limit generalisation, and longitudinal work is needed to test whether the effects persist.

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Observing Collaboration during a Serious Game session: A Multi-Method Assessment Framework Using SYMLOG and Self-Report Measures

Isabella Giacchi[1][0009-0005-7675-4081] and Marika Mascitti[2][0009-0008-6534-4468]

[1] Roma Tre University, Rome, Italy
[2] University of Bologna, Bologna, Italy
isabella.giacchi@uniroma3.it
marika.mascitti@unibo.it

1 Introduction

Collaboration is widely recognized as a core twenty-first century skill, positively affecting cognitive, emotional, and social outcomes [1,2]. Observing and measuring collaborative skills in groups, however, remains methodologically challenging because it is a complex construct influenced by individual, group, and contextual factors [3]. Systematic behavioral observation offers a valuable approach to capturing these dynamics in small-group interactions [4,5]. In particular, the Systemic Multiple Level Observation of Groups (SYMLOG) is an instrument deriving from the field of social psychology that provide a structured framework for mapping interpersonal behaviors along the dimensions of Dominance, U-D; Friendliness, P-N, and Task-Orientation, F-B [6,7].

Serious Games (SGs) offer a promising context for observing collaboration, as their educational purpose and engaging nature encourages authentic interactions and more naturalistic collaborative behavior, promoting motivation and engagement [8]. Nevertheless, most studies rely on a single assessment perspective, such as self-report, behavioral observation or game logs [9]. Berdun et al. [10] provided a notable example of this integration, combining SYMLOG with an online collaborative game to automatically derive players' profiles from their in-game actions. Building on this work, the present study proposes a multi-method assessment framework combining expert observation, self-assessment and peer-assessment through the SYMLOG framework, together with validated self-report measures of collaborative disposition collected before gameplay. The framework aims to explore convergences and discrepancies across assessment perspectives within the same SG session. This multi-method design enables the investigation of convergences and discrepancies across assessment sources, providing a richer understanding of collaborative behavior.

2 Methodology and instruments

The pilot study involved 11 Master's students participating in a single session of the SG "The Mystery of Cremsonville", organised into three small groups of three to four

players. The sample size reflects the pilot nature of the study, whose primary aim was to assess the feasibility of the proposed assessment framework. The study adopted a within-subject multi-method design including validated self-report measures administered before gameplay (T0), experts' observation of collaborative behaviors using SYMLOG during the game session, and self- and peer-assessment based on the SYMLOG dimensions after gameplay (T1).

Three research questions guide the study: RQ1. What SYMLOG profiles (in terms of Dominance, U-D; Friendliness, P-N, and Task-Orientation, F-B), are associated with individuals who self-report higher collaborative disposition at T0? RQ2. Do SYMLOG profiles converge across different perspectives, and where do systematic divergences emerge? RQ3. Is collaborative disposition positively associated with post-game satisfaction, and does this association vary as a function of individual characteristics such as gaming familiarity and habitual study modality?

Before gameplay participants completed validated questionnaires (T0) assessing sense of community in online courses, teamwork orientation, prosocial behavior [11–15]. Socio-demographic items covered gender, age, academic year, study habits, and gaming familiarity. During gameplay, interactions were video-recorded and independently coded by two expert observers using the 26 SYMLOG behavioral vectors [6]. After the session, participants completed both self- and peer-assessments (T1) using ARF-S (self-rating on all three SYMLOG dimensions) and the ARF-P (peer ratings for every other group member on the same dimensions).

2.1 Statistical Analyses

All analyses are exploratory given the pilot nature of the study (N = 11). Data analyses were conducted using IBM SPSS Statistics 25.0 software. Exploratory analyses include descriptive statistics, Spearman correlations between dispositional measures and SYMLOG dimensions, agreement analyses across expert, self- and peer-ratings, and comparisons of the resulting behavioral profiles. The significance level was set at $\alpha = .05$. All findings are preliminary and hypothesis-generating.

3 Expected Contributions and Significance

The study offers two primary contributions. First, unlike previous studies relying on a single assessment perspective or combining only behavioral logs with SYMLOG, this framework proposes a three-level observational protocol (expert observer, self-report, and peer-report) applied to the same gaming episode through the common metric of SYMLOG, addressing the single-perspective limitation that characterizes most extant SG collaboration research [8,9] and enabling examination of self–other discrepancies as data in their own right. Second, by anchoring SYMLOG profiles to validated pre-game measures of collaborative disposition, the study contributes to the gap of operationalizing cooperative behaviors in game-based learning [9], while providing a replicable protocol for future larger-scale studies. Limitations include the small sample (N = 11), which severely limits statistical power; the single-session design, which may

not capture stable collaborative patterns; the sensitivity of the ARF to observer bias and social desirability; and the context-specificity of the game, whose cooperative structure and time pressure may elicit collaborative behaviours not generalisable to other SG formats. Future work should address these constraints through larger and more diverse samples, longitudinal designs, and additional observational modalities.

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A Design Thinking-Based Model for Inclusive Gameful Learning and Teacher Training in Educational Game Design

Arianna Goldoni[1] and Marco Cremaschi[1,2]

[1] Department of Informatics, Systems and Communication - DISCo, University of Milano-Bicocca, Milan, Italy
a.goldoni1@campus.unimib.it, marco.cremaschi@unimib.it
[2] Whattadata S.r.l., Milan, Italy

GIGI EduLab addresses the need to rethink digital education as an inclusive, experiential, and competence-oriented process. The project proposes an educational game design method grounded in Design Thinking, in which videogame creation becomes a pedagogical device for digital empowerment, active participation, accessibility, and the development of transversal competences. The project assumes that digital competence develops through interpreting, designing, testing, and discussing digital artefacts. Educational game design is therefore treated as a structured learning process connecting narrative, interaction, coding, collaboration, and reflection.

The proposal is aligned with research on game-based learning and gameful learning, which emphasizes the role of games in supporting cognitive, motivational, affective, and sociocultural engagement [1]. It also draws on constructionist traditions in which learners build public artefacts in order to think with and through technology [2, 3]. Compared with approaches that apply isolated game elements to non-game contexts, the project focuses on learning by game design: participants analyse problems, imagine possible worlds, define mechanics, prototype playable solutions, and revise them through feedback. This distinction matters because gameful learning can lose educational value when it is reduced to points, badges, or external incentives. A design-centred approach instead foregrounds agency, meaning-making, iteration, and the relationship between game mechanics and learning intentions [4, 5]. This contribution addresses the following research question: How can a Design Thinking-based educational game design model foster inclusive gameful learning while supporting teacher professional development?

The methodological framework follows the main phases of Design Thinking: empathy, definition, ideation, prototyping, and testing. These phases are adapted to educational contexts and used as a scaffold for collaborative game creation. Students and teachers collaboratively identify users' needs, develop game concepts, prototype solutions, and iteratively refine them through testing and feedback. This cycle reflects the educational value of Design Thinking as an analytic and creative process that promotes experimentation, feedback, and problem solving [6].

The project was developed over two school years and started from an initial pilot with a mixed group including students with disabilities. The experience

showed that educational game design can create a flexible learning environment in which students contribute according to different abilities, interests, and available resources. Some participants focused on narrative and visual imagination, others on rule systems, interaction logic, testing, debugging, or peer support. This distribution of roles made participation less dependent on a single expected performance profile and allowed the group to value different forms of competence. The main effects observed concerned autonomy, problem solving, collaboration, creative confidence, and engagement, especially when tasks were open-ended and adaptable rather than narrowly procedural. Qualitative evidence was documented through the analysis of the educational game projects developed by participants, the videogame prototypes produced during the workshops, and the feedback collected from the participating school staff.

From an inclusive education perspective, **GIGI EduLab** is based on the idea that accessibility should not be added at the end of a learning design, but embedded in the structure of the activity. The game design process supports multiple forms of expression: verbal, visual, spatial, procedural, narrative, and computational. This makes it compatible with Universal Design for Learning principles, which recommend multiple means of engagement, representation, action, and expression [7]. It also resonates with inclusive pedagogy, where the aim is not to create separate tracks for specific learners, but to extend what is ordinarily available to everyone in the classroom [8]. In the project, technology becomes a medium for communication and co-construction rather than a barrier or a fixed sequence of technical tasks.

Teacher training is the core of the proposed model. The objective is not only to report a classroom experience, but to make the method transferable to educators who can integrate it into their own practice. For this reason, **GIGI EduLab** adopts a pyramidal dissemination logic: the method is tested in a real environment, refined across different situations, and transferred to teachers through structured professional development activities. This orientation is consistent with research showing that effective professional development requires active learning, coherence with practice, sustained duration, and opportunities for collaboration and reflection [9]. It also connects with DigCompEdu, which positions educators as designers of digitally mediated learning experiences rather than as mere users of technological tools [10].

GIGI EduLab presents gameful learning as a scalable method for inclusive digital education and teacher development. Although piloted in schools, it supports higher-education teacher preparation and technology-enhanced learning design. By linking mechanics, feedback, roles, accessibility, and learning goals, it operationalizes technological, pedagogical, and content knowledge [11]. Future work will validate the model in higher education and faculty-development programmes.

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Designing Gameful Experiential Learning Environments for Technical Transversal Skills in Higher Education: A Process-Oriented Model

Manuela Furlan[1] and Alessandro Cerri[2]

[1] Management and Healthcare Laboratory (MES), Institute of Management, Sant'Anna School of Advanced Studies, 56127, Pisa, Italy
[2] Independent Researcher and Organizational Psychologist, 55100, Lucca, Italy
Manuela.Furlan@santannapisa.it
Info@alessandrocerri.com

1 Introduction

Higher education must prepare professionals for complex, interdependent contexts, particularly in healthcare, where effectiveness relies on both technical and transversal competencies. This has increased interest in approaches that foster communication, teamwork, and adaptive problem solving beyond knowledge transmission. The paper presents a process-oriented experiential model progressively refined through approximately fifteen years of healthcare leadership education at the Sant'Anna School of Advanced Studies, involving about thirty executive healthcare management classes and approximately one thousand healthcare professionals. Although developed within healthcare managerial programmes, the model is transferable to higher education and other complex organizational contexts.

2 Theoretical Background

Experiential learning conceptualizes learning as a cyclical process integrating experience, reflection, conceptualization, and experimentation [1], consistent with adult learning approaches emphasizing experience-based and problem-centered learning [2]. Transversal and non-technical skills are increasingly recognized as critical across professional domains [3-5]. Reflection and critical examination of assumptions and mental models, consistent with double-loop learning [6], further support awareness, behavioral change, and transferability in complex contexts.

3 Training Model

3.1 Experiential Learning Cycle

The model follows Kolb's experiential cycle through collaborative activities characterized by uncertainty and interdependence. Reflection, conceptualization, and experimentation transform experience into learning, while analogical distance and feedback support awareness and adaptation [7, 8].

3.2 Closed-Loop Experiential Design Framework

Learning activities operate as a closed-loop system combining objectives, constraints, resources, rules, and stressors, creating a dynamic environment in which action, feedback, and reflection remain interconnected, supporting the development of transversal skills [9].

3.3 Gameful Learning Perspective

The model can also be interpreted as a gameful learning environment in which goals, constraints, and feedback sustain engagement [9]. Challenging goals, psychological safety, and constructive interdependence promote concentration, reflection, trust, and collaboration [10-14]. Together, the experiential cycle, the closed-loop framework, and the gameful perspective form an integrated design architecture for managerial development in complex organizational contexts (see Fig. 1).

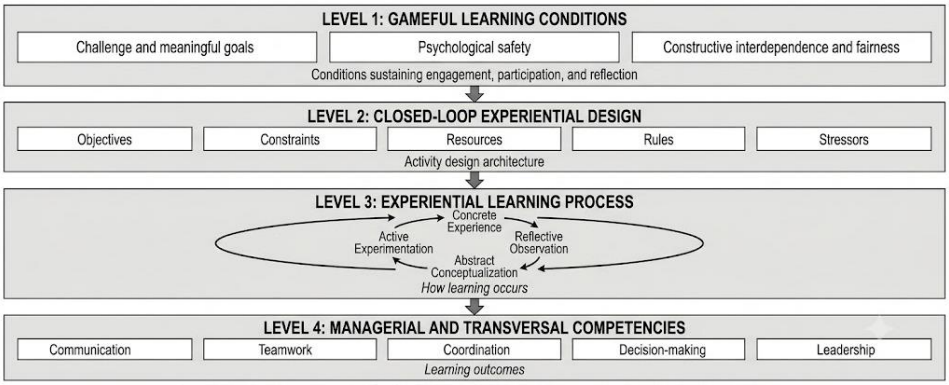

Fig. 1. Integration of gameful conditions, closed-loop activity design, and experiential learning processes within the proposed model

4 Conclusion

Developed within healthcare managerial programmes, the model combines experiential and gameful elements to support engagement, psychological safety, and collective efficacy [12, 15]. An ongoing questionnaire involving Directors of Complex Healthcare Units in Tuscany is examining its impact on transversal competencies, with preliminary results expected at the conference. Rather than proposing a new learning theory, the paper formalizes a process-oriented experiential design approach, progressively refined through healthcare managerial education, transferable to higher education, and other complex organizational contexts. By integrating process awareness, reflective practice, and conditions of challenge, safety, and fairness, it supports collaboration and behavioral development in complex systems, with potential applications across university, online, and blended settings.

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“Learning through Play” Using Digital Technologies: A Study Involving Preschool Teachers and Five-Year-Olds

Cristiano Zappa [0009-0000-7567-4649]

eCampus University, Novedrate CO, ITALY

cristiano.zappa@studenti.uniecampus.it

1.Introduction

This study aims to investigate the potential of play with digital technologies to serve as both a key resource and a powerful learning tool [1] for preschool children.

The aim is to promote empirical research that engages teachers in finding answers to a concrete problem: namely, what correlation exists between digital play and learning [2].

Consequently, it seeks to identify solutions or make adjustments within an “innovative/modifying process” [3] of teaching and learning practices mediated by digital and educational technologies.

These findings are of potential interest to practising teachers and coordinators in preschools, professional educators, and trainee teachers enrolled in faculties of Primary Education and Educational Sciences [4].

2.Objectives and Methodology

Structurally, the research project involves preschool teachers from the Milanese association of preschools, *Associazione Milanese Scuole Materne* (A.MI.S.M.), as co-researchers.

The overall organizational framework comprises eight preschools, eight pedagogical-educational coordinators, 20 teachers, and 53 five-year-old children (the reference group), who participate in four play sessions specifically designed and organized by the teachers.

These sessions are divided as follows: two sessions documented using an observation sheet titled "Digital device chosen by the teacher," and two sessions documented using an evaluation sheet titled "Digital device chosen by the child”.

Specifically, during the first two sessions, the teacher selects a digital device for the children to use during play. In the subsequent two sessions, the teacher sets up a play area equipped with toys, structured and unstructured materials, as well as digital tools and devices (in single or multiple units, of the same or different types), leaving the children free to choose whether to play with a digital device or any other available material.

The specific objective is to compare the children's actions and interactions across two different play modes: play involving the use of a digital device selected by the

teacher (the first two sessions) and play involving the use of a device or object chosen autonomously by each child (the subsequent two sessions).

Play-based interaction with digital devices takes place under the teacher's guidance. At an operational and procedural level, the research process is based on the qualitative model of action research. Furthermore, to support the teacher-researchers, Bell's cyclical model [5] was adopted and adapted to this specific context in order to clearly define the phases, timelines, actions, activities, and tools required for the precise implementation of the research stages.

3.Results

The analysis of the documents provides evidence supporting the three constitutive pillars of the "learning through play" (ludomatetico) model, as formulated by Scurati [6] and adopted by Francipane [7], Salati [8, 9], and Chiappetta Cajola [10], within the context of various play configurations involving digital devices.

The data confirm the following pedagogical elements promoted by the teachers:

1. An active and proactive teacher presence; moreover, a disposition toward care and nurturing [11] emerges, expressed through attitudes of closeness, attentiveness, and receptiveness toward children engaged in media-based play;
2. A learning environment structured around the elements that constitute the implicit curriculum [12];
3. The conventional use of digital play as the predominant form of play, referring to: the number of devices available to children per play session; the introduction of media as daily play tools; the informed use of the features of the provided or chosen digital devices (e.g., interactive whiteboards, digital cameras, digital microscopes); the appeal of digital media for play (particularly the use of tablets and apps); and the observation and repetition of peers' actions.

4.Conclusion

In light of the scenario outlined above, the "learning-through-play" (ludomatetico) model defines the professional role of preschool teachers across three interconnected areas of practice: the educational relationship, the organization of the learning environment, and curriculum planning.

At the same time, this model is considered "an essential foundation for the development of digital skills, enabling pupils to access technological resources and receive professional support" [13].

Indeed, schools tailored to children must regard play [including digital play] as a normal activity, and one fully integrated into the curriculum [7].

From this perspective, play is an educational tool that engages all aspects of the individual. Consequently, play experiences deserve the utmost importance in the continuing professional development of preschool teachers and, more broadly, within the educational sector [14].

Moreover, the use of digital media in play "does not erase physicality, but revitalises it in new forms, making it a crucial aspect of our ability to feel, think, and connect with others" [15].

In fact, "'digital play' is not a degeneration of traditional play, but an evolution that integrates physical, symbolic, and social dimensions in new ways" [16].

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Beyond points, badges and leaderboards: narrativizing the digital gamification

Delio De Martino[1[0000-0003-3107-1816]], Bianca De Vivo[1[0009-0008-8127-5407]], Valeria De Padova[1[0009-0006-3282-3820]], Andrea Tinterri[1[0000-0001-5891-505X]], Anna Dipace[1[0000-0001-9826-073X]]

[1] Pegaso Telematic University, Naples, Italy
delio.demartino@unipegaso.it; bianca.devivo@unipegaso.it; valeria.depadova@unipegaso.it; andrea.tinterri@unipegaso.it; anna.dipace@unipegaso.it

1 Introduction

In recent years a new narrative trend in the field of gamification is emerging. After the spreading of gamification digital apps based on multiple-choice text in the first decade of the new millennium [1, 2] just in recent times, an evolution of these digital tools is changing the game. The playful elements of the test, as badge, points, leaderboards, challenges, levels and streaks, are being inserted within narrative design marks. The most famous is Kahootopia!, a virtual island, inserted in Kahoot! app [3, 4] and built with the punctuation bonus recollected during the multiple-choice test. The island turns the dynamic of the playful section to a new level in the direction of a videogame-like design.

Another similar tool is the escape room by Genially [5], where the user has to unlock the room to achieve some goals. In these innovative tools we could analyse the crossing between classic gamification and storytelling: the user is inserted in an ergodic narration. Indeed, it is a diegetic tale not entirely written by the author, as in the classical book storytelling, but co-constructed with the cooperation of the user.

The player, thanks to the branching narrative, can choose what direction to give to the narrative plot. The tool contains only the underlying principle of an experience that needs to be completed by the active participation of the user. This change could bring to a new level the learning innovation enhancing the learning thanks to the combination and integration of methodological elements of traditional gamification and digital storytelling. The study aims to go into the detail of this recent, and still little explored by literature, phenomenon verifying what are the specific narrative tools in gamification platforms, how they are designed in combination with the gamification structure and the dynamic of these narrative games.

2 Methodology

This study adopts an integrative scoping review approach. The initial identification of relevant gamification platforms was informed by existing literature on widely used

educational gamification tools [6] and further refined through three recent systematic literature reviews on gamification in education [7, 8, 9]. Together, these reviews constitute an evidence base of over 260 primary studies published between 2013 and 2025, spanning higher, secondary, and primary education contexts. Platforms were primarily selected from those explicitly reported in at least one of the included systematic reviews and incorporating gamification mechanics with potential narrative or adaptive features.

The systematic reviews were used as the primary evidence base for identifying trends in educational gamification. This corpus was complemented by the analysis of widely adopted narrative-oriented educational platforms, including Genially-based escape rooms, in order to capture emerging practices not yet fully represented in the review literature. Non-educational tools, non-functional prototypes, and single-institution experimental systems were excluded. This process yielded the set of platforms discussed across the three categories in Section 3. A secondary qualitative analysis coded each platform against narrative-related indicators (e.g., branching pathways, diegetic framing, user-driven progression) derived inductively from the literature, from which the three categories below emerged.

3 Preliminary Results

The analysis identified three main categories of gamification and narrativization structures. (1) Achievement-based legacy systems, built around points, badges, and leaderboards, remain dominant across the reviewed corpus (badges: 62.4%; points/scores: 61.3%; leaderboards: 52.7%, [9]) and constitute the structural baseline onto which other elements are layered. (2) Quest- and challenge-based progression systems, reported in 44.1% of studies analysed by [9] and corroborated by [8], represent a common mechanic in widely used commercial platforms (e.g., Kahoot!, Quizizz, Classcraft, ClassDojo), and mark an intermediate step toward non-linear, goal-oriented task sequencing. (3) Narrative-augmented platforms, combining gamification mechanics with storytelling or branching content, remain comparatively rare: [7] reports that only 20 of 39 analysed empirical studies employed any "deeper" game element, with narrative/storytelling implementations remaining a minority even within this subset. This category is exemplified by narrative-enhanced gamification environments such as Kahootopia! and Genially-based authoring platforms, which integrate storytelling, progression mechanics, and branching learning pathways within gamified educational experiences. Across the reviewed studies, adaptive technologies and, more recently, artificial intelligence emerge as promising enablers of more personalized and narrative-oriented gamification experiences.

4 Conclusions

AI-driven educational gamification increasingly integrates narrative elements, potentially fostering learner engagement and agency. This study provides a first step toward investigating their effectiveness both online and in-person learning environments.

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“Constructing” History Together: Constructionist Gaming as a Public History Practice in Higher Education

Lorenzo Natali[1][0009-0002-3179-0060] and Emiliano Pino[2] and Renzo Repetti[3][0000-0002-5825-8659] and Mattia Drago[4]

[1] Università degli Studi di Genova – CNR/Itd Lorenzo.natali.r@gmail.com
[2] Università degli studi di Genova Emiliano.pino@edu.unige.it
[3] Università degli studi di Genova Renzo.Repetti@unige.it
[4] Nexludica

This paper investigates whether Constructionist Gaming (CG) can operationalize the principles of Public History within higher education by translating them into concrete design practices, while offering an educational experience able to promote deep learning and the development of subject-specific and cross-curricular skills. The CG methodology was applied at the University of Genoa, within the context of the "Public History approach-based" programmes on Modern History and History of Modern Culture and Society taught by Professor Renzo Repetti.

The two courses were based on the theoretical paradigm of Public History, conceived by Robert Kelley (1976) as history applied in the service of extra-academic institutions and policymaking[1]. In 1990, Michael Frisch introduced the concept of "shared authority," transforming the construction of knowledge into a dialogical and co-authorial practice that recognizes the public's intrinsic experiential authority [2]. Lastly, Thomas Cauvin (2016) systematized the discipline as a complex and participatory ecosystem; here, the historian acts as a mediator in a holistic process where rigorous research, accessible communication and civic co-production constantly converge [3].
The game medium is now, through its interactive and immersive mechanics, tangibly embodying the need for shared agency, transforming users from passive consumers into active participants capable of exploring and co-creating the complexity of the past.
In this sense, CG offers a suitable pedagogical and playful methodology within the context of a higher education teaching method focused on a Public History approach. Drawing on constructionist pedagogy, CG regards the creation of tangible, shareable and meaningful artefacts as the optimal way to construct knowledge, giving learners the opportunity to externalize what they have learnt, thereby ensuring deep and meaningful learning [4]. Engaging learners in the process of designing and building, CG fosters the development of a diverse set of skills, including critical thinking, creative thinking, communication, problem solving [5] and systems thinking [6], while relying heavily on the use of digital technologies, ensuring an even more enriching experience for students by fostering digital skills and literacy.
CG applied to the teaching of history thus offers a model of activity akin to the Public History paradigm, promoting a dialogic and participatory approach to history. Game design becomes a process of co-production between the learner and the teacher/historian, generating new tools for dissemination as well as historically literate and

competent individuals. In fact, CG activities engage the learner in a series of tasks fostering historical-domain relevant skills, such as researching and identifying sources; critically analysing information in order to clarify its context and cause-and-effect relationships; and being able to analyse, communicate and disseminate history and its complexity.

To support this, this paper aims to present the activities carried out in two different degree programmes, held at the University of Genoa, showing how CG is able to operationalize Public History's principles. These two programmes engaged students in the creation of historically themed board games on various topics: brigandage; a shipwreck off the Genoese coast in the late 18th century; plagues in the modern era; the Reformation; and the formation of the modern state in France.
While working on various game-based artefacts, the learners grappled with the complexity of history and its various elements (folklore, culture, topography, political and social movements), subsequently integrating these into the board games' design. Games — intended as complex systems in which different interconnected and interdependent levels shape the gaming experience — thus offered learners the opportunity to reflect in a practical, tangible and direct way on the complexity of history, translating it into game design elements.
During the two courses, learners, by making the most of the opportunities offered by artificial intelligence for the generation of images and text, as well as online archives and repositories for searching for information and documents, were engaged in a dialogic and shared process of knowledge co-production and construction, which required: critical analysis and reading of sources; construction of shared narratives and meanings; historical information reworking; development of methods and tools for the transmission of historical knowledge, ensuring that it remains accessible; and reflection on the potential impact of the artefact on the user and its role.
Throughout the game design process, Constructionist Gaming operationalized the core principles of Public History by engaging learners in the collaborative interpretation, negotiation and communication of historical knowledge. Rather than reproducing established narratives, students co-produced historically grounded game artefacts, translating historical sources and interpretations into mechanics, narratives, aesthetics and material components. In doing so, every design decision became simultaneously an act of historical inquiry, public communication and shared knowledge construction, transforming learners from consumers of history into full-fledged historical researchers.

