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VALENCIA, SPAIN ▶ 25 - 27 JULY

PROCEEDINGS OF THE INTERNATIONAL CONFERENCES

e-Learning and Digital Learning 2026

Sustainability, Technology and Education 2026

EDITED BY:

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international association for development of the information society

INTERNATIONAL CONFERENCES
E-LEARNING AND DIGITAL
LEARNING 2026

AND

SUSTAINABILITY,
TECHNOLOGY
AND EDUCATION 2026

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**PROCEEDINGS
OF THE
INTERNATIONAL CONFERENCES**

**E-LEARNING AND DIGITAL
LEARNING 2025**

AND

**SUSTAINABILITY, TECHNOLOGY
AND EDUCATION 2026**

Valencia, Spain

JULY 25 - 27, 2026

Organised by



international association for development of the information society

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FOREWORD

These proceedings contain the papers and poster of the: 20th International Conference on e-Learning and Digital Learning (ELDL 2026) and 14th International Conference on Sustainability, Technology and Education (STE 2026), which was organised by the International Association for Development of the Information Society, 25 - 27 July, 2026. These conferences are part of the 20th Multi Conference on Computer Science and Information Systems (MCCSIS 2026), 25 - 27 July, which had a total of 689 submissions.

The e-Learning and Digital Learning (ELDL) 2026 conference aims to address the main issues of concern within e-Learning. This conference covers both technical as well as the non-technical aspects of e-Learning.

The conference accepted submissions in the following seven main areas: Organisational Strategy and Management Issues; Technological Issues; e-Learning Curriculum Development Issues; Instructional Design Issues; e-Learning Delivery Issues; e-Learning Research Methods and Approaches; e-Skills and Information Literacy for Learning.

The above referred main submission's areas are detailed below:

Organisational Strategy and Management Issues

- Higher and Further Education
- Primary and Secondary Education
- Workplace Learning
- Vocational Training
- Home Schooling
- Distance Learning
- Blended Learning
- Change Management
- Educational Management
- Continuous Professional Development (CPD) for Educational and Training Staff
- Return on e-Learning Investments (ROI)

Technological Issues

- Learning Management Systems (LMS)
- Managed Learning Environments (MLEs)
- Virtual Learning Environments (VLEs)
- Computer-Mediated Communication (CMC) Tools
- Social Support Software
- Architecture of Educational Information Systems Infrastructure
- Security and Data Protection
- Learning Objects
- XML Schemas and the Semantic Web
- Web 2.0 Applications

e-Learning Curriculum Development Issues

- Philosophies and Epistemologies for e-learning
- Learning Theories and Approaches for e-learning
- e-Learning Models
- Conceptual Representations
- Pedagogical Models
- e-Learning Pedagogical Strategies
- e-Learning Tactics
- Developing e-Learning for Specific Subject Domains

Instructional Design Issues

- Designing e-Learning Settings
- Developing e-Learning Pilots and Prototypes
- Creating e-Learning Courses
- Collaborative Learning
- Problem-based Learning
- Inquiry-based Learning
- Blended Learning
- Distance Learning
- Designing e-Learning Tasks
- E-learning Activities
- Online Groupwork
- Experiential Learning
- Simulations and Modelling
- Gaming and Edutainment
- Creativity and Design Activities
- Exploratory Programming
- Learning Analytics

e-Learning Delivery Issues

- e-Delivery in different contexts
 - Higher and Further Education
 - Primary and Secondary Schools
 - Workplace Learning
 - Vocational Training
 - Distance Learning
- Online Assessment
- Innovations in e-Assessment
- e-Moderating
- e-Tutoring
- e-Facilitating
- Leadership in e-Learning Delivery
- Networked Information and Communication Literacy Skills
- Participation and Motivation in e-Learning

e-Learning Research Methods and Approaches

- Action Research
- Design Research
- Course and Programme Evaluations
- Systematic Literature Reviews

- Historical Analysis
- Case Studies
- Meta-analysis of Case Studies
- Effectiveness and Impact Studies
- Evaluation of e-Learning Technologies
- Evaluation of Student and Tutor Satisfaction
- Learning and Cognitive Styles
- Ethical Issues in e-Learning

e-Skills and Information Literacy for Learning

- Teaching Information Literacy
- Electronic Library and Information Search Skills
- ICT Skills Education
 - in schools and colleges
 - for business, industry and the public sector
 - in adult, community, home and prison education
 - informal methods (peer groups, family)
- Education for Computer-mediated Communication Skills
 - Netiquette
 - Online safety for children and vulnerable users
 - Cybercrime awareness and personal prevention
- Student Production of Online Media
 - Web design
 - Digital storytelling
 - Web 2.0 tools
 - etc.
- Digital Media Studies

The International Conference on Sustainability, Technology and Education 2026 (STE 2026) has the purpose to address the main issues which occur by evaluating the relationship between Sustainability, Education and Technology. The main areas of interest for this conference are: Sustainability and Leadership, Sustainability and Green IT, Sustainability and Education.