Preliminary findings, drawn from SWOT analyses, field observations and semi-structured interviews, show encouraging results regarding learning outcomes. Through assessments by lecturers and researchers, as well as students' self-assessments, it was possible to observe how the methodology facilitated a deep understanding of the subject matter, exploring detailed and complex topics that are rarely covered in a traditional history course. Furthermore, the research and reflection on the subject have facilitated the development of skills and competences typical of the historian's work.
This contribution, describing the activities carried out, highlights how CG methodologies can optimally operationalize the Public History paradigm in the context of higher education, acting as a "first step" towards the ideation of an operational framework

capable of supporting the design of CG activities in a Public History-oriented educational environment.

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Reading Between the Levels: Videogame Literacy as a Critical Digital Competence for Business Professionals

Marika Mascitti[1[0009-0008-6534-4468]], Salvatore Messina[1[0000-0003-2591-707X]] and Alessandro Soriani[1[0000-0001-7152-6112]]

[1] University of Bologna, Bologna, Italy
marika.mascitti@unibo.it
salvatore.messina10@unibo.it
alessandro.soriani@unibo.it

1 Introduction and Theoretical Background

Digital transformation has profoundly reshaped the competence landscapes of contemporary organisations, foregrounding not only technical proficiency but also the critical capacity to navigate complex sociotechnical systems. Within this context, videogame literacy has emerged as a significant yet underexplored dimension of digital competence, particularly for professional adults engaged in higher education [1]. Video games constitute one of the most economically and culturally significant media forms of our time, and yet their role as objects of critical study rather than merely as pedagogical instruments remains marginal in higher education. In fact, Klimmt's normative model treats video game literacy as a distinct competence involving resilience to game content effects, management of multiplayer social affordances, and control over motivational inertia, which makes the construct broader than simple gameplay skill [2]. Postdigital literacy scholarship similarly frames videogame literacies as social practices tied to identity, reflective problem-solving, and ways of acting and knowing that students bring into education [3].

This study is situated within a professional Master's Programme for adults in business fields. Drawing on Gee's foundational work on videogames and learning [4] and the New Literacies Studies tradition [5, 6], the study positions game literacy not as a technical skill but as a political, ethical, and affective competence: the capacity to read games as cultural texts that distribute power, construct identities, and shape imaginaries. From a pedagogical perspective, the study adopts a playful approach rather than treating the videogame exclusively as an object to be analysed from an external position. Play is understood as a mode of inquiry through which participants explore possibilities, test rules, experience constraints, negotiate uncertainty, and confront the consequences of situated choices. The playful experience precedes and informs critical analysis: participants are first invited to act within the game system and are then supported in distancing themselves from that experience in order to examine how the system frames problems, represents identities, distributes agency, and encourages particular forms of behaviour.

Therefore, the theoretical framework integrates two complementary perspectives. The first is the Critical Media Education tradition, operationalised through Soriani's seven-

dimensional analytical model for reading videogames in educational contexts [7]. The second is the Queer Media Education (QME) framework developed by Messina [8], which extends media literacies with an intersectional register through the Q.U.A.K.E. model: Queer, Underground/Unlearning, Affective, Knowledge, and Emancipatory. Together, these frameworks constitute the analytical grid used both as a pedagogical tool in the classroom session and as a data collection instrument in the research design.

2 Research Design and Methodology

The study adopts an exploratory qualitative case-study design with a comparative component. The case is constituted by a structured playful learning intervention conducted within the New Literacies module of a professional Master's programme in Advanced Digital Technologies for Business - 198 adult learners: 52% male; M age = 41.1 years, predominantly from Ireland (39%), Portugal (12%), and Italy (7%). The qualitative design is intended to investigate how participants interpret a videogame after direct engagement with it and how they connect the experience of play with cultural, ethical, affective, political, and professional questions.

The session unfolded in two phases. First, an asynchronous gameplay session with the demo version of *Stellar Blade* [9], a video game selected for its analytical richness across all seven dimensions of the grid, set within a scenario in which the game is used as part of a DEI initiative in a professional context. They then individually completed an analytical grid adapted from [7] and [8], structured in two parts: (a) critical analysis of the game across the seven dimensions; and (b) a set of questions in which participants articulate how they would deploy the game in their own professional context, what resistances they anticipate, and what added value the game offers relative to conventional training tools.

The open-ended questions were analysed using a framework analysis approach [10], in order to identify recurring patterns across the response set, compare cases, and draw conclusions. Coding will be conducted with a deductive approach derived from the Q.U.A.K.E. categories and inductive codes emerging from the data.
Participation in the educational activity was mandatory, whereas participation in the research component was voluntary. Written responses were included in the research dataset only after responders gave their consensus and anonymised.

3 Expected Contributions and Significance

The study addresses three interconnected gaps in the literature. The first is empirical: research on gameful learning in higher education has largely overlooked adult professionals in higher education programmes, where the relationship between gaming experience, professional identity, and critical media literacy remains uninvestigated [1]. The second is methodological: the field relies predominantly on questionnaire-based instruments, and there is an explicit call for multi-method approaches that combine observation, reflective artefacts, and structured debriefing [11]. This study proposes and tests an alternative protocol in which the analytical grid itself becomes the primary data

collection tool, avoiding the separation between pedagogical experience and research instrument. The third gap is theoretical: the lack of empirical research has examined the analytical competences that adult professionals bring to bear when engaging with a digital artefact through an intersectional framework [3, 12]. This study addresses this gap by treating participants' analytical responses as evidence of how professional background, disciplinary formation, and prior critical awareness shape the capacity to read a videogame through the seven dimensions of the Q.U.A.K.E. grid. The study contributes a transferable research protocol for practitioners and researchers working at the intersection of game literacy, digital competence education, and professional development. The adapted Q.U.A.K.E. grid, designed for accessibility without sacrificing theoretical rigour, represents a practical contribution to the toolkit of educators in higher education who seek to introduce critical game analysis without requiring prior expertise in game studies or queer theory.

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Special Track 14

European University Alliances, Virtual Exchange and Blended Mobility in Higher Education

Organizers:
Fabio Sorrentino, University of Cagliari, Italy

EDUC VE/COIL as a Rollercoaster: Good Intentions, Pitfalls and Solutions

Per Strömberg[1] [0000-0002-7808-1352], Erika Lázár[2] [0009-0005-5400-3949],

Petra Putzer[2] [0009-0002-4755-3465]

[1] University of South-Eastern Norway, USN School of Business, N-3199 Borre, Norway.
per.stromberg@usn.no
[2] University of Pécs, Faculty of Business and Economics, H-7622 Pécs, Rákóczi Street 80, Hungary
Lazar.erika@ktk.pte.hu, putzerp@ktk.pte.hu

1 Introduction

This paper presents a qualitative case study of a Virtual Exchange/Collaborative Online International Learning (VE/COIL) initiative developed within the European Digital UniverCity (EDUC) alliance and implemented jointly by the University of South-Eastern Norway and the University of Pécs in autumn 2025. The initiative formed part of a bachelor's course in Sustainability Marketing and Circular Economy and involved approximately 130 students working in transnational groups. The aim was to provide students without access to physical mobility with an international learning experience combining disciplinary learning, intercultural collaboration, and digital competence development. [1, 2, 3]

The study addresses the following research question: *How can instructional design support and hinder the implementation of VE/COIL initiatives within a European University Alliance?*

2 Methodology

The course combined problem-based learning with an authentic sustainability case provided by industry. The design was informed by principles of learning design and authentic learning that emphasise the alignment of activities, technologies, and intended learning outcomes. [4]

Students collaborated asynchronously in Moodle and synchronously through Zoom. Data for this study consisted of course-design documents, LMS structures, teacher reflection notes, and student feedback from course evaluations and VE activities. The material was analysed deductively using TPACK [5] and Salmon's five-stage model of online learning. [6, 7]

The course design emphasised early socialisation through synchronous icebreaker activities and structured group formation. Students conducted collaborative research,

presented interim findings online, and produced a final video presentation with strategic recommendations.

3 Findings

The findings indicate that the instructional design effectively supported Salmon's initial stages of access, motivation, and online socialisation. Students reported that the introductory activities and clearly defined tasks contributed positively to engagement and group cohesion across national boundaries.

Challenges emerged during the stages of information exchange and knowledge construction. Students reported difficulties related to LMS navigation, communication across institutional contexts, language-related barriers, and uncertainty regarding the connections between theoretical content, project tasks, and assessment criteria.

The substantial imbalance in student numbers between the two institutions (approximately 100 versus 30 students), together with differing semester schedules, created organisational challenges during implementation. Some groups ultimately consisted solely of Norwegian students because there were insufficient Hungarian participants, reducing the international dimension that many students had expected from the VE/COIL experience. Thus, asymmetries between universities may affect the outcome.

From a TPACK perspective, these challenges reflected partial misalignments between technological affordances and pedagogical intentions. Where links between theory, tasks, and assessment were clearly communicated, groups demonstrated stronger collaboration and produced higher-quality project outcomes. Approximately three quarters of the student groups met or exceeded expected academic standards, while student feedback highlighted the professional relevance of working with an authentic industry case in an international environment.

4 Implications

The case highlights several recommendations for future VE/COIL initiatives: (1) invest early in structured online socialisation activities; (2) minimise LMS complexity and provide clear communication channels; (3) align theoretical content, project tasks, and assessment criteria explicitly; (4) establish common timelines and responsibilities across institutions; and finally (5) provide support for communication in multilingual student groups. These recommendations may be transferable to similar VE/COIL initiatives within European University Alliances and other international higher education contexts.

5 Conclusion

The study demonstrates that successful VE/COIL implementation depends not primarily on technology itself but on coherent instructional design across institutional contexts. By combining TPACK and Salmon's model, the analysis identifies both enabling

factors and recurring challenges in alliance-based virtual exchange. The findings contribute practical guidance for educators seeking to design scalable and inclusive international learning experiences within European University Alliances.

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Pedagogical Engineers in European University Alliances: An Exploratory Study of an Emerging Professional Profile

Fabio Sorrentino

University of Cagliari, Italy
fabio.sorrentino@unica.it

1 Introduction

European University Alliances are transforming higher education through new forms of transnational collaboration, virtual mobility, digital learning, and joint educational initiatives [1][2]. While research has extensively explored governance models, interoperability, and international learning opportunities [2][3][4], limited attention has been paid to the professionals who support the implementation of these innovations. Among these emerging actors are Pedagogical Engineers (PEs), professionals operating at the intersection of pedagogy, technology, academic development, and organisational change. Although their contribution is increasingly visible within alliance-based projects, their professional identity and responsibilities remain only partially understood. This paper explores the role of Pedagogical Engineers within the EDUC Alliance and discusses their contribution to transnational educational innovation.

2 Methodology

This exploratory case study examined PEs in the EDUC Alliance. Data collection combined a structured online questionnaire, dedicated meetings, and follow-up interviews. The questionnaire included closed-ended (multiple-choice and Likert-scale) and open-ended questions on professional backgrounds, responsibilities, areas of involvement, collaboration, EDUC activities, and perceived contributions to the alliance. Of ten invited PEs, eight completed the questionnaire (80% response rate). Percentages refer to valid responses (n = 8). Closed-ended responses were analysed descriptively, while open-ended responses, meetings, and interviews underwent thematic analysis to identify recurring activities and functions. In this study, PEs are understood as professionals providing pedagogical, technological, and organisational support for educational innovation within EDUC. The study aims to identify recurring patterns, not to produce statistically generalisable findings.

3 Results

Respondents had heterogeneous backgrounds, spanning education, IT, languages, engineering, international relations, and teaching. Technology integration was reported by all respondents (100%, n = 8); faculty training and support by 62.5% (n = 5); and curriculum design and quality assurance by 37.5% each (n = 3). Student support was mentioned by 12.5% (n = 1). Open-ended responses, meetings, and interviews show that PEs combine pedagogical support, digital innovation, and institutional coordination. They contribute to virtual mobility, curriculum internationalisation, faculty development, digital services, and collaborative course development. Seven respondents (87.5%) strongly agreed, and one (12.5%) agreed, that their work contributes to EDUC's strategic objectives. Four interconnected functions emerged:

- **Educational design and innovation**. PEs support the development of courses, learning activities and opportunities involving multiple institutions.
- **Digital mediation**. PEs facilitate the adoption and effective use of educational technologies, LMSs, and online learning environments.
- **Faculty development**. PEs provide training, guidance, and pedagogical support to instructors involved in innovative teaching practices.
- **Cross-institutional coordination**. PEs connect stakeholders, systems, and organisational cultures, facilitating cooperation across universities.

4 Discussion and Conclusions

Pedagogical Engineers emerge as a heterogeneous category of higher education professionals whose role extends beyond traditional instructional support. They combine pedagogical, technological, coordinative, and intercultural expertise, although their institutional positioning and responsibilities vary. This variation confirms that the professional identity of PEs is still evolving. The findings are exploratory and context-specific: they are based on eight questionnaire responses within one alliance and cannot be generalised statistically. Moreover, "Pedagogical Engineer" covers professionals with different backgrounds and degrees of involvement in educational design, technology, and coordination. The four functions identified should therefore be interpreted as recurring patterns rather than as a universal definition of the role. European University Alliances provide a particularly valuable environment for observing this evolution. The complexity of transnational educational collaboration requires professionals capable of operating across organisational and disciplinary boundaries. In this sense, Pedagogical Engineers can be understood as boundary-spanning professionals [5][6] who translate strategic educational objectives into operational practices and facilitate collaboration across organisational, disciplinary, and cultural boundaries. Future research should investigate the competencies, career pathways, and organisational positioning of Pedagogical Engineers across different alliances and higher education systems. A better understanding of this emerging profile may contribute to strengthening the sustainability and scalability of educational innovation within European higher education.

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Virtual exchange in a European Alliance context: exploring the role of logbooks in the emergence of learner autonomy

Caroline Cruaud[1] [0000-0001-6908-4116]

[1] University of South-Eastern Norway, Drammen, Norway
caroline.cruaud@usn.no

1 Virtual Exchange COIL: a tool for internationalisation within the European Alliance EDUC

Creating opportunities for international collaboration at student level is one of the main goals of the European Alliance EDUC (European Digital UniverCity Alliance) [1]. However, not all students have the means for a stay abroad and numbers for physical student mobility remain low in Norway [2].

Virtual Exchange, also called COIL (Collaborative Online International Learning), is a pedagogical design bringing meaningful internationalisation to the students, where they are and where they study [3]. Students from different universities and countries collaborate online, within their own course, on a project. Even though COIL cannot replace a physical exchange, it gives students a first or an additional taste of internationalisation. But virtual exchange also comes with challenges. In a COIL project, most meetings between students are organised and conducted outside of class time. Thus, virtual exchange students work in an intercultural group over time with little presence of teachers and must have the capacity to self-organise and take decisions. This situation can be challenging for many students and lead to failure in communication or in completing their projects [3].

2 Learner autonomy and logbooks

Learner autonomy, "the capacity to take charge of, or responsibility for, one's own learning" (p.58) is a crucial competence for successful virtual exchange [4]. For Cotteral and Murray [5], the heart of learner autonomy is "engaging learners and encouraging them to take responsibility for their learning" (p.173). Another important aspect of learner autonomy, but also of successful COIL projects, is the capacity to set goals. However, "learners are not always skilled at identifying or talking about their goals" (p.176) [5].

Logbooks, or other learning diaries, have been investigated in the foreign language learning field and could be a way to address these issues. Indeed, results from multiple studies show that logbooks can support the students' emergence of learner autonomy and help them select and complete goals [6][7][8].

This research study investigates the use of logbooks in virtual exchange by focusing on a COIL project between two EDUC universities: University of Rennes (France) and University of South-Eastern Norway (Norway). In this interdisciplinary project, mathematics students taking an English course and teacher students collaborated online to develop a learning game for school students. Students were invited to use a logbook during the whole COIL project. The logbook was divided in three parts: first, a reflection note at the start of the project where students could choose their own personal goals; second, a series of meeting logs with questions before and after each meeting; last, a reflection note at the end of the project where students could look back on their initial goals and their potential completion.

This research study aims at exploring the students' experience of working in a virtual exchange group with a meeting logbook. The students' logbooks were collected at the end of the project. In addition, focus group interviews were conducted with students after the project completion. These data were analysed using reflective thematic analysis, through the following steps: data familiarisation, initial coding, theme generation, theme review, theme naming and writing the analysis [9][10]. Thematic analysis was selected as it gives a central place to the researcher's interpretation and focuses on the threads of meaning in the data. In other words, thematic analysis is an interesting analytical tool to investigate student experience.

In order to answer the research aim presented above, two research questions were investigated: 1) How did the students experience the role of the logbook while working in virtual exchange groups? 2) Did the logbook support the students' emergence of learner autonomy, and if so, in what ways? Preliminary results will be presented.

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From Bilateral Pilots to a Global Classroom: Developing a COIL-Based Research Methodology Course for Engineering Students

Antonio Maffei[1][0000-0002-0723-1712], Andrea de Giorgio[1,2][0000-0001-6064-5634], David Romero[3][0000-0003-3610-0751], Sivasrinivasu S. Devadula[4][0000-0002-4819-8568], and Gulmira Mukhanova[5][0000-0003-4985-4018]

[1] KTH Royal Institute of Technology, Stockholm, Sweden
[2] Artificial Engineering, Naples, Italy
[3] Tecnológico de Monterrey, Mexico City, Mexico
[4] Indian Institute of Technology Madras, Chennai, India
[5] Satbayev University, Almaty, Kazakhstan
maffei@kth.se, andrea@degiorgio.info, david.romero.diaz@gmail.com, devadula@iitm.ac.in, g.mukhanova@satbayev.university

1 Introduction

Engineering graduates increasingly operate in global environments where effective collaboration requires not only technical expertise but also intercultural communication and teamwork skills, yet physical mobility still reaches only a minority of them [1].

Virtual Exchange (VE) — sustained, technology-enabled and curriculum-embedded collaboration between geographically separated learners [2] — answers this gap as a form of internationalisation at home, with Collaborative Online International Learning (COIL) as its most widely adopted model [3] and intercultural competence as its principal outcome [4]. The course reported here is a virtual exchange in the strict sense: students at partner universities work for a full term on assessed curricular tasks under a shared syllabus and co-facilitated sessions. The online sequence can also serve as the virtual component of a blended intensive programme [5], and the design addresses the governance problem alliances face when running a shared course across different calendars and credit systems [6].

COIL is documented mostly for undergraduate cohorts in short disciplinary modules [7]; reviews confirm intercultural gains alongside obstacles of time zones and asymmetric assessment [8]. It is rarely applied to research methodology and early-stage doctoral education, where the shared object is the student's own research and the step that matters is the move to independent research [9]. This paper presents the design, evaluation and preliminary implementation of a research methodology COIL run by KTH (Sweden), Satbayev University (Kazakhstan), IIT Madras (India) and Tecnológico de Monterrey (Mexico).

Fig. 1. Progressive development of the COIL initiative from bilateral pilots in 2025 and 2026 towards a four-university international learning ecosystem in 2027.

2 Course Design and Collaborative Architecture

Students develop their own research work while interacting with peers and faculty from different institutions, within the Community of Inquiry framework [10] and with reciprocal peer review as the main learning mechanism. Thematic meetings address research diaries, referencing, gap identification, journal selection, peer review, conference participation, proposal development, generative artificial intelligence, and time management, each with an assignment feeding the student's own work. The collaborative dimension does not reside in the meetings: every deliverable is paired with a cross-institutional activity. Diary pairs comment on each other's entries; mixed teams reconcile their citation and integrity norms in a joint checklist; research gaps are defended before peers who challenge their novelty; and manuscripts circulate in a blind cross-institutional review exchange with author rebuttal. Roles rotate, teams are mixed-nationality, and activities are shared while assessment and credit stay local — the condition for scalability.

Implementation is incremental (Fig. 1): a KTH–Satbayev pilot in 2025, a KTH–IIT Madras pilot in 2026, and a four-university edition in 2027.

3 Evaluation, Preliminary Findings and Insights

Evidence collection is systematic: pre- and post-course self-assessment of research and intercultural competences [4], thematic analysis of the research diaries, facilitator logs, workspace data and end-of-course questionnaires. Pilot 1 was formative and qualitative; the full instrument set applies in Pilot 2, and the 2027 edition gives the first comparable cohort.

The international setting opens up different approaches to literature reviews, publication strategies and research planning; time zones remain the main friction. Several insights carry beyond this course. *Authentic artefacts sustain collaboration; discussion alone does not:* interaction persisted where an artefact had to cross the institutional boundary and decayed in purely discursive sessions, so every module now carries a deliverable to exchange. *Asymmetry is a*

resource only when roles are scaffolded: differences in seniority and in exposure to English-language publishing produced one-directional feedback until review templates and rotating roles were introduced. Tacit norms — referencing, supervisor involvement, authorship, uses of generative AI — must become explicit comparative assignments; co-facilitated sessions with local assessment let the pilots run without curriculum re-approval. Future work will evaluate the impact on research and intercultural competencies and test the model with four institutions running simultaneously.

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Intercultural Competences in Mathematics COIL: an Analysis of Multicultural Effectiveness and Cultural Intelligence

Alice Barana[1[0000-0001-9947-5580]], Giulia Boetti[1[0000-0001-5329-3378]], Marina Marchisio Conte[1[0000-0003-1007-5404]], Adamaria Perrotta[2[0000-0001-5611-1103]], Matteo Sacchet[1[0000-0002-5630-0796]]

[1] Department of Molecular Biotechnology and Health Sciences of the University of Turin, Turin, Italy
{alice.barana, giulia.boetti, marina.marchisio, matteo.sacchet}@unito.it
[2] School of Mathematics and Statistics, University College Dublin, Dublin, Ireland
adamaria.perrotta@ucd.ie

1 Introduction and Context

Intercultural competences will play an ever-increasing role in the future [1]. During virtual and blended mobilities, which allow students to practice intercultural learning at their home institutions, intercultural competences should be assessed intentionally through identified dimensions and assessment methods [2]. This contribution examines a Collaborative Online International Learning (COIL) experience [3] in the field of Mathematics, entitled "Linear Algebra for Economic, Finance, Security and Defence strategies". The 10-hour COIL activities have been co-created and co-delivered by University College Dublin (Ireland) and University of Turin (Italy) in November 2024 and in November 2025. The COIL project involved around 70 first-year students across the two editions, from economics & finance and actuarial studies at University College Dublin and strategic and security sciences at the University of Turin, collaborating in mixed virtual teams on case studies and problem-solving tasks in real-world scenarios [4,5]. Students completed an ice-breaking task, a cryptography task connected with security and defence, and a macroeconomic modelling task. Collaboration was supported by synchronous meetings, tutoring sessions, a learning management system and self-organized teamwork [4,5]. In the 2025 COIL experience, intercultural competences were analyzed through: Multicultural Effectiveness (ME), understood as the ability to interact successfully and constructively with people from different cultural backgrounds, measured through a short form of the Multicultural Personality Questionnaire [6-8], and Cultural Intelligence (CQ), defined as a capability to understand, adapt, and work effectively across cultural contexts [9]. The study investigates the following research question: Which ME and CQ dimensions change during a mathematics COIL, and what do these changes suggest for the design of virtual and blended mobility? This analysis extends our prior work on mathematics COIL and BIP by jointly examining ME and CQ while comparing patterns across online-only and blended delivery formats.

2 Data and Results

The empirical analysis concerns the 2025 matched sample of initial and final questionnaires from 36 students after excluding non-completed final questionnaires and missing research consent. The ME dimensions considered were Cultural Empathy (CE), Social Initiative (SI), Open-mindedness (OM), Emotional Stability (ES) and Flexibility (F). The CQ dimensions considered were Knowledge (K), Skills (S) and Metacognition (M). Each variable was calculated with the average of the items of the questionnaires that refer to the factor. Negatively worded items (ES and F) were reverse-coded. Reliability was acceptable for the overall instruments: ME Cronbach's alpha was .782 initially and .793 finally; CQ Cronbach's alpha was .827 initially and .833 finally. After Shapiro-Wilk normality checks, paired t-tests were used for normally distributed paired dimensions and Wilcoxon-Pratt signed-rank Z-tests otherwise. Results are in Table 1.

Table 1. Pre and post changes in ME and CQ dimensions on a 5-point scale.

Dimension	Initial mean	Final mean	Statistic	p-value
CE	4.07	3.95	t = -1.231	.226
SI	3.52	3.81	Z = 2.219	.026
OM	3.69	3.73	t = 0.309	.759
ES	3.53	3.68	Z = 1.029	.303
F	2.44	2.75	t = 2.211	.034
K	3.85	4.07	Z = 1.582	.114
S	3.84	3.97	t = 1.355	.184
M	3.69	3.88	Z = 1.493	.135

3 Discussion and Conclusions

The results indicate changes associated with participation in the COIL project. Within ME, SI increased significantly, as did F. This suggests that a fully online international COIL in mathematics can foster students' readiness to take initiative with peers and teachers as well as adapt strategies in unfamiliar cultural situations. CE, OM and ES did not change significantly. In Blended Intensive Programmes (BIPs), significant gains in CE and OM [10], as well as in SI and F [11] were found. CQ increased in all three dimensions, but no change was statistically significant, as qualitatively found in [5]. CQ may require longer exposure, explicit reflection on cultural sense-making, or assessment designs that combine scales with reflective diaries and interaction data. Overall, the findings suggest that virtual and blended mobility formats may foster complementary dimensions of intercultural competence with significant improvements even in brief (10 hours) COIL experiences. Together with previous findings from a BIP, these results support the view that different international mobility formats may promote distinct yet complementary aspects of intercultural competence. For future COIL designs in mathematics, they suggest combining problem-solving tasks with structured peer roles, sustained interaction, and explicit reflection activities to foster initiative, adaptability and cultural sense-making while broadening access to international learning experiences in higher education.

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Beyond Digital Tools: Building a Shared Ecosystem for Collaboration, Community and Digital Sovereignty in a European University Alliance

Chiara Squilloni

University of Cagliari, Italy
chiara.squilloni@unica.it

1 Introduction

European University Alliances are increasingly adopting digital technologies to support collaboration, mobility, teaching and institutional cooperation, yet their digital services often evolve independently, resulting in fragmented user experiences and disconnected workflows that limit the development of a truly shared European academic community [1][2]. The EDUC Alliance illustrates this pattern: EDUC Learning, the EDUC Course Catalogue and OpenUp each address specific needs, but their separation limits integrated communities of practice and cross-institutional collaboration.

This paper addresses the following research question: How can a European University Alliance evolve from a collection of independent digital services towards a shared digital ecosystem that promotes collaboration, community building and digital sovereignty while preserving institutional autonomy? It presents the EDUC Virtual Campus as an institutional implementation case documenting the design rationale, governance process and technological choices behind its evolution -rather than empirical evidence of adoption -conceived as a community-centred ecosystem where governance, technology and student participation co-evolve, identifying transferable principles for alliances facing similar challenges.

2 Platform Architecture, Governance and Community Building

The Virtual Campus emerged from the progressive evolution of the alliance's digital infrastructure, as discussions within the EDUC IT Expert Group highlighted the need for a unified environment integrating existing services with collaborative workspaces for daily alliance activities. Nextcloud was selected as the technological foundation for its open-source nature, interoperability and customisation capabilities [3][4]. A proof-of-concept was first deployed for a restricted community of expert users, following a staged deployment strategy coordinated by a Product Owner balancing user feedback with scalability and sustainability. Core collaborative services (document management, co-editing, communication, task management) were progressively complemented by integrations with existing EDUC services, including widgets for EDUC Learning, within a governance model ensuring reliability and interoperability across partner institutions. Digital sovereignty has recently emerged as a strategic objective for European higher education, where institutions must balance interoperability, openness and

institutional autonomy (Schön & Ebner, 2025) [5]. In this work, it is understood as the alliance's capability to retain governance over its digital infrastructure, institutional data, AI technologies and innovation processes, while preserving interoperability across partner institutions. This principle is realised through open-source technologies, federated authentication based on institutional identities - allowing users to access the ecosystem with their home university credentials -full control over infrastructure deployment, and EDUC AI, an on-premises solution relying exclusively on open-source language models, keeping data processing under alliance governance and supporting transparent, ethical AI applications [4][5][6][7]. Rather than generic conversational assistants, EDUC AI supports domain-specific institutional workflows -for instance, assistants helping pedagogical engineers harmonise learning opportunities using knowledge extracted from the EDUC Course Catalogue.

A key design principle of the Virtual Campus is the support of communities of practice [8][9]. The initial deployment focuses on alliance staff involved in implementing the EDUC Grant Agreement: dedicated collaborative spaces enable Work Packages and task groups to organise activities, share resources and manage transnational projects, fostering a shared organisational culture across partner institutions.

Beyond technology, the Virtual Campus adopts a student-centred approach reflecting one of the founding principles of the European Universities Initiative: students actively shape the future of higher education rather than simply benefiting from it. At governance level, the Student Board contributes to strategic decision-making within the alliance Steering Committee; at technological level, the Think Lab programme -through which EDUC AI itself was developed -enables multidisciplinary student teams, mentored by IT experts, to co-design new digital services, allowing the ecosystem to continuously evolve according to the needs of its own community.

3 Conclusions

Although the Virtual Campus is currently entering its first deployment phase, targeting alliance staff involved in the Grant Agreement, the EDUC experience already offers insights into the design of digital ecosystems for transnational higher education alliances. Rather than proposing a new technological platform, this paper argues that successful digital transformation requires the alignment of technology, governance and community participation.

The EDUC implementation highlights five transferable principles: (i) integrating rather than replacing existing institutional services; (ii) adopting digital sovereignty as both an architectural and governance principle; (iii) evolving the ecosystem through iterative development and staged deployment; (iv) establishing continuous governance balancing innovation, scalability and sustainability; and (v) promoting student-centred innovation. Future work will evaluate the platform through empirical evidence of adoption and collaboration patterns, and compare the EDUC experience with other European University Alliances; the principles presented here provide an initial conceptual framework for sustainable, sovereign and community-driven digital ecosystems [1][5].

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Special Track 15

AI in Physical Exercise, Kinesiology and Sport: Innovations for Higher Education

Organizers:
Gaetano Raiola, Pegaso University, Italy
Francesca D'Elia, University of Salerno, Italy

Teacher-Guided vs AI-Guided Active Breaks: The Perceptions of Secondary School Students

Gaetano Raiola[1] [0000-0002-7659-1674], Nuno Pimenta[2] [0000-0001-8390-1370], Antonio Tessitore[3] [0000-0002-3542-0991] and Giuseppe Di Lascio[4] [0009-0001-3628-184X]

[1] Research Center of Physical Education and Exercise, Pegaso University, Naples, Italy. gaetano.raiola@unipegaso.it
[2] Sport Sciences School of Rio Maior, Santarém Polytechnic University, Rio Maior, Portugal. npimenta@esdrm.ipsantarem.pt
[3] Department of Movement, Human and Health Sciences, University of Rome "Foro Italico", Rome, Italy. antonio.tessitore@uniroma4.it
[4] Department of Neuroscience, Biomedicine and Movement, University of Verona, Italy. giuseppe.dilascio@univr.it

1 Introduction

Sedentary behaviour among children and adolescents is a phenomenon that is on the rise within school settings. Pupils spend most of their school day sitting down, due to the prevailing teaching methodology characterised by frontal and passive instruction. The link between school-related sedentary behaviour and indicators of health and well-being, quality of life, motivation, and academic performance has been widely documented [1-4]. To break up these periods of prolonged sitting, different strategies can be implemented, including active breaks. Active breaks are simple movement sessions, lasting between 5 and 15 minutes, during which pupils stand up and perform static or static-dynamic exercises behind their desks or in open spaces. Active breaks can positively influence students' attention, classroom behaviour, enjoyment and engagement, whilst promoting healthier lifestyles within the school environment [5]. Active breaks can be led directly by the teacher using a prescriptive-demonstrative approach or supported by digital tools and technologies based on artificial intelligence (AI). However, despite the growing interest in AI in education, the evidence regarding its use remains limited. Specifically, it is unclear how AI can be used effectively in a school setting and what students' perceptions are regarding different ways of conducting active breaks, ranging from those led directly by the teacher (teacher-guided) to those led by AI-based systems (AI-guided).

2 Aim

The aim of this study was to compare the perceptions of students at a secondary school regarding teacher-led active breaks and AI-led active breaks in terms of attention, enjoyment, engagement and classroom atmosphere. The main research question was: "Do students prefer to be guided by a teacher or by an AI-based system?"

3 Methods

A single-group pre–post study was conducted, involving repeated measurements and within-subject comparisons. The study involved 29 students (age, 15.89 ± 1.11) from a technical secondary school. Overall, 41.4% participated in sports during their free time, whilst 37.9% engaged in other forms of physical activity.

The students followed a 6-week protocol based on 5-minute active breaks, three times a week. Teacher-led active breaks were alternated with AI-led active breaks, generated using prompts in ChatGPT and specifying the context and environmental constraints, including limited space, lack of equipment, and activities appropriate to the students' level and age. An ad hoc questionnaire, comprising 13 ordinal items on a five-point Likert scale and 3 nominal questions, was administered. For ordinal items, the median and quartiles were reported, and the Wilcoxon test for paired samples was applied. The dichotomous nominal variables were analysed using McNemar's exact test, whilst for the polytomous variable, the marginal homogeneity test was used, with a significance level set at $p < .05$.

4 Results

The results showed no significant differences in attitudes towards physical activity or in perceptions relating to well-being, concentration, enjoyment of lessons, inclusion, classroom atmosphere and socialisation ($p > .05$). The perceived usefulness of video support in performing active breaks increased significantly ($p = .004$). Preferences regarding the intensity of these breaks and perceived difficulties remained stable, whilst the preferred delivery method changed ($p = .009$). The choice of the combined expert–video method increased from 13.8% to 37.9%, while no students preferred video alone at the post-test (Table 1).

Table 1. Summary of the main results of the pre-post comparison.

Variable	Pre-test	Post-test	Test	p
Usefulness of videos, Md [Q1–Q3]	3 [2–3,5]	4 [2,5–4,5]	Z = −2,863	.004
Preference for low-intensity activities	58,6%	55,2%	McNemar	1.000
Active break with an expert	69,0%	58,6%	ZMH = −2,605	.009
Active break with an expert and a video	13,8%	37,9%		
Active break with a video	17,2%	0,0%		
No difficulty in performing active breaks in the class	89,7%	93,1%	McNemar	1.000

5 Conclusion

Students' perceptions of active breaks remained positive, while the perceived usefulness of the video support increased significantly. However, at the end of the intervention, 96.5% of students preferred an approach that included the presence of an expert, either alone or combined with video support. The results highlighted that artificial intelligence can be a valuable support tool, but not a substitute. The presence of a suitably trained human is an essential component in promoting active breaks in a school setting.

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AI-Supported Functional Assessment for Personalized Exercise Prescription in Adults with Intellectual Disabilities

Cusano Pompilio[1[0009-0002-1619-9969]], Luca Cavaggioni[2[0000-0002-9262-0500]] and Giuseppe Penna[3[0000-0001-5075-1265]]

[1] Research Centre of Physical Education and Exercise, Pegaso University, Naples, Italy
pompilio.cusano@unipegaso.it
[2] eCampus University, Rome, Italy
luca.cavaggioni@uninsubria.it
[3] Faculty of Kinesiology, University of Split, Split, Croatia
giuseppe.penna85@gmail.com

1 Introduction

Adults with intellectual disabilities frequently present reduced levels of strength, balance, and postural control, increasing the risk of falls, injury, and functional limitations [1,2]. Structured exercise interventions can positively influence physical fitness and functional performance in this population, underscoring the importance of targeted, evidence-based programs [3]. Recent advances in artificial intelligence (AI) and computer vision offer new opportunities to enhance functional assessment by integrating multidimensional movement data and supporting individualized exercise prescription [4,5]. This study examined the effects of a structured injury-prevention program on strength, postural stability, and functional mobility in adults with intellectual disabilities, while exploring the contribution of AI-assisted functional assessment through the Kemtai platform to personalized exercise planning.

2 Methods

Sixteen adults with intellectual disabilities (30–50 years) were randomly assigned to an experimental group (n = 8), completing a 12-week program of breathing exercises, myofascial release, mobility training, stretching, and strength development, or a control group (n = 8), following traditional postural activity. Functional performance was assessed with the Chair Rising Test [6], Sit-Up Test, Standing Long Jump Test [7], and Timed Up and Go Test [8].

Assessment and training sessions were supported by Kemtai, an AI- and computer-vision-based platform that tracks body movement through a single camera, without wearable sensors, reconstructing joint kinematics in real time and comparing it with reference movement models; independent studies have confirmed its measurement reliability against clinical instruments such as standard goniometers [9,10]. The platform generates immediate audio-visual corrective feedback (e.g., on postural compensations

or movement asymmetries) and aggregates the four functional indicators into an individual profile that assigns each functional domain (lower-limb strength, core endurance, explosive power, dynamic balance) an intervention priority based on deviation from age-adjusted norms. This profile guided weekly personalization of the experimental group's program – for example, emphasizing quadriceps and gluteal strengthening for participants with greater Chair Rising Test deficits, or dynamic-balance and change-of-direction drills for those with higher Timed Up and Go times – with training load progressed individually according to adherence and execution-quality data collected session by session. Group differences were analyzed using independent-samples t-tests and Cohen's d.

3 Results

A significant improvement emerged in the Chair Rising Test ($p = .028$; $d = 1.22$), indicating enhanced lower-limb strength and endurance in the experimental group. No significant differences were found in the remaining tests; however, effect sizes suggested meaningful improvements in abdominal endurance, explosive strength, and functional mobility, consistent with the magnitude typically reported for strength-training interventions in populations with reduced functional capacity [11]. Kemtai-assisted analysis enabled the identification of individual functional limitations and the prioritization of intervention targets for exercise prescription.

4 Discussion and Conclusions

The intervention improved key indicators of neuromuscular function and functional autonomy in adults with intellectual disabilities. Beyond the single statistical result, integrating AI-collected movement data into the functional assessment process may translate, over time, into concrete support for activities of daily living: continuous identification of specific deficits allows the intervention to target the functional domains most directly linked to critical daily tasks, such as rising from a chair, walking safely, or managing changes of direction. Realizing this potential in practice, however, will require addressing the challenges of implementing AI-assisted tools in community-based care settings – including equipment accessibility, staff training, and organizational sustainability [12]. Given the small sample size and short intervention period, larger, longer-term studies with direct observation of daily-living outcomes are needed to confirm these preliminary findings and to define standardized, sustainable protocols for AI-assisted exercise prescription in this population.

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Artificial Intelligence and Physical Activity Promotion: Effects of Personalized Digital Feedback in Sedentary Young Adults

Rosario Ceruso [1,2][0000-0002-5656-7490]; Arben Kaçurri [3][0009-0005-9788-0693] and Tiziana D'Isanto [2][0000-0001-7151-7486]

[1] Department of Neuroscience, Biomedicine and Movement, University of Verona, Verona, Italy.
[2] Research Center of Physical education and exercise, digital Pegaso University, Naples, Italy
[3] Department of Sports Performance, Sports Research Institute, Sports University of Tirana, Tirana, Albania.

rosario.ceruso@univr.it
akacurri@ust.edu.al
tizidisanto@gmail.com

1 Introduction

In recent years, the integration of digital technologies into health promotion initiatives has profoundly changed the way in which people monitor and manage their levels of physical activity [1-2]. Smartphones, wearable devices and tracking apps are now readily available tools for monitoring daily physical activity, helping to raise awareness of one's behavioural and manage sedentary habits [3-4]. At the same time, Artificial Intelligence (AI) is gradually taking on a central role in digital health systems thanks to its ability to process individual data, personalize feedback and adapt objectives based on user responses [5-6]. Although AI-supported approaches to physical activity promotion have received increasing scientific attention, evidence remains limited regarding how personalized and adaptive AI-generated feedback may influence both daily physical activity and motivational-behavioural outcomes in sedentary young adults [7-8]. Despite the growing availability of AI-based conversational systems, limited evidence exists regarding their effectiveness as personalized behavioural support tools for increasing daily physical activity in sedentary young adults.

The aim was to assess the effectiveness of an AI-based virtual assistant in improving levels of daily physical activity, motivation and behavioural awareness among sedentary young adults, by comparing a simple self-monitoring system with a protocol that incorporates personalized feedback generated by AI.

2 Method

The study employed a pre-post experimental design lasting a total of four weeks. The sample consisted of 46 young adults. Following eligibility screening, participants were randomly allocated to either the control group (CG; n = 23) or the experimental group (EG; n = 23) using a computer-generated randomization procedure.

Eligible participants were sedentary young adults owning a smartphone or wearable capable of recording daily steps; individuals engaged in structured exercise or presenting physical limitations affecting daily activity were excluded. Both groups used a step-counting system via a smartphone or wearable device. Each participant used the same

device throughout both the baseline and intervention periods to ensure within-participant consistency in step-count measurements.

During the intervention, the CG received a standard daily step target, whereas the EG interacted with an AI-based virtual assistant (ChatGPT, OpenAI), which provided personalized motivational feedback and adaptively adjusted daily step goals according to individual progress. During the first week, daily steps were recorded as baseline without intervention. Participants completed a brief self-report questionnaire composed of two single-item measures assessing motivation and physical activity awareness. Each construct was rated on a 10-point Likert-type scale ranging from 1 (very low) to 10 (very high). The questionnaire was specifically developed to provide a rapid assessment of participants' perceived motivation and before and after the intervention.

Descriptive statistics (mean ± standard deviation) were calculated for all study variables. Data normality was assessed using the Shapiro–Wilk test. To evaluate the effects of the intervention over time and between groups, separate two-way mixed repeated-measures ANOVAs were performed for daily step counts, motivation and perceived physical activity awareness, with Time (Pre vs. Post) as the within-subject factor and Group (Control vs. Experimental) as the between-subject factor. Effect sizes were calculated using partial eta squared (η^2p). In addition, Spearman's rank correlation coefficients (ρ) were computed to examine the relationships between changes in daily step counts, motivation and perceived physical activity awareness. Statistical significance was set at $p < 0.05$.

3 Results

Analysis of daily step counts showed an improvement in both the CG and the EG between the baseline and post-intervention phases. In the CG, the average daily step count increased from 4,934 ± 810 to 5,616 ± 925 steps, representing an average increase of 682 steps. In the EG, average daily step counts increased from 4,954 ± 956 to 7,581 ± 1,046 steps, corresponding to an average increase of 2,627 steps. Mixed repeated-measures ANOVA revealed a significant main effect of Time ($F(1,44) = 606.60$, $p < 0.001$, $\eta^2p = 0.932$), as well as a significant Time × Group interaction ($F(1,44) = 209.70$, $p < 0.001$, $\eta^2p = 0.827$), indicating that the increase in daily step counts was significantly greater in the EG than in the CG. A significant main effect of Group was also observed ($F(1,44) = 13.69$, $p < 0.001$, $\eta^2p = 0.237$). Regarding subjective outcomes, the EG showed a marked increase in motivation, with scores rising from 4.52 ± 0.90 to 6.52 ± 1.08, whereas the CG showed a more modest improvement (4.61 ± 1.12 to 5.35 ± 1.30). Mixed repeated-measures ANOVA revealed a significant main effect of Time ($F(1,44) = 185.80$, $p < 0.001$, $\eta^2p = 0.809$) and a significant Time × Group interaction ($F(1,44) = 39.37$, $p < 0.001$, $\eta^2p = 0.472$), whereas the main effect of Group was not significant ($F(1,44) = 3.05$, $p = 0.088$). Similarly, perceived physical activity awareness improved in both groups, with a greater increase observed in the EG (4.04 ± 0.93 to 6.04 ± 1.15) compared with the CG (4.04 ± 0.77 to 4.48 ± 0.85). Mixed repeated-measures ANOVA demonstrated a significant main effect of Time ($F(1,44) = 191.60$, $p < 0.001$, $\eta^2p = 0.813$), a significant Time × Group interaction ($F(1,44) = 79.20$, $p < 0.001$, $\eta^2p = 0.643$), and a significant main effect of Group ($F(1,44) = 9.01$, $p = 0.004$,

$\eta^2p = 0.170$). Spearman's rank correlation analysis revealed strong positive associations between changes in daily step counts and motivation ($\rho = 0.802$, $p < 0.001$), changes in daily step counts and perceived physical activity awareness ($\rho = 0.882$, $p < 0.001$), and between changes in motivation and perceived physical activity awareness ($\rho = 0.752$, $p < 0.001$).

4 Conclusion

The present findings indicate that the integration of an AI-based virtual assistant represents an effective strategy for promoting daily physical activity among sedentary young adults. Beyond the significant increase in daily step counts, participants receiving AI-based behavioural support also demonstrated greater improvements in motivation and perceived physical activity awareness than those receiving standard recommendations alone. The use of personalized and adaptive feedback appears to promote not only an increase in activity levels, but also greater motivation and awareness of one's own behavioural habits. The strong associations observed between behavioural and psychological improvements further suggest that AI-assisted interventions may positively influence both physical activity adherence and behavioural engagement. Although additional studies with larger samples and longer follow-up periods are warranted, the proposed protocol appears to be a low-cost, scalable and easily implementable strategy for health promotion in university, educational and community settings.

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The use of AI for match analysis for training and educational purposes

Sara Aliberti[1*][0000-0002-2470-4032], Raffaele Scurati[2][0000-0003-3247-1977] and Felice di Domenico[1][0000-0002-5897-9704]

[1]Research Center of Physical Education and Exercise, Pegaso University, 80143 Naples, Italy
[2] Department of Biomedical Sciences for Health, Università degli Studi di Milano, 20133 Milan, Italy

sara.aliberti@unipegaso.it
raffaele.scurati@unimi.it
flcdidomenico@gmail.com

1 Introduction

Match analysis is a tool for evaluating and monitoring the performance of sports teams, enabling a quantitative analysis of individual athletes' performance in fundamental technical skills and, consequently, linking the effectiveness of these skills to the result. However, the methods traditionally used in match analysis, based on manual observation and basic descriptive statistics, have some limitations related to processing times and the difficulty of interpreting complex phenomena in real time for methodological and educational applications in training. There is a clear need to complement traditional methods, such as manual observation and basic statistics, with tools capable of capturing the complexity of real-time game situations and tactical interactions. The integration of Artificial Intelligence (AI) in match analysis is an innovative solution for processing large amounts of data and for developing predictive models focused on performance analysis, predicting sporting outcomes and preventing injuries, over the usefulness for the methodological and educational aspects of training activities. Recent studies have documented the applications of AI across different sports disciplines, ranging from widely popular sports to less represented contexts [1, 2]. Previous reviews examined the AI applications in sport, invasion games, football, tactical analysis, computer vision, and physical education [3-8]. Bibliometric evidence showed a rapid growth in AI research in sport, although pedagogical applications remained underrepresented [3]. In invasion games and football, research mainly addressed outcome prediction, athlete and event evaluation, tactical analysis and real-time decision support [4-7]. Educational reviews reported some applications for feedback and personalized instruction, but limited evidence on learning outcomes and specific competencies [8]. However, these reviews have mainly focused on algorithms, data sources, predictive accuracy and technical applications, while educational outcomes and the competencies required to interpret and use AI-supported match analysis remain insufficiently synthesized. A systematic synthesis is necessary to clarify how AI is applied in match analysis for training and educational purposes.

2 Aim

This systematic review aimed to synthesize the scientific evidence on the use of AI in match analysis for training and educational purposes. The research question is: "How is AI used in match analysis to support training, professional learning and educational processes, and which competencies are required for its application in sport science higher education and professional practice?".

3 Methods

A systematic review was conducted and reported according to the PRISMA 2020 guidelines. The adapted PICOS framework (Population, Intervention/Technology, Context, Outcomes/Application, Study design) was used to define the research question and eligibility criteria outcomes. The following electronic databases were used: Web of Science, Scopus, PubMed. The search strategy combined terms on AI, match analysis, educational and professional-training applications. The inclusion criteria were original articles or full conference papers in English published in the range January 2015 - August 2026. The eligibility criteria were articles addressed AI application, data analyses from different sports, interpretation of games, educational and training relevance.

4 Results

The literature search identified 126 articles: 81 from Scopus, 9 from PubMed, and 36 from Web of Science. After removing 40 duplicates, 86 records were screened. Following an evaluation of titles and abstracts, 72 records were excluded, and 14 articles were retrieved in full text. Three full-text articles could not be retrieved; therefore, 11 articles were assessed for eligibility. Of these, 3 were excluded, and 8 studies were included in the final review, divided into direct (n=4) and indirect (n=4) evidence.

5 Conclusion

The findings indicated that AI-supported match analysis may contribute to tactical instruction, feedback, decision-making and personalized training. However, the available evidence was limited and heterogeneous. Students, coaches and match analysts should develop data and AI literacy, critical interpretation of AI-generated outputs, awareness of model limitations and communication skills to translate the findings into actionable feedback for athletes. These competencies support the integration of AI-supported match analysis in sport science higher education, both as disciplinary content and as an educational methodology for laboratory activities, tactical analysis and professional training. AI should complement the judgement of teachers and coaches while remaining connected to reflective dialogue, problem-solving and embodied sports practice.

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Artificial Intelligence Generated Vs. Kinesiologist-Designed Exercise Protocols: A Pilot Study On Anthropometric And Psychophysical Adaptations In Physically Active Adults

Felice Di Domenico[1[0000-0002-5897-9704]] Raffaele Scurati[3[0000-0003-3247-1977]] and Luca Molinaro[2[0000-0001-9030-1998]]

[1] Pegaso University, Napoli 80183, Italy
[2] University of Milan, Via G. Colombo 71, 20133 Milan, Italy
[3]eCampus University, Novedrate 22060 Italy

flcdidomenico@gmail.com, raffaele.scurati@unimi.it, luca.molinaro@uniecampus.it

1 Introduction

International guidelines emphasize the importance of regular, progressive, and individualized physical activity for maintaining overall health and well-being, recommending the integration of both aerobic and resistance exercise [1].