These events received 168 submissions from more than 23 countries. Each submission has been anonymously reviewed by an average of four independent reviewers, to ensure that accepted submissions were of a high standard. Consequently, only 27 full papers were approved, which meant an acceptance rate of 16%. A few more papers were accepted in the short paper, reflection paper, and poster categories. An extended version of the best papers will be selected for publishing in the Interactive Technology and Smart Education (ITSE) journal (ISSN:1741-5659), IADIS International Journal on WWW/Internet (ISSN: 1645-7641) and also in the IADIS International Journal on Computer Science and Information Systems (ISSN: 1646-3692). Other outlets may also receive extended versions of the best papers.

A successful conference requires the effort of many individuals. We would like to thank the members of the Program Committee for their hard work in reviewing and selecting the papers that appear in this book. We are grateful to all authors who submitted their papers to this conference and to the presenters who provided the substance of the meeting. We wish to thank all members of our organizing committee. We are especially grateful to Prof. Claudia Loebbecke, University of Cologne, Germany, for acting as the keynote speaker at MCCSIS 2026. The conference also features a panel discussion entitled “*Between GenAI and Immersive Technologies: How Will GenAI and Immersive Technologies Change Teaching in Higher Education?*”, by Lisa Kammholz and Anett Mehler-Bicher.

Last but not least, we hope that everybody enjoyed the presentations, and we invite all participants for next years’ edition of these conferences.

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TEACHER PROFESSIONAL DEVELOPMENT AND GENERATIVE AI: PROPOSING AN ANALYTICAL THEORETICAL MODEL

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ABSTRACT

The widespread use of generative artificial intelligence (GAI) in education has intensified debates about teacher professional development (TPD), teaching methods, and ethical concerns. Despite increased research, the fragmentation of training models and the lack of unified frameworks highlight the need for a clearer conceptual understanding. This article critically examines the main emerging training models for integrating GAI into pedagogy, identifying their limitations, tensions, and opportunities, especially regarding authorship, autonomy, and teacher mediation. Drawing on recent literature with a theoretical-analytical approach, it proposes an integrated framework that connects technological, pedagogical, ethical, and institutional aspects of TPD. The goal is to help develop more consistent training guidelines and guide future research.

KEYWORDS

Generative Artificial Intelligence, Teacher Professional Development, AI In Education, Pedagogical Integration, AI Ethics in Education, Human-AI Interaction

1. INTRODUCTION

The rapid spread of generative artificial intelligence (GAI) in education has intensified the debate about teacher training, both in initial and continuing education. Although scientific production on the subject has increased significantly, there is a predominance of studies focused on specific interventions, tool usability, and the development of technical skills, while the pedagogical, ethical, and institutional dimensions that shape the sustainable integration of GAI remain less explored. This trend reflects the conceptual fragmentation of existing training models, which rarely articulate, in a systemic way, pedagogical, ethical, and institutional aspects in a context where GAI reconfigures the notions of authorship, professional autonomy, and pedagogical regulation.

The analysis of recent literature, therefore, highlights the need for a conceptual framework capable of effectively integrating the multiple dimensions that permeate teacher training in the GAI era. In this sense, the following guiding question arises: What structural dimensions should constitute a conceptual model of teacher training for generative artificial intelligence that is pedagogically, ethically, and institutionally sustainable? This article aims to critically examine the training models associated with generative artificial intelligence (GAI), identifying assumptions, gaps, and structural tensions, with a view to proposing an integrated framework, contributing to the systematization of the theoretical debate and guiding future research.

This article is organized into five main sections. After the introduction, which contextualizes the problem and defines the objectives of the study, the literature review is presented, where the main teacher training models in the field of generative artificial intelligence are critically analyzed. Next, the adopted methodology, of a theoretical-analytical nature, which supports the construction of the proposed conceptual framework, is described. The results section presents and discusses this framework, highlighting its pedagogical, technological, ethical, and institutional dimensions. Finally, the conclusion summarizes the

main contributions of the study, discusses its implications for teacher training, and identifies avenues for future research.

2. LITERATURE REVIEW

The integration of AI into TPD requires a critical review of the theoretical frameworks that traditionally guide its training. Recent literature highlights two essential dimensions in this regard: the articulation between digital competence and pedagogical integration of technology, and the ethical and professional implications associated with the use of AI in education.