In recent years, the widespread adoption of artificial intelligence (AI) technologies has opened new opportunities in exercise prescription and training pro-gram design. However, the effectiveness, safety, and methodological consistency of AI-generated exercise protocols remain insufficiently investigated. From this perspective, it is important to determine whether AI-generated exercise programs, developed according to standardized criteria, can produce psychophysical adaptations comparable to those achieved through traditional training programs designed by exercise professionals. Therefore, it is necessary to investigate whether such programs comply with fundamental training principles, including progressive overload, methodological coherence, safety, and practical applicability, while also producing measurable improvements over time. Furthermore, it remains unclear whether these protocols are sustainable, well tolerated, and capable of eliciting psychophysical responses comparable to those achieved through interventions designed by exercise professionals [2,3].

2 Methods

The study, designed as a comparative, longitudinal, quasi-experimental pilot study with repeated measurements, lasted 12 weeks, with assessments performed every four weeks (T0, T1, T2, and T3).

A total of 48 physically active adults (18–40 years) were enrolled and allocated to one of four intervention groups: High-Intensity Interval Training (HIIT; n = 12), Peripheral Heart Action (PHA; n = 12), Low-Intensity Steady-State (LISS; n = 12), or an artificial intelligence-generated protocol (AI-g; n = 12). Each training session included common warm-up and cool-down phases and a main training phase specific to each protocol. Exercise intensity was monitored using heart-rate monitors, and all sessions were supervised by qualified kinesiologists. The AI-g protocol was developed using a standardized and reproducible prompt, applied consistently across multiple artificial intelligence platforms. The prompt included participant characteristics, the prescribed training intensity, and the available equipment, and defined body recomposition as the primary objective of the intervention, to be pursued through the application of progressive overload principles and adherence to established safety criteria. Before implementation, the AI-g protocol was evaluated by a panel of exercise science experts. Program quality was assessed based on exercise selection, progression, safety, and coherence with the stated objectives. Each domain was rated using a five-point Likert scale ranging from 1 (not adequate) to 5 (fully adequate). Anthropometric assessments were performed according to the standardized procedures of the International Society for the Advancement of Kinanthropometry (ISAK) [4]. Measurements included body mass, stature, body mass index, waist, hip, and limb circumferences, skinfold thicknesses, somatotype classification, estimated fat mass [5], and estimated skeletal muscle mass [6]. Perceived well-being and subjective responses to training, assessed at T3, were measured using the Rating of Perceived Exertion (RPE), the Physical Activity Enjoyment Scale (PACES), the Feeling Scale, and the Exercise Self-Efficacy Scale. Data normality was assessed using the Shapiro–Wilk test. Within-group changes from T0 to T3 were analyzed using paired-samples t-tests or Wilcoxon signed-rank tests. Between-group differences in changes (Δ = T3 − T0) were examined using independent-samples t-tests or equivalent non-parametric tests. Longitudinal changes were analyzed using Linear Mixed Models, including the effects of Time, Group, and the Time × Group interaction, or repeated-measures ANOVA, when appropriate. Perceived psychophysical well-being scores were analyzed using Mann–Whitney U tests or chi-square analyses.

3 Results

Statistically significant pre-to-post improvements in anthropometric outcomes were observed in both intervention groups (all $p < 0.05$). Improvements were generally more pronounced in participants following the kinesiologist-designed protocol; however, no statistically significant between-group differences were detected (all $p > 0.05$). Psychophysical questionnaire scores were generally higher in the AI-generated protocol group. Among these outcomes, the between-group difference in Physical Activity Enjoyment Scale (PACES) scores was statistically significant ($p < 0.05$), whereas the differences observed for the other questionnaire measures did not reach statistical significance ($p > 0.05$).

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Ecological-Dynamics Custom GPT and Performance in Brazilian Jiu-Jitsu: A Randomized Controlled Study

Giuseppe Giardullo [1,2][0009-0003-9319-4077], Agron Kasa [3][0009-0004-1594-4247], Damiano Formenti [4][0000-0002-2941-937X]

[1] Department of Neuroscience, Biomedicine and Movement, University of Verona, Italy.
[2] Research Centre of Physical Education and Exercise, Pegaso University, 80143 Napoli, Italy.
[3] Sports University of Tirana, Rruga Muhamet Gjollesha 1001, Tiranë 1001, Albania.
[4] Department of Biotechnology and Life Sciences, University of Insubria, Varese, Italy.
giuseppe.giardullo@univr.it, akasa@ust.edu.al, damiano.formenti@uninsubria.it

1 Introduction

Brazilian Jiu-Jitsu (BJJ) is a sport in which performance quality depends on the athlete's ability to continuously adapt to contextual demands and the opponent's behavior [1]. This aspect is particularly relevant in competitive BJJ, a discipline in which the effectiveness of an action often depends on the ability to rapidly recognize functional action opportunities within unstable and unpredictable contexts [2]. Despite the growing diffusion of digital technologies applied to sport, many tools used in combat sports remain predominantly oriented toward the technical analysis of movement, paying less attention to the adaptive, decision-making, and perceptual processes that characterize real combat situations [3]. Beyond athletic performance, this AI-based approach also has potential applications in higher education, where generative AI may foster reflective learning, tactical reasoning, and decision-making skills through personalized, context-aware learning experiences. The aim of this study is to examine whether an ecological-dynamics-based Custom GPT could improve perceptual decision-making and selected performance variables in competitive Brazilian Jiu-Jitsu athletes while exploring its educational potential through personalised reflective feedback.

2 Methods

The study employed an eight-week randomized pre-post experimental design involving 46 competitive Brazilian Jiu-Jitsu athletes (mean age 25.1 ± 4.3 years), equally assigned to an experimental group (n = 23) and a control group (n = 23). Both groups completed the same volume of technical and conditioning training. In addition, athletes in the experimental group used the Custom GPT after each training session to analyze combat situations, reflect on tactical decisions, receive personalized ecological-dynamics-based feedback, and identify alternative action opportunities to be applied during subsequent practice. The variables considered were perceptual decision-making, estimated VO_2max, and grip endurance. Perceptual decision-making was assessed using a questionnaire specifically developed for the BJJ context, consisting of 15 items rated on a 5-point Likert scale relating to the perception of action opportunities, anticipatory ability, and the adaptive selection of motor solutions during sparring. Estimated VO_2max

was assessed through the Yo-Yo Intermittent Recovery Test Level 1, while grip endurance was measured using an isometric test involving the maintenance of a grip on the gi. Statistical analyses were conducted by distinguishing between parametric and non-parametric variables. Perceptual decision-making, assessed through the Likert scale questionnaire, was analyzed using the Wilcoxon signed-rank test for within-group pre-post comparisons and the Mann–Whitney U test for between-group comparisons. Estimated VO_2max and grip endurance were analyzed using a 2 × 2 mixed ANOVA (group × time). Statistical significance was set at $p < .05$.

3 Results

At the end of the intervention, the experimental group demonstrated greater improvements than the control group across all variables analyzed. In particular, the perceptual decision-making score increased from 43.1 ± 6.7 to 63.4 ± 5.9 in the experimental group, whereas in the control group it increased from 42.8 ± 6.9 to 49.6 ± 6.5. Similarly, estimated VO_2max improved from 45.2 ± 4.8 to 51.3 ± 4.5 $mL \cdot kg^{-1} \cdot min^{-1}$ in the experimental group, while in the control group it increased from 45.0 ± 4.9 to 47.4 ± 4.7 $mL \cdot kg^{-1} \cdot min^{-1}$. Grip endurance also showed a greater increase in the experimental group, rising from 42.4 ± 8.1 to 59.1 ± 8.7 seconds, compared with the values observed in the control group. Perceptual decision-making was analyzed using the non-parametric Wilcoxon signed-rank test for within-group comparisons and the Mann–Whitney U test for between-group comparisons at post-test. The analysis revealed statistically significant differences both in the within-group improvement of the experimental group ($Z = -4.11$; $p < .001$) and in the between-group comparison at the end of the intervention ($U = 121.5$; $p = .001$).

4 Conclusion

The findings suggest that integrating a Custom GPT configured according to ecological-dynamics principles may represent an effective and easily accessible tool for supporting performance enhancement in competitive Brazilian Jiu-Jitsu. In particular, the system appears to promote perceptual-decision-making adaptation processes and performance self-regulation, contributing to the creation of learning conditions that are more consistent with the dynamic and unpredictable nature of combat sports. Although developed within Brazilian Jiu-Jitsu, the proposed approach may also be transferable to other combat sports and practice-based learning environments. Furthermore, its integration into higher education programmes in sport sciences may support students' tactical understanding, reflective practice, and autonomous learning through personalized AI-assisted feedback.

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Machine Learning-Based Identification of External Load Profiles in Professional Football Players

Nicola Trotta[1,2][0009-0006-3312-2663], Luigi Armiento[1,2][0009-0003-1178-9596], Federico Abate Daga[3][0000-0003-3976-2443], Italo Sannicandro[2][0000-0003-1284-2136]

[1] Department of Neurosciences, Biomedicine and Movement, University of Verona, Verona, Italy
[2] Department of Clinical and Experimental Medicine, University of Foggia, Foggia, Italy
[3]Department of Clinical and Biological Sciences, University of Turin, Turin, Italy
nicola.trotta@unifg.it, luigi.armiento@univr.it, federico.abatedaga@unito.it, italo.sannicandro@unifg.it

1 Introduction

Performance model analysis has gained considerable attention in football due to the development of advanced tracking technologies (GPS) [1]. These tools enable practitioners to quantify players' external load demands [2]. Furthermore, AI-based assessment tools have been increasingly integrated into sport science, supporting kinesiologists in prescribing training session. Although a growing body of evidence has provided a comprehensive overview of external load metrics in football, limited information is available regarding the profiling of professional football players according to playing position. Therefore, this study aimed to explore the potential of machine learning to identify distinct position-specific external load profiles.

2 Methods

A total of 80 matches and 505 individual player-match observations from an Italian professional football club were included in the analysis. The following playing positions were examined: Centre Backs (CB), Wide Midfielders (WM), Defensive Midfielders (DM), Attacking Midfielders (AM), and Forwards (FW). External load was collected using 18.18 Hz GPS units (GPEXE® SYSTEM, EXELIO srl, Udine, Italy) [2]. Total distance (TD), high-speed running (HSR; 19.8-25.2 $km \cdot h^{-1}$), sprint running (SD; >25.2 $km \cdot h^{-1}$), and bursts were measured. Hierarchical clustering was applied to identify distinct external load profiles. All values were normalized to Z-scores before being entered into the algorithm. Hierarchical clustering was performed using Ward.D2 linkage and Euclidean distance to group players based on combined external load and its quality was evaluated using the silhouette coefficient.

3 Results

Machine learning identified low- (LP), moderate- (MP), and high-profile (HP).

Table 1. External load profiles identified by hierarchical clustering.

	LP	MP	HP
CENTRE-BACKS			
TD (m)	10074.98±529.81	9912.4±605.31	10378.73±529.81
HSR(m)	252.47±77.32	392.41±96.52	531.62±97.52
SD (m)	35.28±27.23	65.84±30.12	148.52±52.03
Bursts (n)	9.61±2.63	21.39±5.62	29.91±7.83
DEFENSIVE MIDFIELDERS			
TD (m)	10294.97±604.64	11080.15±517.19	10770.41±400.12
HSR (m)	286.30±64.42	348.48±82.39	525.71±93.74
SD (m)	29.50±22.02	76.01±37.28	107.25±41.41
Bursts (n)	10.81±3.53	11.31±2.90	17.11±3.33
WIDE MIDFIELDERS			
TD (m)	10653.96±498.25	10164.73±602	10986.86±463.19
HSR (m)	477.14±59.50	602.97±69.10	768.80±83.15
SD (m)	79.51±37.34	172.99±68.96	197.55±75.58
Bursts (n)	25.70±5.21	37.08±8.11	37.96±9.41
ATTACKING MIDFIELDERS			
TD (m)	9897.91±1347.20	11156.99±789.42	10758.72±358.36
HSR (m)	478.16±88.50	769.25±113.21	691.90±108.36
SD (m)	160.40±51.07	169.72±67.39	343.82±45.44
Bursts (n)	29.66±10.05	28.30±6.72	41±4.97
FORWARD			
TD (m)	9068.68±1275.07	10431.93±430.67	10448.64±674.09
HSR (m)	440.51±85.43	626.24±56.72	611.43±104.53
SD (m)	94.07±40.48	134.36±51.05	221.16±65.84
Bursts (n)	27.11±5.70	25.20±6.88	40.75±7.01

4 Conclusion

Machine learning may represent an innovative approach for grouping professional football players according to their external load. The findings observed for CB and DM may suggest training prescriptions combining greater technical–tactical aspects with a progressive increase in running demands. Regarding WM, AM and FW, shuttle runs and transition games may be more appropriate for the physical demands of competition. Finally, these profiles may also help practitioners optimise recovery strategies between matches and subsequent training sessions. A limitation of this study is that the data were collected from a single professional football club, which may limit the generalisability of the findings to other teams.

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AI-Driven Visual Feedback in Kinesiology Education: A Preliminary Study on CNN-Based 3D Spine Topography for Palpation Skills

Luca Molinaro[1[0000-0001-9030-1998]], Giovanni Esposito[2[0000-0002-3659-8943]], Dusko J. Bjelica[3[0000-0001-5272-528X]] and Gaetano Raiola[2[0000-0002-7659-1674]]

[1] Department of Theoretical and Applied Sciences, eCampus University, 22060 Novedrate, Italy; luca.molinaro@uniecampus.it
[2] Research Center of Physical Education and Exercise, Pegaso University, 80143 Naples, Italy; giovanniesposito410@gmail.com, gaetano.raiola@unipegaso.it
[3] University of Montenegro, Podgorica, Montenegro; officemsa@csakademija.me

1 Background

Accurate palpation of anatomical landmarks is a fundamental competency in kinesiology, physical education, and sports science [1]. Traditionally, students learn these skills by transitioning from two-dimensional textbook illustrations to the complex, three-dimensional reality of human bodies [2]. In standard university laboratory settings, pedagogical methods rely heavily on peer practice and subjective instructor feedback. However, literature consistently shows that manual palpation of the spine often yields low inter-examiner reproducibility [3], highlighting the need to review traditional teaching methodologies [4]. Furthermore, high student-to-teacher ratios make it difficult for educators to provide individualized, real-time corrections. Consequently, learners often struggle to accurately assess their margins of error. Recent studies suggest that augmented visual feedback significantly accelerates motor skill acquisition compared to verbal instruction alone [5]. This highlights the need for scalable, objective educational support tools that can guide students autonomously.

2 Objectives

This study investigates the educational efficacy of utilizing a Convolutional Neural Network (CNN) integrated into a 3D spine topography scanner (Spine3D, Sensor Medica), a technology whose landmark identification accuracy has been previously validated [6, 7], as an objective, real-time virtual tutor to enhance students' palpation skills and clinical self-efficacy.

3 Methods

A preliminary study was designed involving 20 undergraduate sports science students, randomly assigned to an Experimental Group (EG, n=10) and a Control Group (CG,

n=10). Participants were tasked with identifying 6 specific anatomical landmarks (C7, left/right acromions, left/right PSIS, and sacral prominence). During the training phase, the EG received immediate visual feedback generated by the CNN, which highlighted the discrepancy between the student's physical marker and the AI-computed reference landmark. The CG trained using traditional peer-and-instructor feedback. Assessment occurred at T0 (baseline) and T1 (post-training) using blind Spine3D scans for both groups. The primary outcome was the total palpation error, measured as the 3D Euclidean distance (in mm) between the student's marker and the AI-computed reference points. Secondary outcomes included clinical self-efficacy and technology acceptance, evaluated via a 5-point Likert scale questionnaire based on the Technology Acceptance Model (TAM). Assuming a normal data distribution for continuous variables, statistical analysis involved parametric t-tests to evaluate within- and between-group differences in palpation errors, while non-parametric tests were applied to analyze the ordinal data derived from the questionnaires.

4 Results

Preliminary findings indicate that both groups improved their palpation accuracy between T0 and T1, confirming the overall value of practical laboratory training. However, the Experimental Group exhibited a slightly lower mean palpation error compared to the Control Group at T1. Furthermore, qualitative data from the questionnaires were largely positive; students in the EG reported increased clinical self-efficacy and yielded high TAM scores. This aligns with recent literature demonstrating that AI-generated objective feedback reduces performance anxiety and enhances student confidence in Higher Education settings [8].

5 Conclusions

Integrating AI-based topographic technologies into kinesiology laboratories transforms complex biomechanical analysis into an interactive educational tool. While traditional practice remains effective, AI-driven systems provide students with scalable, objective supplementary feedback, effectively bridging the gap between theoretical anatomical knowledge and practical assessment skills. This supports the pedagogical shift towards "AI-supported learning" [9], where automated systems handle mechanical supervision, allowing educators to focus on higher-order clinical reasoning [10]. However, given the small sample size of this preliminary study, these promising findings cannot be broadly generalized, warranting further investigations with larger student cohorts to fully validate the approach.

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From Data to Decision-Making in Football: Perceived Effectiveness of AI-Supported Simplification for Communication Between Coaches and Match Analysts

Manuele Taleb[1,2][0009-0000-3985-0617], Giampiero Merati[3,4][0000-0002-1389-7596] and Giovanni Esposito[2][0000-0002-3659-8943]

[1] Department of Neuroscience, Biomedicine and Movement, University of Verona, Verona, Italy

[2] Research Center of Physical Education and Exercise, University of Pegaso, Naples, Italy

[3] Department of Biotechnology and Life Sciences, University of Insubria, 21100 Varese, Italy

[4] IRCCS Fondazione Don Carlo Gnocchi, Milan, 20148, Italy

manuele.taleb@univr.it; giampiero.merati@uninsubria.it; giovanniesposito410@gmail.com

1 Introduction

In recent years, football has seen an increasing integration of digital tools for the collection, analysis and interpretation of technical and tactical information. The widespread adoption of match analysis has provided coaching staff with an ever-increasing amount of data on individual and team performance. Recent evidence shows that the use of big data is progressively transforming tactical analysis and decision-making support processes in professional football [1]. However, the availability of large amounts of information does not automatically guarantee more effective decision making. On the contrary, the excessive complexity of the data can make its interpretation and operational use more difficult. In this context, the match analyst acts as a mediator between data production and the coach's decision-making process. At the same time, Artificial Intelligence (AI) is expanding the possibilities for organising, synthesising and interpreting sports information through applications that are becoming increasingly widespread in football [2]. Despite the growing interest in such tools, there is still limited evidence regarding the perceptions that coaches and match analysts have of the effectiveness of AI-supported data simplification.

2 Aim

The aim of this study was to analyse the perceptions of coaches and match analysts regarding the effectiveness of simplifying match analysis data using Artificial Intelligence. In particular, the study aimed to compare different ways of presenting the same information to assess its perceived usefulness in terms of interpretative clarity, decision-making support, communicative effectiveness, cognitive load, and educational and professional value.

3 Methods

A cross-sectional repeated-measures study involved 30 football practitioners (15 coaches and 15 match analysts), each with at least one year of experience in Italy's fifth-tier regional amateur division. Participants evaluated the same match-analysis information in a fixed sequence: (1) the original notational report; (2) a graphical-visual revision using elements common in professional practice; and (3) an iconographic AI-supported summary integrating the first two formats. The third format was generated using ChatGPT (GPT-5.5, OpenAI) from both reports and a standardised prompt aimed at maximising clarity and ease of comprehension. After each format, participants completed the same author-developed 20-item questionnaire, comprising five four-item dimensions: interpretative clarity, decision-making support, communicative effectiveness, perceived cognitive load, and educational-professional value. Items were rated on a five-point Likert scale; higher cognitive-load scores indicated greater ease. The five dimensions were analysed using separate 2 × 3 mixed ANOVAs, with report format as the within-subjects factor and professional role as the between-subjects factor. Holm-adjusted post-hoc comparisons and partial eta squared effect sizes were reported, while the overall questionnaire score was analysed secondarily.

4 Results

The overall score showed significant effects of report format, $F(2, 56) = 464.95$, $p < .001$, $\eta p^2 = .943$, professional role, $F(1, 28) = 18.87$, $p < .001$, $\eta p^2 = .403$, and their interaction, $F(2, 56) = 43.54$, $p < .001$, $\eta p^2 = .609$. Coaches rated the AI-supported summary highest overall and for interpretative clarity, decision-making support, communicative effectiveness, and cognitive ease. Match analysts rated the graphical-visual format highest overall, followed by the AI-supported summary and the notational report; graphical-visual and AI-supported formats were generally rated similarly across these dimensions, while the graphical-visual report was favoured for educational-professional value.

5 Conclusion

Presentation format substantially influenced perceived usefulness, with role-specific preferences. The AI-supported summary appeared particularly effective for coaches, whereas graphical-visual reporting retained greater value for match analysts. AI should therefore be viewed as a role-sensitive communication resource, not a replacement for professional interpretation. The findings may contribute to the development of educational pathways for coaches and match analysts, supporting the integration of AI literacy and data interpretation skills within sport science curricula.

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Decision Support in Football Match Analysis: A Systematic Review of Artificial Intelligence Applications

Manuele Taleb[1,2][0009-0000-3985-0617], Domenico Scognamiglio[2][0009-0005-4307-8283] and Pompilio Cusano[2][0009-0002-1619-9969]

[1] Department of Neuroscience, Biomedicine and Movement, University of Verona, Verona, Italy
[2] Research Center of Physical Education and Exercise, University of Pegaso, Naples, Italy

manuele.taleb@univr.it
domenico.scognamiglio_2066@studenti.unipegaso.it
pompilio.cusano@unipegaso.it

1 Introduction

The increasing availability of performance data has transformed football match analysis, making interpretation and communication central to decision-making. Artificial Intelligence (AI), including Machine Learning, Deep Learning, Explainable AI, and Computer Vision, increasingly supports football analytics and data-driven performance evaluation [1]. For coaches and analysts, however, analytical value also depends on whether AI-derived outputs can be interpreted, communicated, and translated into actionable knowledge. Previous systematic reviews examined AI-supported orientation and decision-making in football [2] and AI-based tactical behaviour, collective dynamics, and movement patterns [3]. Building on these perspectives, the present review places specific emphasis on the practitioner-facing use of AI outputs, including performance interpretation, data visualization, information usability, explainability, knowledge transfer, communication processes, and coach–analyst interactions. Accordingly, this review aimed to address the following research question (RQ): How has AI been applied in football match analysis, and what evidence exists regarding its contribution to tactical decision-making, data interpretation, information usability, communication, knowledge transfer, and coach–analyst interactions?

2 Methods

The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The research question was developed using PICOS: (P) football contexts, coaches, analysts, and football-related datasets; (I) AI applications for football match analysis; (C) traditional analytical approaches or alternative AI-based systems; (O) decision support, tactical decision-making, data interpretation, communication processes, information usability, explainability, knowledge transfer, and coach–analyst interactions; and (S) original experimental, observational, validation, and applied studies. Eligible studies were original peer-reviewed studies in English (2018–2026) applying AI to football match, performance, or tactical analysis, data

visualization, or information management and addressing at least one predefined outcome. Studies were excluded if they concerned other sports, lacked a direct football match-analysis application or relevant outcome, focused solely on prediction without decision-support, communication, or information-transfer implications, or were reviews, editorials, commentaries, conference abstracts without full text, or inaccessible publications. Searches were conducted in Scopus, Web of Science, and PubMed. Of 106 records identified, 2 duplicates were removed; 104 records were screened, 69 excluded, 35 reports sought for retrieval, 2 not retrieved, and 33 full texts assessed. 21 studies were included in the qualitative synthesis and 12 excluded.

3 Results

The qualitative synthesis included 21 studies, and four main application domains emerged. First, Machine Learning, Deep Learning, and Reinforcement Learning were used across studies for tactical-pattern identification, player evaluation, key-performance-indicator analysis, and automated assessment [4, 5]. Second, AI-based decision-support systems facilitated data interpretation and tactical decision-making by coaches and analysts. Third, Computer Vision enabled automated extraction of tactical and positional information from match video, reducing manual workload and improving accessibility [6]. Finally, Explainable and Generative AI broadened applications toward interpretable decision support, tactical learning, knowledge transfer, and communication. In one crossover experiment, AI-assisted tactical instruction produced significantly greater improvements than traditional instruction in tactical knowledge, tactical decision-making, and learning satisfaction (all $p < .001$) [7]. Overall, the evidence indicates a shift from prediction toward AI systems that transform complex performance data into actionable knowledge.

4 Conclusion

Artificial Intelligence is evolving from a predictive technology into a decision-support resource capable of enhancing data interpretation, tactical understanding, and communication within football match analysis. Current evidence suggests that AI can facilitate the transformation of complex performance information into actionable knowledge for coaches, analysts, and technical staff. For practitioners, these findings highlight the value of interpretable and usable AI outputs for decision support and coach–analyst communication. For researchers, they identify the need to evaluate AI-supported reporting and decision-support tools in real-world football environments. Explainable AI, Computer Vision, and Generative AI appear particularly promising for improving coach–analyst collaboration and supporting training and educational processes.