In the field of digital competence and technological integration, frameworks such as DigCompEdu have structured teacher training around proficiency levels and domains of pedagogical action (Lucas et al. 2022). However, they reveal limitations in the face of the probabilistic and adaptive nature of AI, which requires continuous critical validation of the outputs generated (Bernardi et al., 2025; Shi, 2025). Similarly, the TPACK model (Mishra et al. 2006) continues to be a reference for understanding the articulation between technology, pedagogy, and disciplinary content. Their extensions to the context of AI, such as AI-TPACK (Ning et al. 2024) and GenAI-TPACK (Lan et al. 2025), seek to integrate dimensions of algorithmic literacy and ethics. Still, they maintain a logic of intersection of domains that tends to conceptualize technology as a support tool, not fully contemplating the reconfiguration of the dynamics of authorship, planning, and pedagogical decision-making introduced by AI (Shrestha et al., 2025; Zhou et al., 2025).

In parallel, the literature highlights the growing relevance of the ethical and institutional dimensions associated with the use of AI in education. Issues related to algorithmic bias, data privacy, transparency, and professional accountability demonstrate the need for teacher training that goes beyond the technical mastery of tools and incorporates critical judgment skills and regulation of human-AI interaction (Cordero et al., 2025; Montes & Elizondo-Garcia, 2025). These transformations directly impact teaching professionalism, since collaboration between humans and generative systems challenges traditional conceptions of authorship, pedagogical mediation, and professional autonomy (Shrestha et al., 2025).

In summary, the literature shows significant advances in the conceptualization of digital teacher competence and the pedagogical integration of technology, as well as growing attention to the ethical implications of the use of artificial intelligence in education. However, limitations persist in the ability of existing models to capture the dynamic, probabilistic, and co-creative nature of generative artificial intelligence, as well as its implications at the level of authorship, pedagogical mediation, and teacher professional autonomy. These gaps point to the need for a more integrated conceptual approach, capable of articulating technological, pedagogical, ethical, and institutional dimensions. It is within this framework that the present study is positioned, proposing a theoretical framework that aims to contribute to a more systematic understanding of teacher professional development in the era of generative artificial intelligence.

3. METHODOLOGY

This study adopts a qualitative, theoretical-analytical approach, focused on the conceptual structuring of teacher professional development in the context of generative artificial intelligence. The article is based on a previously conducted integrative literature review that systematized recent scientific evidence on the role of generative artificial intelligence in initial and continuing teacher training.

Based on this corpus, an interpretative analysis of the main categories, concepts, and tensions identified in the literature was carried out, particularly regarding the articulation between teacher digital competence, pedagogical integration of technology, and ethical and professional implications associated with the use of artificial intelligence in education. At the same time, a critical comparison of digital competence frameworks and technological integration models was conducted, including DigCompEdu and the TPACK model, as well as their extensions to the context of artificial intelligence.

This analytical process made it possible to identify conceptual gaps and structural limitations of existing models, particularly in light of the dynamic, probabilistic, and co-configuring nature of generative artificial intelligence, as well as its implications in terms of authorship, pedagogical mediation, professional autonomy, and regulation of human-AI interaction.

From this synthesis, an integrated conceptual framework was developed, which articulates technological, pedagogical, ethical, and institutional dimensions of teacher professional development. The proposed model assumes a heuristic and exploratory character, constituting an analytical basis for understanding the phenomenon and for future empirical validation in different educational contexts.

4. RESULTS

Based on the analytical process described, centered on the critical reinterpretation of the literature and the comparison of digital competence and technological integration frameworks, a set of structuring dimensions emerges for understanding teacher professional development in the context of generative artificial intelligence. This section presents the main results of this analysis, organized in the form of an integrated conceptual framework, which seeks to address the gaps identified in the literature and offer a structured basis for the articulation between pedagogical, technological, ethical, and institutional dimensions. The following subsection provides a detailed presentation of the components of the proposed model.

4.1 Limitations of Traditional Models and The Emergence of AI Literacy

The interpretative reanalysis of emerging categories indicates that a large part of teacher training proposals for AI remain anchored in traditional models of digital competence, such as DigCompEdu, SQD, and TPACK. Although these frameworks have contributed to guiding technological integration in education, they reveal limitations in the face of the generative and probabilistic nature of AI, which introduces new epistemological, pedagogical, and ethical challenges. Many training initiatives are centered on the development of operational skills, such as the use of tools or the creation of prompts, remaining within an instrumental logic. In response to these limitations, approaches oriented towards AI literacy are emerging, focusing on a critical understanding of algorithmic principles and the pedagogical implications of the technology.

4.2 Emerging Training Models

Analysis of recent literature reveals the coexistence of different formative models for the integration of AI in TPD, reflecting a field still under consolidation. Among the frameworks used, adaptations of TPACK stand out, such as GenAI-TPACK, which seeks to integrate dimensions of literacy and ethics in the pedagogical use of AI (Lan et al., 2025). In parallel, some studies resort to models oriented towards the regulation of human-AI interaction, such as Human-AI Shared Regulation of Learning-HASRL (Tran et al., 2025), or structured pedagogical approaches, such as SQD (Zhou et al., 2025). In specific disciplinary contexts, frameworks such as Knowledge for Teaching Mathematics with Technology (KTMT), applied to the training of mathematics teachers, also emerge, highlighting experiences of adapting technological integration models to curricular particularities (Bernardi et al., 2025).

Despite this theoretical diversity, the studies analyzed reveal two predominant formative orientations. The first corresponds to instrumental approaches, centered on the technical mastery of tools and the exploration of specific applications, frequently associated with short-term interventions and focused on supporting pedagogical planning or the production of teaching materials (Guerrero-Zambrano et al., 2025; Lan et al., 2025). In contrast, a second orientation prioritizes reflective and pedagogically mediated approaches, in which AI is integrated as an element of problematizing teaching practice. In these models, training includes mentoring activities with AI systems, regulation of human-AI interaction, and development of critical thinking, favoring more consistent impacts on the pedagogical and reflective dimensions of teaching practice (He et al. 2025; Shrestha et al. 2025; Tran et al. 2025). Some studies also explore the use of immersive simulation environments supported by generative AI, which allow future teachers to experience complex pedagogical scenarios and practice teacher decision-making (Hong et al. 2025).

Although both approaches contribute to the development of skills, the analysis suggests that more structured training models, supported by explicit theoretical frameworks and contextualized practical experiences, tend to promote a deeper integration of AI into the pedagogical process. Still, the diversity of frameworks and the absence of consistent empirical validation indicate that the field remains fragmented, reinforcing the need for integrative conceptual models capable of articulating technological and pedagogical skills, as well as ethical and institutional challenges in TPD.

4.3 Institutional and Ethical Challenges

In addition to the differences between training models, the literature analyzed shows that the integration of AI in teacher training is strongly conditioned by institutional and ethical factors. In many educational contexts, the adoption of these technologies occurs relatively spontaneously, without a strategic framework or clear institutional guidelines, which limits the consistency of training and pedagogical practices (Cordero et al., 2025; Montes & Elizondo-Garcia, 2025).

From an institutional point of view, studies indicate that educational policies, technological infrastructures, and favorable organizational cultures are determining elements for the sustainable integration of AI in teacher training. In the absence of these factors, the use of the tools tends to occur in a fragmented way and is dependent on the individual initiative of teachers, hindering the consolidation of structured pedagogical practices (Montes & Elizondo-Garcia, 2025).

In parallel, the literature highlights a set of ethical challenges associated with the use of AI in the educational context. Among the most frequently cited problems are the risk of technological dependence, the difficulty in assessing the authorship and originality of productions generated with AI support, as well as concerns related to privacy, algorithmic transparency, and possible biases in generative systems. These challenges make it clear that teacher training cannot be limited to the technical mastery of tools; it is essential to also include the development of critical literacy and the ability to regulate human-AI interaction (Bernardi et al., 2025; Shrestha et al., 2025).

In addition, some studies indicate that the introduction of AI can trigger deeper transformations in the professional identity of teachers. The possibility of collaboration between humans and generative systems reconfigures practices of planning, evaluation, and production of pedagogical knowledge, requiring new forms of reflection on the role of the teacher in the educational context (Shrestha et al., 2025).

In summary, the evidence suggests that the integration of IAG into TPD depends on an articulation between adequate institutional conditions, explicit ethical frameworks, and pedagogically structured training models. The absence of this articulation tends to produce superficial or technocentric integrations, reinforcing the need for more comprehensive conceptual frameworks capable of guiding teacher training in the IAG era.

4.4 Proposal for The Conceptual Framework

A critical analysis of the literature shows that the models currently used to guide TPD in the context of AI remain fragmented, addressing only partially the pedagogical and ethical dimensions involved in its educational integration. Although frameworks such as TPACK and its adaptations for AI constitute relevant contributions (Lan et al., 2025), the results of this review indicate the need for a more comprehensive conceptual framework, capable of integrating the multiple dimensions that condition the effective and sustainable pedagogical use of AI.