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AI-Supported Design and Critical Analysis of Physical Activities in Primary Teacher Education: An Exploratory Study on Design Quality

Francesca D'Elia[1][0000-0003-1441-8101] and Vera Simões[2][0000-0001-5124-2446]

[1] University of Salerno, Department of Human, Philosophical and Educational Sciences, Fisciano (SA), Italy
[2] Sport Science School of Rio Maior, from Polytechnic Institute of Santarém (ESDRM-IPSantarém), Portugal
fdelia@unisa.it; verasimoes@esdrm.ipsantarem.pt

1 Introduction

1.1 AI-Supported Enhancement of Physical Activity Planning in Teacher Education

The ability to analyze and design physical activities is a key component of professional preparation for future primary school teachers. Effective planning requires clear objectives, appropriate methodological choices, attention to safety, and the capacity to propose inclusive adaptations. However, trainee teachers often struggle to critically evaluate existing activities and to formulate their own proposals using precise, coherent, and pedagogically aligned language.

This study explores whether generative Artificial Intelligence (Microsoft Copilot) can support students in improving the quality of their physical activity designs by enhancing clarity, internal coherence, and professional formulation.

The study adopts an exploratory approach, focusing on how AI assisted revision affects the structure and clarity of students' written plans, without extending these effects to students' autonomous competence.

1.2 Rationale for Integrating Generative AI into Physical Activity Design

Large Language Models are increasingly used in higher education to support writing, revision, and instructional design [1]. Recent reviews highlight that AI is reshaping physical education through digital monitoring, instructional support, and data-driven evaluation, and that future PE teachers will need new technological and pedagogical competencies to operate effectively in this evolving landscape [2]. In parallel, research on teacher education in physical activity and sport has highlighted the value of innovative pedagogical approaches such as service-learning, which can strengthen professional, social, and personal skills in pre-service physical education teachers [3]. However, these approaches do not address the use of generative AI as a tool for supporting didactic planning, leaving a gap in how digital technologies can scaffold the design of

physical activities in initial teacher education. This study investigates whether AI-assisted reformulation can:

- strengthen the alignment between learning objectives and proposed tasks,
- improve the organization and clarity of physical activity plans,
- enrich the specificity of inclusive adaptations,
- and support the development of a professional pedagogical register suitable for primary school contexts.

The rationale is to examine AI as a design-oriented scaffold within generalist teacher training in Physical Exercise and Teaching Methodology. The rationale is to examine AI as a design support tool, focusing on changes in the written products rather than on measurable competence development.

2 Integrated Analysis of AI-Supported Activity Design: Methods and Outcomes

2.1 Design and Procedures

An exploratory single-group design was implemented with 57 third-year students enrolled in a university laboratory in Physical Exercise and teaching methodology. All participants:

1. analyzed pre-structured physical activities
2. designed an original physical activity plan
3. used Microsoft Copilot to revise their design through the prompt: *"Improve the coherence between objectives and activities in my design. Suggest an additional inclusive adaptation and reformulate the text using language appropriate for primary school contexts."*
4. completed a questionnaire on perceived improvements, clarity, inclusivity, and limitations of AI use.

Data included original and AI-revised designs, AI-generated suggestions, and students' perceptions. Quantitative ratings captured students' perceived usefulness and clarity of the AI-supported revision, and qualitative thematic analysis examined changes in structure, inclusivity, methodological alignment, and professional tone.

2.2 Effects of AI-Assisted Revision

A total of 57 original designs and 57 AI-revised versions were collected and analyzed. Thematic analysis identified three main patterns:

- Improved structural coherence, with clearer links between objectives and tasks.
- Enhanced inclusivity, through more specific and actionable adaptations.
- More consistent professional register, with age-appropriate pedagogical language.

Quantitative ratings showed that 82% of students perceived improvements in clarity, 76% in objective–activity coherence, and 71% in inclusivity. Students also reported

limitations, including concerns about over-reliance and the AI's lack of knowledge of the specific classroom context.

These results describe changes in the revised texts and should not be interpreted as evidence of competence development or transfer.

3 Conclusion

The analysis indicates that AI-supported revision was associated with clearer, more coherent and more inclusive activity plans. The revised texts showed better alignment between objectives and tasks, more specific adaptations, and a more consistent professional register.

Students perceived AI as a useful aid for refining ideas and improving the clarity of their written plans, while also noting limitations such as the risk of over-reliance and the AI's lack of knowledge of the specific classroom context. These observations refer to the revised written products and do not extend to students' autonomous performance.

Overall, the study offers initial evidence on how generative AI can support the revision of physical activity design in teacher education, and suggests directions for future research on competence transfer and on the integration of LLMs into curriculum and laboratory design.

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AI Supported Metacognitive Reflection in Physical Education Teacher Training: A Quasi Experimental Advancement of an Integrated Self-Assessment Model

Francesca D'Elia[1][0000-0003-1441-8101] and Susana Franco[2][0000-0002-5752-5233]

[1] University of Salerno, Department of Human, Philosophical and Educational Sciences, Fisciano (SA), Italy
[2] Sport Science School of Rio Maior, from Polytechnic Institute of Santarém (ESDRM-IPSantarém), Portugal
fdelia@unisa.it; sfranco@esdrm.ipsantarem.pt

1 Introduction

1.1 AI as a Reflective Scaffold in Motor Self-Assessment for Trainee Teachers

Metacognitive reflection plays a crucial role in the development of professional competence in trainee primary school teachers [1, 2], particularly in the domain of physical education, where awareness of bodily sensations, execution strategies and movement quality supports both physical literacy and methodological decision making [3]. However, university students often struggle to articulate their physical experience using technical, coherent and educationally meaningful language.

Previous research has shown that integrating quantitative motor tests with qualitative self-reflection can generate multidimensional motor profiles and enhance body awareness. In a recent study, has been [4] proposed an integrated assessment model combining objective performance measures with subjective observations to support reflective competence in trainee teachers. The present study explicitly extends this model by introducing generative Artificial Intelligence (Microsoft Copilot) as an additional reflective scaffold within the self-assessment process. Building on this model, the present study explicitly investigates whether generative Artificial Intelligence (Microsoft Copilot) can enhance metacognitive processing, linguistic clarity and technical accuracy in students' motor self-assessment.

1.2 Generative AI as a Tool for Reflective Learning in Physical Education

The study addresses the following research question: Can AI-supported text reformulation and AI-generated prompts improve the quality of metacognitive reflection compared to traditional self-assessment? This objective is grounded in the hypothesis that AI may facilitate the re-formulation of thought, deepen awareness of bodily sensations and strategies, and support the emergence of more coherent and technical educational language.

Generative AI and Large Language Models (LLMs) are increasingly used in higher education to support writing, feedback generation and reflective learning [5, 6]. Their potential in kinesiology and physical education, however, remains underexplored. This study examines whether AI-supported text reformulation and AI-generated reflective

prompts can enhance clarity, depth and technical accuracy in students' physical self-evaluations.

2 Methods and Outcomes of the AI-Supported Self-Assessment Study

2.1 Design and Procedures

A quasi experimental parallel group design was implemented with 440 third year students enrolled in a university laboratory on motor education. Group assignment followed the preexisting laboratory schedule: the first three groups served as the control group (traditional self-assessment), while the last three groups formed the experimental group (AI supported self-assessment).

All participants completed a battery of standardized field tests and an open ended qualitative self-evaluation. Only the experimental group used Copilot to reformulate their written reflection and respond to AI generated metacognitive questions. All students in the experimental group followed a standardized procedure: they pasted their original reflection, applied a fixed Copilot prompt, obtained an AI reformulated version, received AI generated metacognitive questions, and produced additional reflective answers.

Data collection included original and AI reformulated texts, AI generated prompts, questionnaires on motor experience and attitudes toward physical activity (all participants), and questionnaires on AI perception (experimental group).

Clarity, technical accuracy and metacognitive depth were evaluated using a structured rubric and qualitative coding applied to both original and AI supported reflections. Quantitative analyses examined perceived usefulness, clarity and reflective depth, while qualitative thematic analysis compared structure, technical accuracy and metacognitive richness across groups.

2.2 Outcomes of AI-Supported Reflection Compared to Traditional Self-Assessment

Out of 440 participants, a total of 372 complete self-assessment responses were collected and analyzed across both groups.

Analysis of the control group revealed that only 35% of students used at least two technical terms (e.g., posture, coordination, rhythm) in their reflection, and only 32% articulated explicit metacognitive strategies such as focusing on breathing, fixing a visual point or adapting movement.

Rubric scoring showed higher metacognitive depth in the AI-supported group (3.8/5) compared to the control group (2.3/5). AI-generated prompts elicited more structured reflections, with explicit references to bodily sensations, execution strategies and movement quality, which were largely absent in the control group.

Students in the experimental group also reported higher perceived clarity and usefulness of the reflective process, confirming the hypothesis that AI can support the re formulation of thought and the emergence of more coherent educational language.

3 Conclusion

The results demonstrate that AI supported self-assessment substantially improves the clarity, technical accuracy and metacognitive depth of students' reflections. The integration of Copilot enabled students to articulate bodily sensations, strategies and movement quality with greater coherence and disciplinary precision. AI generated prompts played a decisive role in stimulating deeper analysis and fostering the emergence of technical educational language.

Students perceived AI as a valuable scaffold for clarifying thought and enhancing reflective writing, while also expressing concerns about over-reliance and the need for pedagogical guidance.

Overall, the study advances the integrated self-assessment model by showing that generative AI can function as an effective reflective partner in physical education teacher training, supporting digital competence, metacognitive awareness and professional language development.

These findings offer evidence-based insights for AI-enhanced laboratory design, curriculum innovation and the pedagogical integration of LLMs in kinesiology and physical education within higher education.

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Artificial Intelligence and Sport Sciences: Pedagogical Implications of Digital Learning

Giuseppe Giardullo [1,2][0009-0003-9319-4077], Anna Antonia Valenzano [3][0000-0002-9346-4108], Gaetano Altavilla [2][0000-0001-8436-7819]

[1] Department of Neuroscience, Biomedicine and Movement, University of Verona, Italy.
[2] Research Centre of Physical Education and Exercise, Pegaso University, 80143 Napoli, Italy.
[3] Department of Clinical and Experimental Medicine, University of Foggia.
giuseppe.giardullo@univr.it, anna.valenzano@unifg.it, gaetano.altavilla@unipegaso.it

1 Introduction

The use of Artificial Intelligence (AI) in educational contexts is significantly transforming teaching, learning, and assessment processes, increasingly affecting the field of Sport and Exercise Sciences as well [1]. The introduction of intelligent digital tools, adaptive platforms, and learning analytics systems has expanded opportunities for the personalization of educational pathways and the monitoring of performance. At the same time, however, it has raised pedagogical, ethical, and methodological concerns [2]. Despite the growing adoption of these technologies, the scientific literature remains fragmented and characterized by heterogeneous approaches, making it difficult to achieve a comprehensive understanding of the impact of AI on educational processes related to movement and physical activity [3,4]. The aim of this study is to identify the main educational applications, the reported benefits, and the emerging pedagogical and relational issues associated with the use of Artificial Intelligence.

2 Methods

A systematic literature review was conducted following the PRISMA guidelines and the PICOS framework. The search was carried out in the Scopus, Web of Science, and PubMed databases, selecting articles published within the last five years in English and Italian. The inclusion criteria encompassed studies focusing on the use of Artificial Intelligence, intelligent systems, and digital technologies in educational contexts related to Sport and Exercise Sciences, sport, and physical activity. Following the PRISMA process, 312 records were identified across the three databases, 76 duplicates were removed, and 236 records were screened by title and abstract. Fifty-five full-text articles were assessed for eligibility, and 22 studies met the inclusion criteria and were included in the qualitative synthesis. The search combined keywords related to Artificial Intelligence, Sport Sciences, Physical Education, Learning, and Education using Boolean operators across the selected databases.

3 Results

The 22 included studies mainly investigated Artificial Intelligence applications for personalized learning, motor performance monitoring through wearable sensors, computer vision, and intelligent feedback systems, automated assessment, and educational decision-making. Most studies adopted qualitative or mixed methods approaches and were conducted in higher education and teacher education settings, with the majority originating from Europe and Asia. Overall, the evidence indicates that AI enhances student engagement, supports individualized learning pathways, improves the monitoring and assessment of motor performance, and facilitates data-informed educational decision-making. At the same time, the reviewed studies consistently highlighted concerns regarding data privacy, algorithmic transparency, and the need to preserve the embodied and relational dimensions of learning in Sport and Exercise Sciences.

4 Conclusion

The review confirms that Artificial Intelligence represents an important resource for innovation in physical education and motor learning, provided that its use is accompanied by critical pedagogical reflection and by educational models capable of integrating technology, embodiment, and educational relationships. Unlike other educational domains, Sport and Exercise Sciences require AI to support, rather than replace, embodied interaction, motor experience, and the educational relationship between teacher and learner. This highlights the need for pedagogical models that integrate technological innovation while preserving the relational, experiential, and embodied nature of learning in Sport and Exercise Sciences.

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Artificial Intelligence and Boxing: Use of AI as Support for Match Preparation

Giuseppe Penna[1[0000-0001-5075-1265]], Francesca Martusciello[2[0009-0006-5451-6944]] and Gaetano Altavilla[3[0000-0001-8436-7819]]

[1] Faculty of Kinesiology, University of Split, Split, Croatia
[2] Foro Italico, University of Rome, Rome, Italy
[3] Research Centre of Physical Education and Exercise, Pegaso University, Naples, Italy
giuseppe.penna85@gmail.com
francesca.martusciello@uniroma4.it
gaetano.altavilla@unipegaso.it

1 Background

Artificial intelligence is playing an increasingly important role in sports performance and decision-support systems [1, 2]. In recent years, the application of machine learning, motion analysis, and video analysis tools has shown potential applications in performance analysis and monitoring within combat sports [2-4], with similar applications also emerging across other sports disciplines [5, 6]. In boxing, match preparation requires the integration of technical-tactical, physical, and cognitive components closely related to opponent characteristics and the specific demands of the bout. Currently, opponent analysis and training planning are mainly based on direct observation and video analysis, with limited possibilities for systematic extraction of performance patterns [7]. In this context, artificial intelligence may represent an innovative support tool for the identification of recurrent patterns and for the personalization of match preparation.

2 Purpose

The aim of this preliminary study was to evaluate the potential applicability of artificial intelligence systems in the analysis of combat patterns, in order to support match preparation through greater personalization of the athlete's technical-tactical, physical, and cognitive preparation according to opponent characteristics and match demands [2-4]. In particular, the study aimed to explore the possible contribution of AI in understanding the technical-tactical, physical, and cognitive demands of the match, in order to support a more specific and individualized preparation of the athlete.

3 Methods

Publicly available videos of boxing matches were analyzed using video analysis tools and a computer vision-based methodological framework integrating modules for athlete detection and tracking, pose estimation, automatic action recognition, and temporal analysis of recurrent movement patterns [1-4, 7]. The analysis considered parameters

such as punch frequency and typology, offensive combinations, defensive behaviors, movements, combat rhythm, and recurrent movement patterns. The extracted data were subsequently interpreted in relation to their possible applications in match preparation planning and in defining the specific technical-tactical, conditional, and cognitive demands of the bout [3, 4].

4 Results

The preliminary analysis highlighted the possibility of identifying punch frequency and typology, prevalent offensive combinations, repetitive defensive behaviors, preferred movement directions, combat rhythm variations, and recurrent technical-tactical patterns [1, 2]. Furthermore, the integrated interpretation of the extracted data suggested the potential usefulness of AI in identifying specific conditional and cognitive match demands potentially relevant for the personalization of athlete preparation. The findings suggest that such information may contribute to supporting match preparation, promoting greater personalization of the athlete's technical-tactical, physical, and cognitive demands according to opponent characteristics and the specific requirements of the bout [3, 4].

5 Conclusions

The use of artificial intelligence applied to video analysis in boxing may represent an innovative support tool for coaches and athletes during match preparation. Although further methodological validation and applied developments are still required, the preliminary findings suggest a potential role of AI in the personalization of technical-tactical, physical, and cognitive preparation in combat sports. The integration of video analysis, machine learning, and performance analysis may contribute in the future to the development of increasingly specific and individualized preparation models according to opponent characteristics and match demands, while also representing a potential educational support for the training of coaches and sport science students in the analysis of the technical-tactical, physical, and cognitive demands of boxing.

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ChatGPT as a Support Tool for Neuromuscular Data Interpretation in Sport Science Education: A PRISMABased Scoping Review

Giuseppe Di Lascio[1,2][0009-0001-3628-184X], Elton Spahiu[3][0000-0001-7500-6229], Vincenzo Manzi[2][0000-0002-0331-5417]

[1] Department of Neuroscience, Biomedicine and Movement, University of Verona, Italy
[2] Research Center of Physical Education and Exercise, University of Pegaso, Italy
[3] Department of Physical Activity, Recreation and Tourism, Faculty of Physical Activity and Recreation, Sport University of Tirana, Albania
giuseppe.dilascio@univr.it

1 Background

The rapid evolution of Artificial Intelligence (AI), particularly Large Language Models (LLMs) such as ChatGPT, has generated increasing interest in their potential applications across higher education and sport science and applied practise [1,2], where they are being explored as tools to support learning, critical thinking, evidence-based reasoning, and decision-making [3,4,5]. Within sport science, AI has also been progressively integrated into athlete monitoring, biomechanics, performance analysis, and health management, highlighting the need for future practitioners to develop competencies in the interpretation of increasingly complex datasets [6,7,8]. Among these competencies, the interpretation of biomechanical, neuromuscular, and performance-related data has become fundamental for evidence-based assessment, exercise prescription, and athlete performance optimization. Despite the rapid expansion of AI applications within sport science, it remains unclear to what extent ChatGPT and other LLMs have been investigated as educational support tools for developing these analytical competencies. Given the limited evidence directly addressing neuromuscular data interpretation, the review also considered studies investigating broader educational applications of LLMs within sport science to contextualize the current state of knowledge. Therefore, rather than evaluating the effectiveness of ChatGPT, the primary aim of this PRISMA-ScR was to systematically map the available scientific literature concerning the educational use of ChatGPT and other LLMs within sport science, with particular attention to studies addressing biomechanical, neuromuscular, and performance-data interpretation. A secondary aim was to identify the characteristics of the existing evidence, highlight current knowledge gaps, and provide directions for future research.

2 Methods

This scoping review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMAScR) guidelines. Electronic searches were conducted in PubMed, Scopus, and ERIC for studies published between January 2022 and July 2026. The search strategy

combined terms related to ChatGPT, Large Language Models, Artificial Intelligence, sport science, exercise science, education, learning, and performance analysis. The searches identified 979 records (PubMed = 721; Scopus = 217; ERIC = 41). Following duplicate removal, title and abstract screening, and full-text eligibility assessment according to predefined inclusion and exclusion criteria, 11 studiesmet the eligibility criteria and were included in the final synthesis. Data extraction focused on study characteristics, educational context, AI application, reported educational benefits, limitations, and implications for sport science education.

3 Results

The review identified an emerging body of literature investigating the application of ChatGPT and other LLMs within sport science and related disciplines. Most of the included studies explored AI as a tool to support learning, exercise prescription, trainingprogram development, knowledge acquisition, and professional decision-making. Several studies also described broader applications of AI in biomechanics, athlete monitoring, sports medicine, and performance analysis. However, the mapping of the available evidence revealed that only a small proportion of the literature specifically investigated the educational use of LLMs for interpreting biomechanical, neuromuscular, or performance-related data. Across the included studies, the principal reported benefits included improved accessibility to scientific information, interactive learning, personalized educational support, and enhanced reflective reasoning. Conversely, common limitations included concerns regarding response accuracy, hallucinations, transparency, ethical implications, and the continuing need for expert supervision.

4 Conclusion

This scoping review mapped the current literature concerning the educational application of ChatGPT and other LLMs within sport science and demonstrated that, despite growing scientific interest, the available evidence remains limited and highly fragmented. Current research primarily focuses on educational support, exercise prescription, and general decision-making, whereas studies specifically addressing the interpretation of biomechanical, neuromuscular, and performance-related data remain scarce [9,10,11]. Rather than indicating a lack of potential, these findings identify an important knowledge gap and suggest that this represents an emerging area of investigation. Future research should move beyond descriptive applications and experimentally evaluate whether AI-assisted educational strategies can effectively improve students' analytical competencies, interpretation of neuromuscular data, and evidence-based decision-making within sport science education.

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Doctoral Consortium

From Biosignals to Learning Outcomes: A Counterbalanced Machine Learning Framework for Evaluating e-Learning Effectiveness

Pietro Squeri[1,2][0009-0006-8241-2704],
[1] CNR-IMEM. Parma, Italy
[2] CHIMOMO Dept., University of Modena and Reggio Emilia, Modena, Italy
pietro.squeri@studenti.unimore.it

1 Introduction

The increasing adoption of online and hybrid learning environments has increased the need for evaluation and improvement of instructional design. In traditional classroom settings, instructors can continuously modify their teaching based on direct observation of students' reactions, questions, and participation while online learning environments often rely predominantly on post-hoc evaluation methods such as test scores, questionnaires, and course evaluations. Thus, understanding how learning processes react and adapt to instructional material during the learning process itself remains a major challenge in educational research [1].

With the recent advances in Multimodal Learning Analytics (MMLA) [2,3] there have been several attempts in using physiological signals, such as electroencephalography (EEG), electrodermal activity (EDA), and heart rate variability (HRV), to model learner-related constructs, such as engagement, cognitive load or stress. These approaches, however, are mostly focused on modeling the student and often show limited generalizability across learners due to the highly individual nature of physiological responses [3]. This study proposes a shift in perspective, focusing on instructional materials rather than on individual learners. The underlying idea is to treat learners as sensors of instructional quality: instead of investigating what physiological responses reveal about the learner, aggregated responses across multiple learners are used to characterize the effectiveness of instructional materials. While individual physiological responses are inherently noisy and subject specific, aggregating physiological responses across multiple learners may reveal stable patterns associated with specific instructional design choices.

The PhD research will be guided by the following questions:

RQ1: Can aggregated physiological responses reliably discriminate between instructional materials implementing different instructional design principles?

RQ2: Which physiological modalities provide the most informative indicators of instructional effectiveness and can therefore be prioritized in MMLA models?

RQ3: Can eXplainable Artificial Intelligence (XAI) techniques identify interpretable relationships between instructional design features, physiological responses, and learning outcomes?

2 Proposed Methodology

To investigate these questions, a controlled experimental protocol is proposed. Participants are exposed to two instructional units (Material A and Material B), covering different topics but designed to be equivalent in terms of learning objectives, duration, and difficulty. A provisional target sample of approximately 40–60 university students is planned for the initial study.

Participants will be recruited through participating courses and institutional calls. The target sample size will be refined after an initial pilot phase assessing protocol feasibility and physiological signal quality. The units systematically differ with respect to selected pedagogical variables, such as segmentation, information density, or use of visual aids, following established principles of multimedia learning and instructional design [4]. This study adopts a counterbalanced experimental design to control for order effects. One group is exposed to Material A followed by Material B, while the second group is exposed to Material B followed by Material A. Participants complete a pre-test before being exposed to each instructional material and a post-test immediately after. Learning gains are computed as the difference between post-test and pre-test scores [5]:

$$\Delta\text{Score} = \text{PostTest} - \text{PreTest}$$

Physiological data will be continuously collected during the learning sessions, such as HRV, EDA, and, optionally, EEG signals. Behavioral data will be extracted from the Virtual Learning Environment (VLE), such as navigation patterns, interaction frequency, and time-on-task indicators. A Machine Learning (ML) pipeline will be employed for signal preprocessing, feature extraction, and multimodal data fusion [6]. Interpretable ML models and XAI [7] will be used to investigate physiological and behavioral patterns associated with learning gains. As the research progresses, temporal multimodal models will be explored to capture the dynamic nature of learning processes. The proposed framework will be considered successful if it identifies physiological patterns that consistently generalize across learners and reliably characterize specific instructional design features associated with higher learning gains.

3 Conclusions

This PhD project proposes a shift from traditional learner-focused physiological modeling toward a content-focused perspective for evaluating instructional effectiveness. Rather than using physiological signals to predict the learner's internal states such as stress, engagement, or cognitive load, the proposed framework investigates whether aggregated physiological and behavioral responses can reveal characteristics of instructional materials associated with specific learning outcomes.

By combining MMLA, biosignal processing, and XAI within a controlled counterbalanced experimental design, this research aims to provide new evidence on how instructional design influences learning processes in online environments.

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THE TRANSCOMPLEXITY OF APPLICATIONS IN NEW AI TECHNOLOGIES, IN THE TRAINING OF OLDER UNIVERSITY TEACHERS.

Hidalgo. Panecasio, Denisse [1][0009-0001-0561-0532]

[1]University of eCampus, Italy
denissepanecasio@gmail.com
denisse.panecasio@uniecampus.

1 Introduction and Objectives

This article is presented as a proposal to the doctoral consortium, with the intention of fostering discussion and receiving guidance on the potential dimensions that will arise in transcomplex research. The work aims to address the inclusive reality experienced by adult university faculty regarding the use of new AI technologies. Its general objective is to demonstrate the inclusive reality experienced by adult university faculty regarding the conscious use of AI applications from a transcomplex perspective. The goal is to understand the cognitive domains, sociocultural criteria, and real educational perspectives that professors between 55 and 75 years of age experience with new AI technologies geared towards the productive development and planning of their academic activities. The research seeks to generate theoretical approaches that facilitate better guidance and interdisciplinary support in the continuing and inclusive professional development of older university faculty, and the conscious use of this technological tool.

2 Theoretical Perspectives

Transcomplex research is based on transdisciplinarity, which involves dialogue between the natural sciences, the social sciences and the humanities, as well as between scientific knowledge and traditional or popular knowledge; because it seeks ways of understanding and acting in the world that goes beyond complexity, that integrates different dimensions and that seeks to generate innovative and transformative solutions to current problems [1]. Transcomplex research is assumed to be an investigative vision of complementarity that allows the production of complex and transdisciplinary knowledge [2,3]; It is an integration of knowledge that fosters understanding between cultures, communication, scientific knowledge, and philosophical reflection, recognizing the coexistence of multiple logics. It takes as a reference point Rogerian theory in the development of the concept of self; people possess characteristic physical, relational, and cognitive traits that make them unique. Being aware of these characteristics leads the individual to relate through their behaviors and physical attributes, which constitutes the subject as a person [3]. These characteristics are important elements when

conducting social research studies, since the subject or subjects in the study, by being aware of their own individual characteristics, will allow them to make use of their full freedom and personal dignity of thought and action within a climate of equal inclusive opportunities in their work environment and in their free time [3,4]. From the perspective of social constructivism; Every change in cognitive organization is a personal construction, based on the learning experience, in which people put their abilities into play and expand them [4,5]; Our knowledge is not a copy but a true construction and a condition for new learning. The individual is not a passive recipient but an entity that mediates the selection, evaluation, and interpretation of information, giving meaning to their experience [5]. The correspondence between knowledge and reality is understood as the functional adaptation of people to an interpretive world [6]. In the academic field of social sciences, hermeneutics has been recognized as a philosophy of understanding through language. Hermeneutic reflection is the being of consciousness that is exercised in symbolic implication with the world, with science, identity, and meaning. It is essential to accept that interpretation is not univocal; no one possesses a single interpretation, nor the final one: we live in a world of contrasts and have developed in different spaces, so we face things from diverse angles [7]. Technological literacy promotes the critical use of technologies, as well as the knowledge to take advantage of their diverse pedagogical, educational, social and communicative potential; A digital literacy model goes far beyond the simple acquisition of skills to use the computer [8]. We must attend to all population sectors to achieve local and subsequently global developments, focusing on technological literacy to access information, communication and training [8]. Facilitating access to and literacy in digital technologies enables adults and people living in rural areas and from different social classes to actively and critically participate in a democratic society, developing their potential and generating human capital that is the core of integral social development [8].

3 Methodology

The method to be used to approach the research will be the hermeneutic one, which seeks the interpretation of the information obtained from the key informants; the study will be of a qualitative nature, which directs its development towards obtaining knowledge of reality with its informants and actors; the information collection technique will take place in three phases: Preparatory: compilation of diverse information with an exploratory character from the theoretical perspective [9]; Fieldwork: Setting selection: In the interpretive paradigm, people are not reduced to variables but considered as a whole, since the researcher studies them in the context and situations in which they find themselves [9,10]. For data collection, three Italian universities will be selected as the setting; the key informants are people with specialized knowledge and good information capacity [11,12]. To be defined. The interpretation of the information will be supported by coding and categorization respectively; these are activities that revolve around a fundamental operation: In this sense, the information will be categorized, which will consist of finding characteristics that will

allow the researcher to identify emerging categories using the information collected [12].

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Listening Through the Body: A Fully Digital Experimental Pilot on Body-Focused Attention and the Receptive Musical Listening State

Giorgio Giuliano[[0009-0006-0361-0922]]

Pegaso Telematic University, Naples, Italy; University of Camerino, Camerino, Italy
[giorgio.giuliano@unipegaso.it]

1 Context and State of the Art

Structured bodily practices, whether contemplative, physiological or musical, recur across cultures as ways of inducing beneficial non-ordinary states relevant to mental health. The doctoral project in which it is embedded treats them as a coherent programme pointing toward the therapeutic use of the mind-body connection; this study is one of its empirical stations. The clinical motivation is concrete: meta-analytic evidence indicates that receptive, listening-centred approaches reduce anxiety substantially more than active music-making [1]. How such a state arises, and whether it can be deliberately induced, remains poorly understood. The question is also instructional: the manipulation is a brief mediated instruction, and what it should modify is not knowledge but how attention is directed. Bodily engagement affects learning outcomes in technology-mediated settings [2], yet whether it can be induced briefly and measured remotely is untested. The literature itself flags a specific gap. A single music-listening session can raise state mindfulness even against an active control [3]; the same authors call for exactly the comparison this pilot performs, never yet carried out. "Interoceptive music listening" has been proposed as the deepest level of a receptive-listening continuum, on qualitative grounds [4]. Studies placing a body-scan or breath-focus before listening report that participants listened "in a different way", yet the state was never isolated or measured [5,6]. The "going-toward" pole of musical engagement, or groove, is well mapped; the receptive, "letting-go" pole is not, despite reports of involuntary movement during intense listening [7].

2 Research Objectives and Questions

In a fully remote digital pilot, the study estimates whether a brief body-centred mindfulness exercise before listening shifts the listening experience, relative to a matched exercise directing attention elsewhere. Does the body-focused induction raise *state* interoceptive awareness more than its control? Is the induced state associated with more receptive, immersive listening and more positive affect? And, exploratively, does it elicit spontaneous, non-agentive movement rather than volitional, groove-like movement?

3 Methodological Approach

The design is between-subjects, two-arm and fully remote, with adults recruited online, mostly students. After a state assessment, they are randomly allocated to one of two brief audio-guided inductions: a mindfulness exercise directing attention to the body, or a matched exercise directing it elsewhere. The recordings are identical in voice, length, format, framing and expectations, differing only in the direction of attention, a demanding contrast: over two weeks such exercises raised interoception similarly, with only fragile evidence favouring the body scan [8]. They then listen to a standardized programme chosen for its receptive and immersive potential rather than any established effect, with preference controlled [9].

Embodied, receptive listening, the primary outcome, is measured not by a bespoke instrument but through validated inventories of immersive and absorbed listening [10,11] and phenomenological items. Since the receptive state must be told apart from sedation and dissociation, activation is decomposed into energetic and tense components, alongside retained-awareness items. *State interoceptive awareness*, the hypothesised mediator [12], is the change on a state measure taken before the music. *Spontaneous, non-agentive movement* has no validated instrument: a pictographic module types each reported posture as ceded, groove-like or still, with duration and intensity. Declared exploratory, it keeps the architecture non-circular. Safeguards include naïve participants, screening with a stop-rule, adverse-event monitoring and pre-registration.

4 Expected Outcomes and Contributions

No data have been collected yet: what follows states expected contributions, not preliminary results. The mechanism is not expected to be confirmed here: against so close a twin the induction contrast should be small, and a null on the mediational path would be uninformative rather than disconfirming. The pilot estimates these effects to inform a confirmatory study. Two applications may be considered, provisionally and without empirical support. In practice, a few minutes of mediated guidance before a receptive task, needing no specialised equipment, would suit guided listening in music education and attentional preparation before receptive work, in a lighter format than multi-week curricula reporting attentional gains [13]. For instrumentation, capturing bodily presence and absorption in a sensor-free session addresses a recognised difficulty for distance and blended learning, where embodied engagement matters but is rarely measurable without dedicated hardware [2]; the toolkit assembled here would need pairing with learning-relevant outcomes.

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From Virtual English Learning to AI-Enhanced CLIL Science Education: A Mixed-Methods Protocol for Pre-Service Primary Teacher Education

Alfonso Filippone[1][0009-0009-1120-6630]

[1] Department of Educational and Sports Sciences, Pegaso Telematic University, Italy
alfonso.filippone@unipegaso.it

1 Introduction

The digital transformation of education requires learning environments capable of fostering participation, accessibility, collaboration, and meaningful learning, going beyond the mere technological delivery of content. From this perspective, immersive virtual worlds can support interaction, authentic tasks, motivation, and knowledge construction, provided they are grounded in coherent and inclusive instructional design [1-3].

This study is part of a broader doctoral project on learning and knowledge co-construction in virtual worlds as an innovative methodology to fostering disciplinary competences, life skills, and digital soft skills in school and higher education. The project includes two longitudinal strands: a three-year study on the Technology CLIL Virtual World in lower secondary school and a study on virtual worlds in English language courses within bachelor's and master's degrees. Within the higher education strand, the present work focuses on teacher education, considering virtual worlds as spaces for learning, instructional design, and professional reflection [4-8].

2 Background, preliminary evidence and study aim

An empirical phase of the teacher education initiative was conducted using the English LAB Virtual World – a FrameVR environment integrated into university English language laboratories for prospective primary school teachers. This quasi-experimental, mixed-methods study involved 430 Primary Education students and compared an immersive blended learning pathway with a traditional face-to-face setting. The experimental group showed significant improvements in language proficiency, motivation, perceived usability, and life skills, especially critical thinking, collaboration, communication, and problem-solving ($p < .001$) [9]. Qualitative data also highlighted engagement, autonomy, peer interaction, and a safe, learning climate.

Based on these findings, the study developed and evaluated a CLIL science education protocol set in AI-enhanced virtual worlds, aimed at prospective primary school teachers. The protocol's architecture was refined during a six-month visiting research period at the Universitat Oberta de Catalunya, focusing on online learning design,

inclusive digital pedagogy, and technology-enhanced higher education. It aimed to support both the learning of scientific content through English and the development of the pedagogical, linguistic, digital, and reflective skills needed to design inclusive CLIL pathways for primary education [10].

3 Research questions

The main research question was how an AI-enhanced CLIL-science protocol in a virtual world supported pre-service primary teachers' scientific learning, subject-specific English, and ability to design inclusive teaching pathways. Secondary questions addressed its effects on motivation, self-efficacy, digital and design competences, the AI tutor's contribution to linguistic, conceptual, metacognitive, and pedagogical scaffolding, accessibility, inclusion, ethics, and organizational issues, and transferability of to lower school cycles.

4 Methodology

The study adopted a mixed-methods design with a quasi-experimental structure and cycles of design, implementation, evaluation, and revision. The environment integrated immersive learning, inquiry-based learning, CLIL, Universal Design for Learning, socio-constructivism, and reflective teacher training. The virtual world included scientific scenarios, simulated laboratories, inquiry tasks, collaborative activities, and CLIL lesson-design spaces [11].

The study design distinguished three conditions: a traditional or non-immersive blended condition; a CLIL-science condition in a virtual world without an AI tutor; and a CLIL-science condition in a virtual world with an integrated AI tutor. The tutor, designed and configured by the doctoral researcher, provided terminological, conceptual, metacognitive, and pedagogical scaffolding for CLIL lesson design. It was not conceived as a replacement for the teacher, but rather as a transparent, bounded, and supervised tool aimed at fostering agency, self-regulation, and professional reflection [8, 9, 12].

Quantitative data included pre/post measures on scientific knowledge, English for science, CLIL self-efficacy, motivation, digital competence, perceived inclusion, attitudes towards AI, and usability. Qualitative data included reflective journals, focus groups, observations, lesson plans, open-ended responses, and interaction logs. The analysis combined pre/post and between-group comparisons with thematic analysis of immersive experience, scaffolding, inclusion, reflection, and transferability.

5 Expected Contributions

The study situated the AI-enhanced CLIL science protocol within the broader doctoral framework on virtual worlds, clarifying the connections between lower secondary education, higher education, and teacher training. Theoretically, it explored the

integration of immersive virtual worlds, CLIL, educational AI, and inclusive pedagogy. Methodologically, it proposed a comparative framework to distinguish the contributions of immersion, CLIL design, and the AI tutoring. Practically, it offered a transferable model for designing science education pathways in English through accessible and pedagogically grounded digital environments.

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Academic Writing Online: An E-Tivity-Based Course Design Integrating Process and Product Approaches

Oleksandra Zagorulko[1][0009-0004-0746-7719]

[1] Pegaso Digital University, Centro direzionale, Isola F2 - 80143 Naples, Italy
oleksandra.zagorulko@unipegaso.it

1 Introduction

Academic writing (AW) is a complex, multidimensional competency that depends on iterative interaction between instructor and learner. The shift toward online and higher education has outpaced the development of course-design frameworks suited to this kind of interaction, leaving AW instruction poorly served by generic online formats. This study addresses that gap by adapting the e-tivity model [1, 2] for online AW instruction, drawing on Mayer's Cognitive Theory of Multimedia Learning [3] to manage the cognitive demands of digitally mediated writing tasks and on a Language Awareness (LA) [4] perspective to ground the pedagogical rationale behind feedback-centered course design.

2 Research Objectives and Questions

The study investigates whether a completely online course for AW, structured around an adapted e-tivity model, affects students' writing competencies, and how such a model should be designed to support this. AW, here, is treated as a competency requiring both product- and process-oriented instruction in tandem, i.e. clear target texts and explicit criteria on one side, iterative drafting and feedback cycles on the other, which is a combination that generic online delivery formats do not support well.

Two questions guide the design: (1) How can academic writing be taught effectively in online university-level contexts, given the iterative, feedback-dependent nature of the competency? (2) To what extent can the e-tivity model be adapted and adopted to a discipline-specific, language-focused instructional context without losing its structural coherence?

3 Context and Motivation

Online AW instruction compounds several documented failure points. Learners face delayed feedback and limited peer collaboration under distance-learning conditions [5]; multimedia-rich delivery adds cognitive load on top of an already demanding writing process [6]; LA remains difficult to sustain and transfer in online settings [7]; and process-oriented writing skills are frequently underdeveloped [8]. Existing online AW approaches tend to address these dimensions separately without a comprehensive

framework that integrates them. This gap motivates a case study testing whether an e-tivity structure, paired with essay-based rather than purely self-reported assessment, can address these problems within a blended AW course.

4 State of the Art

The course design draws on three converging strands: (a) blended product/process pedagogy for AW [8, 9]; (b) the e-tivity model [1], adapted and adopted as the operational framework for this study; and (c) Mayer's multimedia learning principles [3], applied to manage cognitive load in digitally mediated AW tasks. The design is further informed by the LA perspective [4, 10], which frames explicit reflection on language use.

5 Methodological Approach

The study adopts a case study design centered on the second implementation of the course, delivered to fourth-year bachelor's students in Applied Linguistics, preceded by a pilot implementation with doctoral students that informed early design iterations and is reported here as background context rather than as primary data. The course was structured as five sequential e-tivities, each building cumulatively on competencies developed in the previous unit, combining theoretical input with applied writing practice within each stage.

Three data sources triangulate the analysis: pre/post questionnaires capturing students' self-assessed writing competencies and attitudes toward the blended format; student essays assessed through a an analytic rubric spanning five criteria (structure, grammar, vocabulary, coherence, logic), each scored across four performance levels and adapted from established assessment frameworks [11, 12], complemented by a lexicographic analysis of the essay corpus; and a teaching diary documenting lesson-by-lesson design decisions and instructor observations.

6 Expected Outcomes and Contribution

The study offers several related contributions. First, a transferable, ladder-structured e-tivity adaptation for discipline-specific, language-focused online instruction, specifying which design features transfer to this context and which require modification. Second, an operationalization of the product/process blend for AW specifically within this online, e-tivity-based structure. Third, a needs-assessment-driven approach to course design that grounds instructional decisions in the specific competency profile and learning context of the target cohort. Together, these position the study as a case-study contribution to online pedagogy and learning methodologies for writing instruction.

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Medical Humanities and Artificial Intelligence: Towards an Integrated Training Model for Healthcare Education in the Digital Era

Valeria De Padova [1][0009-0006-3282-3820]

[1] Pegaso Telematic University, Naples
valeria.depadova@unipegaso.it

1 Objectives and Research Questions

This doctoral project investigates how AI and immersive technologies can support the development of communicative, relational, and empathic competencies in healthcare professionals, fostering an explicit dialogue with the Medical Humanities (MH).

It originates from the general research question: *How can AI and immersive realities contribute to developing empathic, communicative, and relational competencies in future healthcare professionals?* Findings from the first scoping review, showed that MH are substantially absent from the AI-in-medical-education literature, despite clear thematic overlap. This led to two more specific questions: *Why is the MH framework absent from this literature? How can a conversational AI tool be designed to address this gap, across both adult and pediatric doctor-patient communication?*

2 Context and Motivation

The diffusion of technologies based on algorithms that simulate human cognitive functions has reshaped professional dynamics in healthcare, making citizens more aware of their health status and fostering health literacy (Cardoso *et al.*, 2021). This scenario, however, requires physicians to develop increasingly solid communicative, relational, and empathic competencies alongside clinical ones (Amatori *et al.*, 2024).

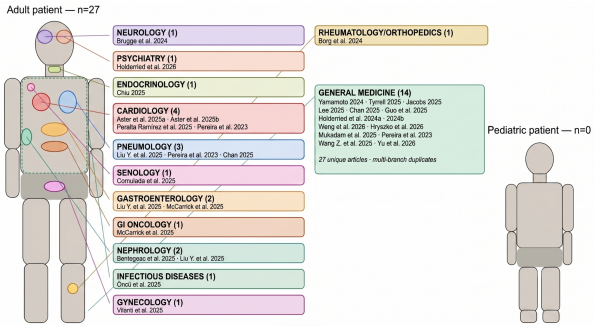
The MH respond to this need, combining scientific and humanistic knowledge to humanize the care experience. In this direction, AI-based conversational chatbots are particularly promising: when embedded in a structured pedagogical pathway, they can become a dialogic space for developing empathic and communicative competencies (Dipace & Olivencia, 2025), in addition to diagnostic ones, within broader forms of synthetic-immersive work supported by AI and the metaverse (Ellerani, 2022).

This perspective becomes all the more urgent the more medicine becomes technologized: as AI enables reaching an increasing number of patients, the need to approach them with greater humanity grows in parallel (Paglialonga & Simonetti, 2025), especially as the rise of chronic conditions turns care into an ongoing process rather than an episodic one (Bobbo, 2020). To empirically ground this framework, a first scoping review was conducted (De Padova, Amatori & Dipace, 2026): from 1.030 records (PRISMA-ScR; Scopus, PubMed, Google Scholar, Elicit), 65 studies (2023-2026) were

included. Results show a predominance of ChatGPT/OpenAI-based chatbots (61.5%) and communication skills as the most frequent training target (27/86 occurrences).

However, two critical gaps emerged: the total absence of the co-occurrence "Medical Humanities", despite implicit relational and empathic content; and the absence of studies on pediatric patients (27 studies on adults, 0 on pediatric patients), likely attributable to the greater complexity of the physician-child-caregiver triadic communication.

Fig. 1. Medical fields involved in the experimental studies: adult n=27, pediatric n=0 (De Padova, Amatori & Dipace, 2026).



This second finding informed a second scoping review on communication and empathy in pediatric settings, currently in preparation (De Padova, Amatori & Dipace, submitted), and reinforced the need to develop AI conversational tools in explicit dialogue with MH and Narrative Medicine (Demetrio, 2021), building on existing experiences such as AskLea (IRCIT Research Centre, European University of Rome).

3 Methodological Approach, Preliminary Findings, and Expected Results

The project follows a phenomenological approach: the biographical method (Demetrio, 2021) for collecting illness narratives, in dialogue with Narrative Medicine; a transformative Research-Action method for developing and testing an AI conversational tool; and focus groups on the perceived role of AI in training contexts.

Preliminary results include the mapping of the MH/AI and pediatric gaps, emerging from the first scoping review (published), and the completion of the second scoping review, currently in preparation. Next steps involve designing a conversational chatbot prototype, configurable for interaction with both adult and pediatric patients (in the presence of a caregiver), and conducting a pilot study with medical students, working towards a tested and transferable training tool for healthcare education curricula.

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Sustainable learning environments: exploring the role of technologies in developing self-regulation

Marika Lamacchia[1] [0009-0008-9944-9217]

[1] University of Macerata, Italy
m.lamacchia2@unimc.it

1 Context and State of the Art

Self-regulated learning (SRL) is widely recognised as a key competence for effective learning and academic success across educational contexts [1]. It refers to learners' ability to regulate cognitive, metacognitive, motivational, and behavioural processes through planning, monitoring, and self-reflection to achieve learning goals [2]. These processes are particularly relevant in technology-enhanced learning environments, where students are increasingly required to learn autonomously and monitor their progress [3,4]. Despite growing interest in digital technologies for supporting SRL, empirical evidence in secondary education remains limited, and many interventions address isolated components of self-regulation rather than integrating cognitive, metacognitive, motivational, and inclusive dimensions within a coherent instructional design [5,6]. Universal Design for Learning (UDL), combined with evidence-based instructional principles, provides a promising framework for designing sustainable learning environments that support both disciplinary learning and SRL [7–11], where sustainability refers to long-term pedagogical effectiveness, inclusiveness, and adaptability.

2 Research Objectives and Questions

The PhD project, Sustainable Learning Environments: Exploring the Role of Technologies in Developing Self-Regulated Learning, investigates how evidence-informed and inclusive technology-enhanced learning environments can promote SRL in secondary education.

More specifically, the project aims to: design and validate a UDL-oriented MOOC integrating evidence-based instructional principles; evaluate its effects on SRL, academic achievement, motivation, and prosocial behavior; examine whether learner characteristics, including Special Educational Needs (SEN), influence the effectiveness of the intervention; derive evidence-informed design principles for developing sustainable and scalable digital learning environments.

The project addresses the following research questions: (**RQ1)** To what extent does a UDL-oriented MOOC improve students' self-regulated learning and disciplinary achievement? (**RQ2)** How do learner characteristics, including SEN, influence the effectiveness of the proposed instructional design? (**RQ3)** Which evidence-based

instructional design principles most effectively support sustainable technology-enhanced learning environments?

3 Methodological Approach

A longitudinal mixed-method quasi-experimental design (T0–T1–T2) compares students participating in a UDL-oriented MOOC with a control group receiving conventional instruction. The MOOC integrates UDL principles with evidence-based instructional strategies to foster disciplinary learning and SRL. Data are collected through validated questionnaires assessing SRL, metacognition, motivation, and prosocial behaviour (MSLQ, MAI, SRQ-A, SDQ), disciplinary performance tasks, and an adapted version of the Self-Regulated Learning Interview Schedule (SRLIS) to explore students' regulatory processes.

4 Preliminary Results

Preliminary findings from the first implementation cycle (N = 27) provide encouraging evidence supporting the feasibility of the proposed instructional framework. A significant positive association emerged between self-regulated learning and prosocial behaviour ($\rho = .360$, $p = .028$). Students participating in the MOOC showed greater procedural recall (Mann–Whitney $U = 49.5$, $p = .043$). Metacognitive performance showed a positive, although non-significant, trend ($p = .072$). Qualitative analyses further indicated that students in the experimental group more frequently reported monitoring and revision strategies, suggesting increased awareness of their learning processes. Overall, these findings provide initial evidence of the framework's potential to foster self-regulated learning in inclusive technology-enhanced environments.

5 Expected Contributions

The project aims to contribute to the development of sustainable learning environments, understood as digital learning ecosystems that remain pedagogically effective, inclusive, and adaptable over time. By integrating Universal Design for Learning with evidence-based instructional principles, the proposed framework seeks to generate transferable instructional design principles for sustainable and inclusive technology-enhanced learning environments. Unlike existing UDL- or SRL-oriented approaches, it combines inclusive design principles, evidence-based instructional strategies, and longitudinal evaluation within a single pedagogical model.

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The Critical and Strategic AI Mediator: Frameworks for Teacher Competence in the Generative-AI Era

Francesco Facciorusso[1][0009-0003-7563-5182]

[1] Department of Education, Cultural Heritage and Tourism, University of Macerata, Italy
f.facciorusso@unimc.it

1 Introduction and State of the Art

The educational landscape is currently experiencing a veritable "pedagogical lag": we are seeing Generative Artificial Intelligence (GenAI) tools being adopted at an increasing rate, while frameworks for teacher competencies and relevant policies remain largely static. In this context, educators risk being left without the "toolbox" needed to identify critical elements inherent to the AI landscape, such as algorithmic biases, echo chambers, and other biases. This research proposes a conceptual shift: moving from passive digital literacy to a critical and strategic mediation of AI, in which teachers not only consume or limit the use of AI, but act as active mediators between the algorithm and the student.

Existing frameworks address AI and digital competence from complementary but partial angles. DigCompEdu [1], Italy's primary reference for teacher certification, defines a general digital-competence progression but predates generative AI and does not address hallucination or algorithmic bias; its revision (3.0) is not expected before 2027. At the same time, the UNESCO AI Competency Framework for Teachers [2] offers a human-centred, ethics-oriented structure across five dimensions, yet remains policy-level. The OECD/EC AI Literacy Framework [3] targets student-facing knowledge and attitudes but not the teacher's mediating role. In Italy, the Ministry's "Linee guida per l'introduzione dell'IA nelle Istituzioni scolastiche" (DM 166/2025) [4] define governance and AI Act "deployer" responsibilities, but remain administrative rather than didactic. This research distinguishes itself by moving beyond theoretical policy models to introduce a practical, classroom-level operational protocol. None of the existing frameworks offers a structured method for teachers and students to jointly audit AI outputs in real-time, nor do they connect such practice to student motivation. Current AI-UDL integrations remain largely static, with limited empirical research on dynamic, non-biased scaffolding that sustains intrinsic motivation during collaborative learning tasks in AI-Mediating Contexts.