Based on the synthesis of the analyzed evidence, a conceptual framework for TPD in the AI scenario is proposed, structured in four interdependent dimensions, as shown in Figure 1.

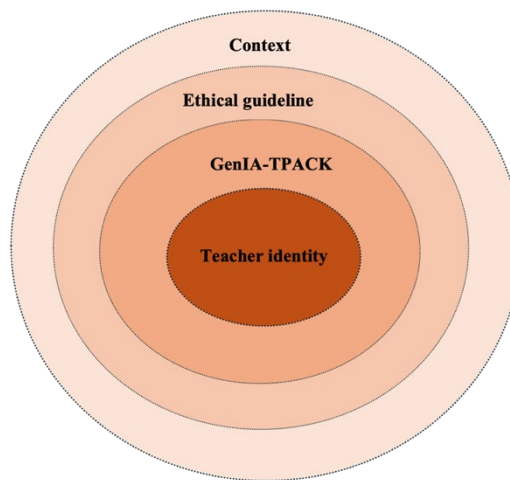


Figure 1. Proposal for the conceptual framework

The proposed conceptual framework is organized into interdependent layers, represented in the model by concentric circles that show different levels of influence on the pedagogical integration of AI in teacher training.

At the core of the model is teacher identity, understood as the set of professional beliefs, pedagogical values, and conceptions about teaching and learning that guide educational practice. The integration of AI is not only a technical challenge but also implies processes of critical reflection and reconfiguration of professional identity in a context where authorship, pedagogical mediation, and the relationship between humans and intelligent systems become progressively more hybrid (Shrestha et al., 2025).

The second layer corresponds to GenIA-TPACK, which represents the articulation between technological, pedagogical, and disciplinary knowledge applied to the use of AI. At this level are situated the competencies necessary to understand the functioning of the tool, explore its potential in didactic planning, and integrate it into teaching, learning, and assessment strategies aligned with curricular objectives. Shi (2025) operationalizes teaching competencies for AI in the T-GAIC (Teachers' Generative Artificial Intelligence Competence) instrument, which integrates technical, pedagogical, evaluative, ethical, and creative dimensions. Furthermore, the literature shows that the effectiveness of technological integration depends on the ability to articulate these different domains of knowledge in the context of specific disciplines (Guerrero-Zambrano et al., 2025).

The third layer concerns ethical guidelines, which function as a normative framework for the responsible use of AI in education. This dimension involves understanding issues related to authorship, data privacy, algorithmic transparency, biases, and academic integrity. The development of critical literacies in these domains is considered fundamental to promoting ethically informed and socially responsible pedagogical practices (Bernardi et al., 2025).

Finally, the outermost layer corresponds to the context, which includes the institutional, organizational, and political conditions that shape the integration of AI in teacher training. At this level, factors such as educational policies, technological infrastructure, institutional training programs, curricular guidelines, and organizational cultures influence the opportunities and limitations of the use of these technologies (Cordero et al., 2025).

In this way, the framework proposes an ecological and integrated perspective of teacher training for IAG, in which technological integration is not understood as an isolated process, but as a result of the interaction between professional identity, pedagogical-technological knowledge, ethical principles, and institutional conditions. By systematizing these dimensions in an articulated model, the framework contributes to the conceptual clarification of the field and can serve as a reference for the design of teacher training programs and to guide future research.

5. CONCLUSIONS

The analysis identified emerging trends and limitations in teacher training models that integrate AI, which are still marked by primarily instrumental approaches. The review shows that teacher training with AI is multidimensional, involving technological, pedagogical, curricular, ethical, and institutional aspects, and highlights the emergence of more reflective training approaches, focused on the regulation of human-AI interaction, critical literacy, and professional identity.

Based on this evidence, a conceptual framework for teacher training in the context of AI was proposed, structured in four interdependent dimensions: teacher identity, GenIA-TPACK, ethical guidelines, and context, which includes institutional, organizational, and educational policy conditions. This model seeks to respond to the conceptual fragmentation identified in the literature, offering an integrated framework that articulates different levels of analysis of teacher training.

From a scientific point of view, it is expected that the study will contribute to the conceptual clarification of the field by systematizing and structuring dimensions that can guide future investigations on the pedagogical integration of AI. In practical terms, the proposed framework could support the design of teacher training programs and inform educational policies aimed at a more critical, ethical, and pedagogically grounded adoption of these technologies.

Despite these contributions, it is important to recognize that research on AI in teacher training is still in the consolidation phase. Thus, it is recommended that empirical studies be developed to test and validate the proposed model in different educational contexts, as well as longitudinal investigations that analyze the impact of integrating AI on pedagogical practices and on TPD (Teacher Development Program).

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