2 Methodology

The core innovation of this project lies in operationalizing the Critical and Strategic AI Mediator framework as a concrete pedagogical model which turns classroom interactions into a space for critical co-evaluation of AI outputs.

The study addresses three research questions: RQ1: What cognitive and ethical dimensions constitute the profile of the "Critical AI Mediator," and how can teachers be trained to perform real-time Prompt-and-Response Auditing?; RQ2: How does active pedagogical mediation of AI outputs affect student motivation and cognitive engagement within peer-tutoring frameworks, compared to unmediated AI interaction?; RQ3: How can AI tools be aligned with UDL [5] to create a Dynamic Scaffolding Loop that adapts to diverse learner needs without replicating systemic biases?

The methodological approach includes:

1. Systematic Literature Review: PRISMA-guided reviews [6], cross-referencing AI literacy frameworks, algorithmic bias research, and psychological models of motivation, to ground the AI-Auditing Model in current evidence.

2. MOOC Design and Prototyping: Development of a five-module MOOC that operationalizes the Critical AI Mediator framework: (1) AI Literacy – opportunities, risks and societal impact; (2) Critical Evaluation of AI-Generated Content – text, image/video and deepfake verification, feeding directly into the project's Bias & Hallucination Rubric; (3) AI Bias, Information Bubbles and Misinformation; (4) Ethics, Fairness, Transparency and Responsible Decision-Making; and (5) Prompt Engineering for Accuracy, Creativity and DEI. Each module pairs conceptual input with collaborative prompt-deconstruction activities. Crucially, this research project will focus specifically on Module (2). This module serves as the primary empirical and analytical engine of the study.

3. Empirical Validation: To bridge the validation of the teacher competence framework (RQ1) with the experimental evaluation of student outcomes (RQ2 and RQ3), teachers trained via MOOC Module 2 will actively implement the AI-Auditing protocol. The study employs a Cluster-Randomized Controlled Trial (cRCT) within secondary education settings over an 8-week intervention period. Classrooms will be randomized at the cluster (class) level to ensure ecological validity. To precisely isolate the specific effect of AI mediation from the novelty effect or general collaborative learning, control clusters will utilize the exact same peer-tutoring structures but with unmediated AI access. Variations in student motivation and cognitive engagement (RQ2) will be measured using the Intrinsic Motivation Inventory [7] in a pre- and post-test design. To evaluate AI tools as a Dynamic Scaffolding Loop (RQ3), learning analytics from digital workspaces will be analysed using mixed-effects models tailored for clustered data. Concurrently, the fidelity of implementation and the teachers' real-time auditing efficacy will be assessed via the Bias & Hallucination Rubric, which will undergo prior validation through expert panels and inter-rater reliability testing.

3 Expected Contributions and Potential Impact

This research yields three contributions scope:

Theoretical: a definition of the Critical AI Mediator framework, addressing a gap in international teacher professional development literature.

Methodological: a replicable mixed-methods protocol to quantify the impact of AI evaluation on student cognitive load and motivation.

Practical: an open-access toolkit of AI-UDL rubrics that turns a classroom vulnerability (hallucinations, biases) into a metacognitive learning opportunity.

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Accessibility as a Professional Posture: A Situated Analysis of the Educational Architecture and Disciplinary Structure of the EduNext Master's Degree Course in "Designing Accessible and Inclusive Living Environments"

Alessandro Roveda[0009-0003-6959-9728]

University of Bergamo, Bergamo, Italy
alessandro.roveda@unibg.it

1 Context, Motivation and Theoretical Framework

Over the last two decades, international and European legislation has progressively redefined the construct of accessibility, transforming it from a technical and bureaucratic requirement into a structural condition for the inclusion and full participation of persons with disabilities. At the international level, the *United Nations Convention on the Rights of Persons with Disabilities* [1], the *2030 Agenda* [2], the *European Disability Strategy 2021–2030*, and the *European Accessibility Act* [3] have consolidated this principle. In Italy, this orientation has recently been reinforced through broader and more systemic legislative interventions, including *Legislative Decree No. 62 of 2024* [4], implementing Law No. 227 of 2021, which links the right to accessibility to the definition of the personalized and participatory life project of the person with disability and to the adoption of the bio-psycho-social model promoted by the *International Classification of Functioning, Disability and Health* [5].

Within this framework, accessibility is increasingly understood not as an ex post corrective measure directed exceptionally at a few individuals as an emergency response, but as a *cultural posture* [6] that should permeate the education of every professional involved in designing contexts from the earliest stages of their conceptualization, regardless of their role and disciplinary specialization. This requires professionals capable of interpreting the needs and contexts of persons with disabilities through a systemic perspective integrating multidisciplinary knowledge and competences. Universities are therefore called upon to develop research-based pathways on inclusion and accessibility in sustained dialogue with territorial stakeholders [7]. Despite this normative and cultural evolution, however, university curricula remain largely organized around disciplinary silos that confine accessibility to circumscribed thematic spaces, with limited capacity to support its internalization as a stable and transversal professional disposition [8, 9]. This doctoral research addresses this gap by taking as a case study the inter-university Master's Degree in *Design of Accessible and Inclusive Living Environments*, promoted by the University of Bergamo and the University of Salento within the *Digital Education Hub EduNext* [10]. The programme is structured according to the ECOBI model (Educational Cluster, Open Badge, Blended Intensive Programme) [11], which organizes interdisciplinary clusters, certifies competences through open badges, and combines predominantly online teaching with intensive in-person sessions. The blended design places the traditionally campus-based university within debates on online learning as an environment with its own epistemology rather than a mere transposition of face-to-face teaching [12].

The study draws on transformative learning theory [13, 14], the notion of habitus [15], and the perspective of communities of practice [16] to frame accessibility not simply as a set of fragmented knowledge and skills distributed across a curriculum, but as an embodied and multidimensional disposition shaped through the critical and collective elaboration of educational experience.

2 Research Question and Objectives

The research question investigates which pedagogical processes and conditions the EduNext Master's Degree activates or hinders in transforming students' representations and developing design competences, and to what extent these processes are associated with the emergence of a professional orientation toward accessibility and inclusion.
The specific objectives include: evaluating the coherence between the pedagogical architecture of the programme and its predominantly online delivery; identifying the factors that facilitate or hinder the acquisition of transversal accessibility competences; verifying the alignment between disciplinary content and the expected graduate profile; and formulating recommendations for instructional design grounded in the ECOBI model.

3 Methodological Approach

The research is conceived as a single instrumental case study [17, 18], based on situational analysis [19] and structured around a logic of multi-source triangulation. Data will be collected longitudinally across the ex ante, in itinere, and ex post phases of the programme to trace the diachronic transformation of students' representations, while synchronic triangulation among students, faculty, tutors, instructional designers, and external stakeholders will be pursued through document analysis, structured and semi-structured interviews, focus groups, systematic observation, and qualitative analysis of students' artefacts. A complementary quantitative strand will treat data from learning analytics descriptively and comparatively. The internal components of the ECOBI model (interdisciplinary clusters, intensive sessions, distance activities) will in turn be compared to assess their relative contribution to the acquisition of the desired professional disposition, while a parallel review of national and international literature on accessibility and online higher education will provide an additional external point of reference. Data will be analysed through thematic analysis [20].

4 Expected Outcomes, Contributions and Current Progress

The research aims to produce an analytical framework that relates the pedagogical architecture of the programme to the activation - or inhibition - of transformative learning, together with a description of the practical dynamics that support a shared professional disposition among students and faculty. Beyond the evaluation of this specific case, the study seeks to generate transferable recommendations for the design of accessible and inclusive higher education programmes.

Since the doctoral project is still in its initial phase, the work carried out so far has focused on the conceptual and methodological framing of the study: clarifying the epistemological function of multilevel comparison (across time, sources, educational activities, and the literature) as a tool for relating cases, perspectives, and theoretical constructs within the case study design, necessary for subsequent empirical detection.

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Artificial Intelligence and Individualized Educational Planning: a pilot exploratory study on supporting IEP development among Italian teachers

Lucia Miranda[1][0009-0005-9701-3880]

[1] Pegaso University, Italy
lucia.miranda@unipegaso.it

1 Background and Research Objectives

Developing an Individualized Education Plan (Piano Educativo Individualizzato, PEI) is a complex, cognitively demanding task: Italian teachers must integrate information on a student's functioning, goals, support measures, and teaching strategies into one operational document. Cognitive Load Theory [1] suggests that coordinating this much interacting information can overload working memory, making perceived cognitive workload a relevant dimension for tools that support PEI drafting. Teacher self-efficacy [2], defined as beliefs about one's capacity to organize and execute the actions required to reach a goal, is equally relevant in inclusive education, where teachers must respond to heterogeneous learning profiles [3].

Artificial Intelligence may support teachers in complex educational tasks such as planning and documentation [4], provided it is implemented with a human-centred, responsible approach that preserves teachers' professional judgement [5]. Evidence on AI-supported IEP development is still emerging and mixed: generative AI assistance has been found to improve IEP goal quality and reduce drafting time for novice special educators [6] and for teachers of preschoolers with autism [7], while at least one comparative study found no significant quality difference between AI-assisted and teacher-only goals [8]. This limited and inconsistent evidence, together with the near absence of studies on teachers' cognitive workload during AI-assisted IEP drafting, motivates the present pilot study.

The study explores the feasibility, acceptability, and preliminary utility of IA-CREATE, a tool that presents teachers with structured questions across 23 functioning subdomains and, from their answers, suggests individualized objectives that teachers can review, edit, or discard before finalizing the PEI. Preliminary calibration observations suggest the tool can occasionally propose objectives with limited ecological validity (e.g., resources requiring equipment not ordinarily available in Italian classrooms) or imprecise clinical phrasing; the study documents such occurrences systematically as part of its qualitative component rather than assuming error-free output.

The study does not aim to establish definitive effectiveness, but to generate preliminary insight into whether and how IA-CREATE may support teachers during PEI development.

2 Methodology and Research Hypotheses

The study addresses the following research questions, which guide the methodological choices described below:

RQ1. Is IA-CREATE associated with reduced perceived cognitive workload during PEI drafting, compared to a traditional procedure?

RQ2. Is IA-CREATE associated with differences in teachers' task-specific self-efficacy?

RQ3. Is IA-CREATE associated with differences in the completeness and quality of the goals produced?

RQ4. Is IA-CREATE associated with differences in drafting time?

RQ5. How do teachers perceive the usefulness, ease of use, and practical acceptability of IA-CREATE?

The study uses a within-subject, counterbalanced (AB/BA) pilot design on multiple single cases: each teacher completes two drafting sessions on different days, once with IA-CREATE and once with the traditional procedure, serving as their own control. Role (special education vs. general education), condition order, and initial case are combined in a full 2×2×2 factorial structure across a purposive sample of 8 Italian teachers (4 special education, 4 general education), recruited through the researcher's professional network. Inclusion criteria are current teaching status, at least one prior experience drafting a PEI, and availability for both sessions.

Teachers draft the PEI on two synthetic (fictional) case vignettes, one describing autism spectrum disorder (support level 1), one ADHD with a comorbid Specific Learning Disorder, matched for structural complexity but differing in diagnostic category, to limit domain-specific transfer between sessions; no authentic student data are used. Case and condition order are fully counterbalanced. Sessions use an identical template across conditions, organized by the four PEI Dimensions defined by Italian regulation, with self-reported start/end times for completion time.

Each construct is linked to a specific measure: perceived cognitive workload via the Raw NASA-TLX [9]; task-specific self-efficacy via a 7-item ad hoc scale informed by the teacher self-efficacy literature [2, 3], not yet psychometrically validated, and treated as exploratory; completeness and quality of individualized goals via the Revised IEP/IFSP Goals and Objectives Rating Instrument (R-GORI) [10], translated into Italian and applied after data collection on anonymized, randomly ordered documents, by the researcher and an independent second rater blind to condition and teacher identity, with agreement calculated via Cohen's Kappa; technology acceptance via the full Technology Acceptance Model questionnaire [11], administered only after the IA-CREATE session. Open-ended items collected after each session are analyzed thematically, complemented by a structured qualitative log of goal-level anomalies identified during R-GORI coding.

Analysis is primarily descriptive, combining within-case and cross-case comparisons. For each quantitative outcome, directional differences between conditions are examined per teacher, and a sign test is applied across the sample to assess consistency of direction, consistent with the study's exploratory, non-confirmatory purpose.

Comparisons by role, case, or order group are treated as purely descriptive given small subgroup sizes.

3 Expected Results

The expected contribution is mainly exploratory and methodological: preliminary indications on the role of AI-supported tools in inclusive educational planning, informing the design of future, larger-scale research. IA-CREATE is not conceptualized as a substitute for teachers' professional judgement, but as a possible support tool whose pedagogical relevance, usability, and sustainability require careful examination before broader implementation.

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State-Aware Intelligent Tutoring Systems Using Large Language Models

Umberto Barbieri[0009−0000−0357−3371]

Pegaso University, Naples, Italy
umberto.barbieri@unipegaso.it

1 Problem and Motivation

Two students complete the third week of an introductory Python course with the same quiz score of 70%. The first writes `for`-loops but not `while`-loops; the second writes every loop but cannot yet define a function. The score hides the one thing an adaptive tutor needs: which concept each student is ready to learn next. Tutors built on large language models rarely recover it: they adapt on the interaction, tracking fluency, engagement, and a running score. None of these shows what the learner knows, and answering on request offloads the reasoning the task was meant to develop. The binding constraint is therefore a measurement problem. The scalar grade is at best an ordinal summary [1], and without a valid model of the knowledge state a tutor cannot know what a learner is ready to learn. The learning-theoretic name for that target is Vygotsky's zone of proximal development (ZPD) [2], a construct left without an instrument [3] and only partially operationalized since [4]. Knowledge Space Theory supplies the missing instrument (Sect. 2), realized as a tutoring loop in Albert (Sect. 3), and the central claim can be confirmed or refuted (Sect. 4).

2 Knowledge States and an Operational ZPD

Knowledge Space Theory (KST) represents competence set-theoretically [5, 6]. Let Q be a finite domain of problems. A *knowledge state* $K \subseteq Q$ is the set of problems a learner can solve, and a *knowledge structure* $\mathcal{K} \subseteq 2^Q$ is the family of admissible states. When $\mathcal{K}$ is a well-graded learning space, states are reachable one problem at a time, and the *outer fringe*

$$K^O = \{\, q \in Q \setminus K : K \cup \{q\} \in \mathcal{K} \,\} \tag{1}$$

is the set of problems the learner is ready to learn next. Assessment infers the most likely state from a short response sequence [7]. The outer fringe serves as a *structural* operationalization of the ZPD. A Python learner who has mastered assignment, conditionals, and `for`-loops has an outer fringe of `while`-loops and comprehensions; recursion, needing function definition, lies beyond it. The claim is narrow: the fringe is ordinal and structural, makes no metric claim, and captures item-level readiness without the social, mediated character of Vygotsky's construct. This paper makes that identification exact and puts it to work inside an intelligent tutoring system.

3 Assessment-Driven Tutoring in Albert

The instrument defines the tutor. Given an estimated state $\hat{K}_t$, the loop computes the fringe $\hat{K}_t^O$ from (1), selects a target $q^\star \in \hat{K}_t^O$, scaffolds it without revealing the solution, re-assesses, and sets $\hat{K}_{t+1} = \hat{K}_t \cup \{q^\star\}$ on mastery. Well-gradedness guarantees a path from the initial to the complete state Q; the loop walks it. The language model delivers the scaffolding but does not diagnose; that division keeps the reasoning with the student [8]. Albert, an intelligent tutoring system developed by the author [9, 10], instantiates this loop as a mixture-of-agents tutor, operational in an introductory Python course for which Q and $\mathcal{K}$ are defined, following competence-based KST tutors [11]. Three prior studies ($N \approx 245$) show that adaptive ITS delivery produces learning gains against traditional, human, and chatbot comparators. They did not measure the knowledge state itself. Closing that gap is the aim of the ongoing Albert study.

4 Research Question and Validation

Knowledge Space Theory already maps knowledge states well [7, 11]. Its value inside AI-based tutoring is the open question: whether an intelligent tutoring system coupling a knowledge-state model with large language models produces better learning than the alternatives. The primary study compares Albert against two controls under a fixed language model: a generic LLM tutor, and a variant of Albert whose scaffolding ignores the outer fringe. This isolates the measurement layer. The outcomes are learning gains [12] and transfer to systematic problem variants [13], the signature of learning that resists cognitive offloading. A tutor that fails to outperform both controls refutes the approach.

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Title of my research project: Technology Enhanced Learning: the impact of digital transformation on teachers

Carolina Mele[1][0009-0009-7954-6244]
[1]Pegaso University, Naples 80132, Italy

1 Background and Research Objectives

The fast dissemination of Generative Artificial Intelligence (GenAI) systems and Large Language Models (LLMs) has caused a revolution in the instructional design process [1], providing educators unique technological opportunities for content generation. However, the pedagogical effectiveness of the produced output does not reside solely within the computational capabilities of the machine, but rather in the psychopedagogical refinement of the human-computer interaction, mediated by prompt engineering practices. In modern educational psychology, the concept of learning styles plays a pivotal role as a conceptual and operational framework for differentiating instruction. According to Luciano Mariani [2], learning style refers to person's preferred approach to learning, representing their typical and stable way of perceiving, processing, storing, and retrieving information, encompassing sensory, cognitive, and socio-affective preferences [3,4]. To deeply operationalize individual differences, this framework inter-sects with David Kolb's Experiential Learning Theory [5], which conceptualizes learning as a continuous four-stage cycle driven by the tension between concrete experience, abstract conceptualization, reflective observation, and active experimentation, giving rise to divergent, convergent, assimilating, and accommodating profiles.

Psychopedagogical research has not yet systematically investigated how the formal and psychologically oriented explication of students' cognitive characteristics, learning profiles, and diverse intelligences within AI configuration prompts influences the professional experience, technological acceptance, and psychological-professional constructs of teachers interacting with these technologies. The general objective of my PhD research is to evaluate the causal impact of including structured information regarding learning styles within GenAI prompts, examining both the evaluation metrics of the produced educational material and the intrinsic psychological and attitudinal constructs of teachers. Specifically, the research aims to compare the formal quality (clarity, ac-curacy, organization and coherence) and the level of perceived personalization of educational materials generated via standard prompts versus prompts enriched with learning styles-based heuristics. Furthermore, it examines whether exposure to psychopedagogically optimized educational materials determines a significant increase in teachers' perceived sense of self-efficacy [6] and technology acceptance levels [7], while analyzing the relational patterns linking the perceived quality of the material to teachers' feelings of professional competence and confidence. Finally, it explores the moderating role of individual and demographic variables, such as years of experience, familiarity with Special Educational Needs, prior AI expertise, and general technological attitude.

2 Methodology and Research Hypotheses

Consistent with these objectives, it is hypothesized that materials produced through prompts enriched with learning styles will receive significantly higher ratings from teachers in terms of perceived quality, subjective personalization, and educational appropriateness compared to those produced by standard prompts. Consequently, teachers are expected to report higher levels of professional self-efficacy, conceptualized as confidence in classroom management and the perceived capacity to respond to classroom needs, following interaction with the optimized materials. A complex mediation model posits that perceived quality and personalization of the material will mediate the causal relationship between the type of prompt and teacher self-efficacy.

To neutralize potential biases related to teachers' subjective variability, such as intrinsic grading severity or baseline self-efficacy levels, this research adopts a rigorous within-subjects, repeated measures experimental design where each participant evaluates both educational materials generated for the two experimental conditions. The first is Condition A, configured by entering only standard contextual variables like grade level, discipline, and learning objective, and the second is Condition B, configured by integrating a detailed profile of the target student's learning style alongside the same contextual variables. The procedure is structured into sequential phases, beginning with the codification and standardization of the psychopedagogical profiles of students based on learning styles, followed by the systematic generation of educational materials under the two mirror conditions using the same GenAI engine. To prevent order and carryover effects, the materials' presentation is randomized, ensuring the evaluation occurs in a double-blind manner that prevents teachers from knowing which prompt string generated the output. Participants will then evaluate the dependent variables, including perceived quality, personalization, educational appropriateness, and technology acceptance mapped through validated questionnaires. The gathered quantitative data will undergo statistical processing to verify the significance of the differences found be-tween the two conditions and to test the causal paths defined by the mediation hypotheses, demonstrating whether prompt enrichment exerts an indirect effect on teacher self-efficacy through the sequential mediation of perceived quality and material personalization.

3 Expected Results

The expected results aim to confirm that the psychopedagogical structuring of the prompt acts as a cognitive and professional scaffold, meaning that by providing material perceived as highly targeted and structured, the AI reduces the teacher's cognitive reloading burden, simultaneously enhancing their emotional-behavioral confidence in classroom management and their acceptance of the technology itself as a strategically. The scientific value of this work lies in its interdisciplinary approach at the intersection of educational psychology and human-computer interaction. By expanding technology acceptance models to include professional self-efficacy as a core psychological out-come of AI use, this research provides empirical guidelines for teacher training, demonstrating that AI literacy must integrate psychopedagogical competencies to formulate prompts capable of generating inclusive, effective, and sustainable personalization.

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Designing teacher mediation for AI-Assisted Storytelling

Bianca De Vivo[1][0009-0008-8127-5407]

[1] Pegaso Telematic University, Naples, Italy
bianca.devivo@unipegaso.it

1 Research objectives and questions

AI-assisted storytelling has recently emerged as one of the most promising applications of generative AI in education, reshaping the linguistic, cognitive, and pedagogical interaction between teachers, learners, and technology. This contribution investigates how the teacher can act as a critical mediator between students and generative AI/Large Language Models (LLMs) in narrative writing activities, fostering conscious and responsible use of these tools. The study addresses the following research questions: (i) How do teacher-mediated prompting strategies influence students' narrative creativity and authorship? (ii) How can prompt literacy foster metacognitive awareness of narrative and ethical decision-making? (iii) Which design principles emerge from iterative DBR cycles for AI-assisted storytelling?

2 Context and motivation

Generative AI is increasingly used in educational settings as a co-creative partner for narrative writing, offering opportunities to stimulate creativity and inclusion, but also risks of passive reliance on automated output and a diminished sense of authorship. Storytelling constitutes an ideal educational context because narrative writing simultaneously engages creativity, linguistic competence, identity construction, and reflective thinking, making it particularly suitable for investigating teacher-mediated interactions with AI.

This need for critical mediation is formally recognised by the Italian Ministry of Education's Guidelines for the Introduction of Artificial Intelligence in Schools [1], which establish ethical, technical, and regulatory principles for a structured adoption of AI in educational contexts, in continuity with the European Commission's Ethical Guidelines on the Use of AI and Data in Teaching and Learning for Educators [2]. Both frameworks place human oversight, transparency, and equitable, inclusive learning at the center of AI adoption in schools.

3 State of the art / key related work

Recent scholarship highlights both the educational opportunities and the pedagogical challenges introduced by Large Language Models in classrooms [3]. As Selwyn [4] argues, AI cannot replace the teacher: its educational value lies in the teacher's capacity to orient and enhance students' cognitive and critical potential. Woo, Guo and Salas-Pilco [5] show that AI-generated narrative prompts can act as productive stimuli for students, including less confident writers, enriching rather than replacing their creative

voice, provided the interaction is scaffolded and critically reflected upon. Without adequate awareness, however, there is a risk that AI may be perceived as the "main author," reducing students' sense of creative ownership. Torrance's [6] creativity framework (originality, flexibility, elaboration) offers a validated lens to assess such outcomes. This underlines the importance of prompt literacy as a metacognitive practice [7, 8], through which the teacher translates the complex processes of language models into comprehensible, formative activities.

4 Methodological approach

The study adopts a Design-Based Research (DBR) approach, developing and iteratively refining an AI-supported storytelling activity for secondary school classrooms, structured in four phases: (1) individual/guided prompting, in which students formulate teacher-guided prompts to generate initial narrative stimuli; (2) collaborative development, in which students revise and enrich AI-generated story elements (plot, characters, style), comparing multiple AI outputs; (3) shared presentation, with peer discussion of narrative choices, voice, and coherence; (4) metacognitive reflection, analysing the boundary between human and AI-generated content, the creative process, and its ethical implications. Reflection journals, prompt revision logs, and classroom discussion transcripts will provide qualitative data to inform subsequent DBR iterations. Each phase will be piloted with 2-3 classes over a 6-month period, with data coded independently by two raters. Students' narrative productions will also be assessed through Torrance-inspired creativity rubrics, with inter-rater reliability (Cohen's k) ensuring validity of originality, flexibility, and elaboration scores. Findings from each cycle will be analysed to identify recurring patterns in prompting strategies and mediation needs, which will directly inform redesign decisions (e.g., scaffolding adjustments, revised prompt templates) in the subsequent cycle, within the broader three-year doctoral project.

5 Expected outcomes / expected contributions

The study is expected to explore the extent to which AI becomes educationally meaningful when mediated by conscious pedagogical guidance, transforming students' interaction with LLMs into an opportunity for developing narrative competence, ethical responsibility, and creative autonomy. Using Torrance-inspired creativity rubrics, the activity is expected to demonstrate measurable gains in originality, flexibility, and elaboration, particularly benefiting less confident writers. Broader contributions include a set of transferable design principles (prompting scaffolds, mediation checkpoints, reflection protocols), conceived as applicable to Higher Education contexts where similar tensions between AI co-creation and authorial identity emerge, together with an operational guideline document for teacher training. This pilot represents the first classroom-level study within the broader doctoral research project, which aims to design AI-supported narrative environments for education and cultural heritage through iterative DBR cycles.

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A Research Toolkit for Reliable Retrieval-Augmented Generation in Education

Francesco Congiu[1,2][0009−0000−7821−0663]

[1] University of Cagliari, Cagliari, Italy
francesco.congiu6@unica.it
[2] University of Macerata, Macerata, Italy
f.congiu@unimc.it

1 Context and Related Work

Large Language Models (LLMs) offer unprecedented opportunities for Technology-Enhanced Learning (TEL), enabling scalable conversational tutoring systems and automated feedback. However, their deployment in educational contexts is significantly challenged by the problem of hallucinations. To mitigate this risk, modern TEL systems increasingly rely on Retrieval-Augmented Generation (RAG) for dynamically injecting verified knowledge throughout the generation process [5, 4] (e.g., for course syllabi, lecture slides, and proprietary textbooks). Although promising, RAG systems introduce a critical bottleneck: the generator should continually decide whether to trust the retrieved context, rely on its internal parametric memory, or abstain from responding [1]. In educational platforms, this Knowledge Reconciliation (KR) process is extremely relevant. When institutional Knowledge Sources contain up-to-date or specialized knowledge that diverges from the LLM's pre-training data, rigidly constraining the model to the retrieved evidence alone frequently triggers two distinct failure modes: hallucinating a response when evidence is absent, or erroneously abstaining when complex yet valid evidence is retrieved. Controlling this trade-off is essential for building reliable AI tutors that neither mislead students nor withhold accessible knowledge.

This research is positioned at the intersection of LLMs and Information Retrieval (IR). Recent work on RAG has addressed retrieval quality and hallucination mitigation through isolated lenses. While retrieval-centric studies focus on passage ranking and context scaling [6, 2], they overlook whether and how the generator correctly interprets the retrieved content. Conversely, faithfulness frameworks (e.g., RAGAS [3]) primarily evaluate post-hoc textual grounding, thereby struggling to distinguish a prudent refusal from an erroneous omission of available evidence. Open-source research toolkits are particularly relevant to advance this field, as modular libraries like FlashRAG [7] have significantly accelerated systematic RAG experimentation. The closest reference for this work formalizes the KR phenomenon in open-domain Question Answering (QA). While this line of research introduces evidence-aware taxonomies for factoid QA, it leaves several open challenges for the educational domain, including the absence

of support for pedagogical anchoring constraints, education-related document structures, and the strict access-control protocols required.

2 Methodological Approach

This doctoral research aims to develop, evaluate, and release an open-source research toolkit designed to standardize the evaluation of KR within educational RAG systems. Targeting university education, the framework explicitly distinguishes between the corpus and the dataset, which is used to evaluate the complete end-to-end system. To align with Open Science principles, constructing the corpus presents a unique challenge due to the proprietary nature of many textbooks and lecture slides; thus, a key contribution will be the curation of an ad hoc, open-access educational corpus. Conversely, the evaluation dataset will be designed to reflect authentic pedagogical requirements and curricular objectives. Drawing inspiration from recent longitudinal deployments [10], the dataset will be built by leveraging real and simulated tutor-student interactions. Furthermore, the evaluation metrics will penalize ungrounded parametric fallbacks that risk misleading students. Specifically, this doctoral project is guided by four research questions: (i.) How can we construct a resource that can help studying the tension between an LLM's parametric knowledge and the underlying corpus in education?; (ii.) To what extent do the taxonomy and behavioral patterns observed in generic QA generalize to vertical domains, with particular reference to TEL?; (iii.) What is the isolated impact of the individual components of a RAG system on the dynamics of abstention and the faithfulness of the generator?; and (iv.) How can we design adaptive abstention mechanisms that can reduce or eliminate both parametric fallbacks and false refusals?

3 Preliminary Results and Expected Contributions

In a preliminary TriviaQA [8] study, we operationalized a taxonomy of six generator states based on evidence availability: *Correct Answer*, *Incorrect Answer*, *False Abstention*, *Justified Abstention*, *Parametric Answer*, and *Hallucinated Answer*. Our results revealed that although increasing the retrieval depth improves evidence availability, it does not uniformly optimize generator behavior. Indeed, larger contexts successfully reduce false abstentions when evidence is present, but fail to mitigate hallucinated responses when evidence is absent [9]. The primary expected outcome of this thesis is the release of an open-source research framework designed to establish a rigorous benchmarking standard under this context. By providing the community with a complete, open science-compliant corpus and dataset, along with modular pipelines and evidence-based metrics, this research aims to enable researchers to systematically validate educational RAG architectures from the lens of KR. Finally, while the exact evaluation protocol is currently under design, the toolkit's practical viability and pedagogical impact will be validated through user studies with real learners. Such final phase

will investigate how faithful generation and adaptive abstention influence student trust and learning outcomes prior to real-world deployment in classrooms.

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Artificial Intelligence and Professional Agency in the Third-Sector Social-Educational Field

Emmanuele Gatti[10009-0008-0126-0943]

eCampus University, Novedrate (CO), ITALY
emmanuele.gatti@uniecampus.it

1 Research Objectives and Questions

The research goal is to understand to what extent a training pathway co-designed with the organizations of the CGM consortium modify, between T0 and T1, the professional positioning of educators and practitioners with respect to generative AI (GAI), and how the resulting evidence can inform the improvement of the university's educational offer?

The research is grounded in the rapid introduction of GAI into educational practices [1][2], especially in services working with adolescents, where the quality of the educational relationship remains crucial. In this context, unregulated use of AI may weaken professional judgment, whereas its use, when guided by reflective practices and a structured training pathway, may strengthen practitioners' professional agency [3][4].

The central question is articulated into four sub-questions: What practices, representations, and training needs emerge regarding the use of GAI? What is the initial position of the sample, as measured through the PAIR questionnaire? What characteristics should a co-designed training pathway have in order to address the needs that emerge and support a critical use of AI? What change emerges after the training pathway, and which elements prove useful for rethinking the university's educational offer?

2 Context and Motivation for Your Research Project

The project focuses on educators and practitioners in the third sector who work with adolescents, in a field where the use of GAI affects documentation, educational planning, teamwork, and decision-making processes. In these settings, AI can provide operational support, but it can also increase data-related risks, reduce room for professional judgment, and weaken the educational relationship [1].

Adolescent-focused educational work is highly relational and thus especially sensitive to how AI is introduced, making it a privileged context for examining how professional AI literacy can develop in a human-centered way [5]. In this study, professional agency represents practitioners' capacity to make informed and autonomous professional judgments when integrating GAI into their practice.

The research therefore responds to the need to understand under what conditions AI can support, rather than undermine, educational work. Training is treated as a

critical device for observing this shift and for producing useful indications at the institutional level as well [6].

3 State of the Art and Key Related Work

Literature highlights both the benefits of AI in educational and social contexts and the critical issues associated with it, including bias, decision-making opacity, deskilling, and the loss of relational quality [7]. Research specifically addressing the use of AI in the third sector, especially in services for adolescents, remains extremely limited [2]. Even fewer studies combine empirical assessment, co-designed training, and evaluation of change [8]. The project adopts the TEACH-AI framework, which interprets AI adoption through three dimensions: capability, affordance-in-practice, and sentiment. This framework makes it possible to analyze practitioners' competencies, uses, and attitudes from a human-centered perspective [6][9][10].

4 Methodological Approach

The research adopts a mixed-methods [11] design with a pre-post comparison between T0 and T1 through the PAIR questionnaire [12], a validated instrument developed within the TEACH-AI project to investigate AI integration in socio-educational services. PAIR was selected because it is validated on Italian socio-educational practitioners and directly operationalizes the dimensions of the adopted framework. The first phase involves administering PAIR at T0 to a sample of 180 educators and practitioners identified through the CGM consortium to capture practitioners' initial positioning.

In parallel a qualitative phase is activated, including focus groups and the co-design of the training pathway with the participating organizations, based on the initial quantitative and qualitative results [11]. Together with the cooperatives involved, a training pathway is developed [13]; after its implementation (structured in 4 modules spread in 8-10 weeks combining workshops, guided experimentation with AI tools, and reflective sessions structured as a community of practice), PAIR is administered again at T1: change is assessed through paired T0–T1 comparisons with effect sizes, while focus group data undergo thematic analysis, with the two strands integrated to interpret the measured change and inform both training and the university's educational offer.

5 Expected Outcomes

The project aims to produce empirical knowledge on the relationship between GAI, professional agency, and educational work with adolescents. It also aims to define a co-designed and evaluated training pathway capable of supporting a critical and human-centered use of AI in socio-educational services.

The project is also expected to provide actionable insights for both organizations and higher education institutions seeking to strengthen AI literacy, professional judgment, and human-centered educational practice.

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Responsible Multi-Agent Instructional Design through Large Language Models

Marco Cabras[1,2][0009−0008−4590−8422]

[1] University of Macerata, Macerata, Italy
m.cabras1@unimc.it
[2] University of Cagliari, Cagliari, Italy
marco.cabras4@unica.it

1 Context and Motivation

Designing university course materials is a demanding process that combines disciplinary expertise, pedagogical planning and assessment literacy. Instructors need to define learning objectives, organize content, prepare lecture materials, design learning activities, anticipate students' difficulties and construct assessments aligned with the intended outcomes [1]. In many contexts, this work is carried out without dedicated instructional-design support, reducing scalability and limiting the time available for direct interaction with students. LLMs offer new opportunities to support this process [2], but mere usage alone is not enough: a fluent, well-formatted course package may still be weakly aligned, poorly grounded or evaluated through unreliable criteria. For this reason, the project focuses on responsible instructional design, understood as the integration of pedagogical alignment, source traceability, transparent personalization, computational efficiency and evaluation against expert judgment.

2 Key Related Work

The project is positioned at the intersection of LLMs for education, multi-agent systems, instructional design, and personalized learning. Recent work has shown that LLMs support tasks such as feedback generation, tutoring, content explanation, lesson planning and assessment drafting [2]. However, many systems address isolated tasks and do not ensure coherence across the whole instructional package. Multi-agent architectures are particularly relevant because course design is naturally multi-role [3]: it requires disciplinary expertise, pedagogical design, assessment planning, learner perspective and quality control. The closest reference for this research proposes a framework that uses role-specialized LLM agents and the ADDIE model [4] to generate learning objectives, syllabi, slides, scripts and assessments [5]. This work treats instructional design as an end-to-end process and evaluates outputs through human and automated reviewers. At the same time, it leaves several central challenges open.

3 Research Objectives and Questions

The main objective of this research is to develop and evaluate a responsible multi-agent LLM framework for instructional design in higher education. The framework should support instructors in generating review-ready materials rather than final autonomous outputs, making pedagogical decisions inspectable, connecting generated content to reliable sources, enabling controlled personalization and reducing unnecessary computational cost. The doctoral project is guided by the following research questions:

1. **RQ1.** How can multi-agent LLM pipelines generate course materials that are pedagogically aligned, source-grounded and usable by university instructors?
2. **RQ2.** How can learner modelling support controlled personalization of explanations, examples, activities, feedback and assessments?
3. **RQ3.** Which architectural choices reduce token usage, generation time and cost while preserving or improving instructional quality?
4. **RQ4.** To what extent do LLM-based evaluation scores align with expert scores, and under which conditions is human evaluation necessary?

4 Methodological Approach

The project will develop a multi-agent pipeline that takes as input course information, instructor constraints and available source materials, and produces a full course package: learning objectives, syllabus, slides, lecture scripts, activities and assessments. The first methodological contribution concerns explicit pedagogical modelling. Agents will provide concise rationales linking objectives, content, activities and assessments, so that instructors can inspect and revise the design process, not only the final documents. The second contribution concerns retrieval-augmented generation [6] to ground the generated materials in course resources, instructor notes, institutional documents and scientific references. The third contribution concerns controlled personalization through learner and context models representing prior knowledge, expected difficulties, learning goals and accessibility constraints. These models will adapt explanations, examples, exercises, feedback and remediation suggestions while keeping the process transparent and under instructor control. The fourth contribution concerns efficiency and assessment: alternative generation strategies, including reduced-agent pipelines, content-once generation, deterministic layout compilation, selective regeneration, prompt compression and retrieval filtering, will be compared in terms of instructional quality, token usage and generation time. Evaluation will compare LLM-based rubric scores [7] with expert scores [8].

5 Preliminary Results and Expected Contributions

The preliminary phase reproduces and extends a recent multi-agent instructional-design baseline. Initial experiments suggest that pipeline architecture strongly

affects both quality and efficiency. Generating core content once and using deterministic components for formatting and layout appears to reduce unnecessary LLM calls and stabilize outputs, especially for slides. Improvements are also not uniform across instructional materials: learning objectives and syllabi benefit more directly from structured pedagogical prompts, whereas lecture scripts, assessment design and personalization require deeper modelling of teaching strategies, learner needs and evaluation criteria. These observations rest on a first working version of the pipeline, whose generated materials are its concrete result. The expected contribution is therefore a responsible methodology for multi-agent instructional design, based on the claim that such systems are useful only if pedagogically explicit, source-grounded, efficient, personalized under human control and expert-evaluated.

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Beliefs, Confidence, and Instructional Practice in Primary Mathematics Teaching: Evidence from a Professional Development Intervention

Federica Siddu

Università degli Studi di Cagliari, Via Is Mirrionis n.1– Cagliari 09100, Italy
Federica.siddu@unica.it

1 Theoretical Framework

Research in mathematics education highlights the central role of cognitive, epis-temological, and affective factors in shaping teaching and learning processes. Within this framework, teachers are viewed not merely as transmitters of knowledge but as active interpreters of mathematics whose beliefs inform in-structional decisions and classroom practices [1, 2, 3].

Both classic literature and recent empirical research suggest that teachers' epistemological beliefs significantly affect how they design learning activities, interpret students' errors, and assess mathematical understanding [4, 5].

These beliefs range from viewing mathematics as a fixed body of rules to conceiving it as a process of inquiry and meaning making [6, 7], with direct implications for students' learning opportunities. Building on these foundational and contemporary insights, this study investigates the relationships among teachers' epistemological beliefs, teaching self-efficacy, and instructional practices in primary education, examining how these dimensions interact and influence students' mathematical learning.

2 Research Questions.

Drawing on research on teacher beliefs, self-efficacy, and mathematics teacher education, this study seeks to investigate the impact of a professional development intervention on primary school teachers and their students. Speci-fically, the study addresses the following research questions:

RQ1. How does participation in a professional development programme shape primary school teachers' attitudes toward mathematics, particularly with regard to anxiety, openness, and flexibility in mathematical thinking?

RQ2. How does the intervention affect teachers' perceived self-efficacy and instructio-nal practices in mathematics education?

RQ3. Does the intervention promote greater coherence among teachers' attitu-des to-ward mathematics, self-efficacy beliefs, and instructional practices?

RQ4. To what extent are changes in teachers' professional beliefs and practices associated with improvements in students' mathematical problem-solving com-petencies?

In addition, the qualitative component of the study seeks to explore how teachers interpret and experience the professional development process and which elements of the intervention they perceive as most influential in supporting professional change.

3 Methodology

The study adopts a quasi-experimental mixed-methods design to investigate the effects of a professional development intervention on primary school mathematics teachers' attitudes, self-efficacy beliefs, and instructional practices. Approximately 40–50 primary school teachers and their classes will be assigned to either an experimental or a control group.

The intervention will comprise a series of collaborative workshops cen-tred on the analysis of students' errors, the exploration of multiple solution strategies, the discussion of alternative mathematical reasoning, and the design of open-ended learning activities. Quantitative data will be collected through validated instruments assessing attitudes toward mathematics, teaching self-efficacy, instructional practices, and students' mathematical problem-solving competencies. Pre- and post-intervention measures will be compared to examine changes associated with participation in the program.

To complement the quantitative findings, a focus group will be conducted with teachers involved in the intervention. Discussions will explore participants' per-ceptions of the training experience, perceived changes in beliefs and teaching practices, implementation challenges, and reflections on the relationship between professional development and classroom practice. Qualitative data will be analysed through thematic analysis to identify recurring themes and provide a deeper understanding of the processes underlying teacher change.

4 Expected Contribution and Issues for Discussion

The study aims to contribute to research on mathematics teacher education by examining the interplay among teachers' epistemological beliefs, self-efficacy, instructional practices, and students' mathematical problem-solving competencies in primary education. Rather than considering these dimensions separately, the project investigates how they may evolve in relation to a professional development intervention and how changes at the teacher level may be associated with students' learning opportunities.

Attention will be devoted to the methodological challenge of assessing changes in teachers' epistemological beliefs after a professional development intervention and to the identification of suitable indicators for examining whether and how such changes may be related to pupils' mathematical learning processes.

By addressing these issues, the project is expected to provide insights into processes of teacher change and to inform the design of future professional development programmes in mathematics education.

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EduAI: transforming inclusive education by strengthening teachers' digital skills

Aleksandra Majkut[1][0009-0002-4659-9430]

Jagiellonian University, Gołębia 24, Kraków, Poland
aleksandra.majkut@doctoral.uj.edu.pl

1 Introduction

Artificial intelligence (AI) and generative artificial intelligence (GenAI) offer significant opportunities to support inclusive education by personalising the teaching process, analysing pupils' progress and tailoring learning pathways to their in dividual needs. They can also improve access to education through tools that facilitate communication and the use of VR and AR technologies. At the same time, research findings point to the need for further analysis of the long-term impact of artificial intelligence on education and for ensuring equal access to these technologies [1]. In the context of Poland, where inclusive education is still developing and teachers' digital skills remain at a relatively low level. Polish teachers rank only 20th out of 23 European Union countries; therefore, action in this area appears particularly important [2]. Drawing on the concept of the teacher as a reflective practitioner [3], [4] and on the DigCompEdu [5] and DigComp 3.0 [6] frameworks, this study bridges the gap between technological potential and its actual application in school practice [7]. The aim of the project is to develop, implement and evaluate solutions that support the development of teachers' digital competences and the effective delivery of inclusive education. The project involves the use of generative artificial intelligence to personalise the teaching process, adapt teaching methods to pupils' diverse needs, and support teaching and educational activities that promote equal educational opportunities [8]. Main problem: How can teachers' digital competences be effectively enhanced and inclusive education implemented in a way that ensures educational support and equal educational opportunities for pupils? Specific questions include, amongst others: to what extent does the level of teachers' digital competences determine their attitude towards artificial intelligence (AI); and whether the anticipated usefulness and ease of use of AI tools correlate with their actual use in teaching practice within the context of inclusive education. To understand how primary and secondary school teachers perceive artificial intelligence, a pilot study was conducted in late December 2024 and early January 2025 [9]. The study was conducted amongst teachers from the Podkarpackie Voivodeship (N=289). It examined their concerns, attitudes, digital competences and intentions regarding the use of artificial intelligence. The Extended Educational Technology Acceptance Model (EETAM) was applied to identify factors facilitating and hindering the integration of artificial intelligence in education. After analysing the results, the following conclusions were drawn: interest in artificial intelligence amongst teachers is growing; the greatest barriers to the implementation of artificial intelligence are a lack of training

and privacy concerns; teachers with more years' experience are more sceptical about artificial intelligence; AI-based resources are most commonly used for searching for information and translating texts. Respondents recognised the positive impact of artificial intelligence on education, par ticularly in terms of tailoring teaching to pupils' in dividual needs. The effective imple mentation of artificial intelligence (AI) in education requires the adaptation of curricu lum content, but also the preparation of teachers to work with new technologies.

2 Project methodology

The study is being conducted within a pragmatic paradigm, using a mixed-methods approach [10] and based on the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), which ensures a systematic approach to enhancing teachers' digital skills and implementing inclusive education. In order to empirically verify the adopted model, a pedagogical quasi-experiment will be conducted, following a pre-test, mid-test, post-test design involving an experimental and a control group. Purposive sampling will be used for the study, comprising teachers of Years 1–8 in primary schools. The analysis of teachers' acceptance of technology will be carried out using the extended model of educational technology acceptance (Technology Acceptance Model + Unified Theory of Acceptance and Use of Technology) [11]. The project involves assessing teachers' digital competences and the schools' technological infrastructure using tools based on the DigComp model and a Likert scale, conducting training on the use of artificial intelligence, and implement ing an AI supported educational platform. The qualitative part will involve individual in-depth interviews with teachers who actively use AI tools in their teaching. The analysis will examine, amongst other things: the relationship between digital com petences and attitudes towards AI; expectations and barriers associated with its use; and ethical, legal and technological concerns. The quantitative part will be based on questionnaire surveys among teachers of Years 1–8, covering self-assessment of competences, frequency of ICT use, an assessment of the usefulness and ease of use of AI, as well as real life examples of its use in working with pupils.

3 Expected outcomes

It is expected that the project's outcomes will lead to a better understanding of the mechanisms underlying the responsible implementation of generative artificial intelligence in education and will lay the foundations for the development of a model to support teachers, which can be used both in professional development programmes and in further research into the transformation of inclusive education. The expected outcomes are an improvement in teachers' digital competences and an enhancement of the quality of inclusive education through better adaptation of the teaching process to the diverse needs of pupil

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A Hybrid AI Framework for Educational Skill Extraction and Semantic Curriculum Alignment from Arabic Educational Videos

Walaa Wahba[1] , Asmaa Sbaih[1]

[1]Department of Computer Engineering, The Islamic University of Gaza, Gaza, Palestine

Introduction

The rapid growth of Arabic educational video repositories has created a pressing need for automated methods capable of understanding instructional content and evaluating how well it addresses official school curricula. Current AI-based educational video analysis systems mainly target speech transcription, content retrieval, or learner interaction, while the automatic extraction of curriculum-oriented skills and their alignment with official curricula remain largely unexplored, particularly for Arabic, where rich morphology and varied pedagogical expression make semantic alignment more challenging than simple keyword matching.

This doctoral research addresses the following questions: (i) How can curriculum-relevant educational skills be automatically extracted from Arabic instructional videos? (ii) To what extent can extracted skills be semantically aligned with official curriculum competencies using multilingual sentence embeddings? (iii) How does a semantic, many-to-one alignment strategy compare with lexical and contextual baselines in capturing curriculum coverage? The overarching objective is to design and validate an end-to-end AI framework that transforms unstructured spoken instructional content into structured, curriculum-aware educational knowledge, using official Palestinian Grade 3 Mathematics videos and teacher-guide competencies as a case study.

1 Related Work

Recent advances in automatic speech recognition, natural language processing and large language models have improved automated understanding of educational content [1], and Arabic-specific studies have shown that combining speech transcription with semantic language models supports the organisation of Arabic instructional material [2]. Semantic representation learning has also proven effective for multimodal educational-resource matching [3] and for Arabic NLP under low-resource conditions [4]. In parallel, transformer-based sentence embeddings have been shown to outperform lexical methods such as TF-IDF for semantic textual similarity [5] and have been applied to competency mapping in occupational settings [6]. However, to the best of our

knowledge, no prior study has combined Arabic educational-video analysis with a manually curated official curriculum benchmark for semantic skill alignment, which motivates the framework proposed in this research.

2 Methodological Approach

The proposed hybrid framework integrates: (1) Whisper Large-v3 for Arabic automatic speech recognition; (2) an LLM-based transcript-refinement stage (Gemini 2.5 Flash) that corrects linguistic artefacts while preserving instructional meaning; (3) Arabic NLP preprocessing for normalisation and segmentation; (4) an educational skill-extraction module that identifies curriculum-related competencies from the refined transcripts; and (5) a semantic curriculum-alignment module that encodes both extracted and curriculum skills with the multilingual SentenceTransformer model paraphrase-multilingual-mpnet-base-v2 and computes cosine similarity to identify the best-matching curriculum competency for every extracted skill, allowing a many-to-one mapping consistent with real classroom practice.

The framework is being validated on 74 official Grade 3 Mathematics instructional videos from the Palestinian Educational Portal (PsELearn), evaluated against a ground truth of 157 curriculum skills manually extracted from the Palestinian Grade 3 Mathematics Teacher Guide by a domain expert. Performance is assessed with Precision, Recall (reported as Curriculum Coverage Rate) and F1-score, and compared against TF-IDF and AraBERT baselines.

3 Preliminary Results and Expected Outcomes

Preliminary experiments extracted 585 educational skills from the 74 videos, of which 421 were successfully aligned with the curriculum, covering 95 of the 157 official competencies. The framework achieved a Precision of 71.97%, a Recall (Curriculum Coverage Rate) of 60.51% and an F1-score of 65.74%, outperforming TF-IDF (F1 = 15.43%) and AraBERT (F1 = 45.10%) baselines. A qualitative analysis of the matched pairs (Exact, Semantic, Partial and Not-Matched) further indicates that most extracted skills provide finer-grained pedagogical detail than the curriculum descriptions, rather than reflecting extraction errors.

Expected contributions of this doctoral research include: an end-to-end, curriculum-aware pipeline for Arabic educational-video analysis; a reusable, expert-validated curriculum benchmark; and an empirically grounded semantic-alignment strategy for evaluating curriculum coverage. Future work will extend the framework with semantic knowledge graphs to capture prerequisite relationships between skills, incorporate multimodal cues such as teacher prosody and visual/board content, and generalise the approach to additional grades, subjects and Arabic curricula.

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