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Rethinking teaching with GenAI: Theoretical models and operational tools

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Abstract: The rapid evolution of generative Artificial Intelligence (AI) has raised new questions regarding the effective integration of digital tools into the educational process, necessitating theoretical and methodological approaches capable of fully harnessing its potential. This paper examines the ESLAI framework (Situated Learning Episodes with AI) (Panciroli et al., 2023) and the TPAIK model (Technological, Pedagogical, Artificial Intelligence Knowledge) (Pratschke & Islam, 2023) to highlight how the informed use of generative AI must be supported by disciplinary, pedagogical, and computational competencies. Additionally, the S.P.Ai.C.E. model (Synergy between People and Artificial Intelligence for Collaborative Education) is presented as a framework designed to guide educators in the selection and validation of AI tools in contexts characterized by rapid technological obsolescence. The analysis of these three models demonstrates how a training design based on situated learning can leverage AI affordances to make teaching practices more dynamic, personalized, and context sensitive. The findings from the implementation of these models (Adamoli et al., 2024) suggest that by combining a solid theoretical foundation with operational procedures for testing and evaluation, it is possible to foster an ethical and sustainable use of AI in education. This approach promotes co-creative knowledge processes while developing meta-reflective competencies.

Keywords: GenIA; Situated Learning; Instructional Design; TPAIK; S.P.Ai.C.E.

1. Introduction

In recent years, the development of Artificial Intelligence (AI), particularly in its generative form (GenAI), has led to innovations in the ways learning and teaching are approached within schools and other educational contexts. Applications such as chatbots, avatars, and automated systems for generating textual, visual, and audiovisual content have raised a series of questions regarding their impact on the learning process and educational innovation (Holmes et al., 2019). At the same time,

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there has been a growing proliferation of frameworks and theoretical models aimed at guiding the integration of AI into educational settings, emphasizing that mere technological availability is insufficient to ensure a genuine transformation of teaching practices (UNESCO, 2021).

This article presents an analysis of two particularly relevant models:

1. ESLAI (*Situated Learning Episodes with AI*) (Panciroli et al., 2023), theorized based on the EAS method (Rivoltella, 2013), situated learning theories (Lave & Wenger, 1991), and the connectivist approach (Siemens, 2005);
2. TPAIK (*Technological, Pedagogical, Artificial Intelligence Knowledge*), an evolution of the well-known TPACK framework (Mishra & Koehler, 2006), which integrates AI and computational thinking to address the new challenges posed by GenAI (Pratschke & Islam, 2023).

These two approaches represent potential enhancements to ABC Learning Design (Young & Perović, 2016) and the *Conversational Framework* (Laurillard, 2015), highlighting how AI can support more dynamic and personalized learning processes. Additionally, this paper introduces the S.P.Ai.C.E. model (*Synergy between People and Artificial Intelligence for Collaborative Education*), developed by the authors, which serves as an operational guide for researching, selecting, and validating AI tools aligned with pedagogical objectives.

2. Theoretical Framework: Situated learning, connectivism, and computational intelligence

The adoption of digital technologies and GenAI in educational settings has often been justified by the need to make learning more effective, engaging, and personalized. However, the literature emphasizes that these benefits do not stem solely from the introduction of technological tools but rather from a rethinking of instructional design (Laurillard, 2015). This consideration underscores the importance of theoretical foundations that support the adoption of approaches with a long-standing empirical tradition, leveraging digital technologies to enhance, strengthen, and improve teaching and learning processes.

- *Situated Learning*: According to Lave and Wenger (1991), learning is a process of situated participation within communities of practice, where learners acquire competencies through interaction with real and authentic contexts. This approach moves beyond the notion of linear content transmission, emphasizing instead the co-construction of knowledge within realistic scenarios.

- *Connectivism*: Siemens (2005) posits that knowledge resides within a network of connections between individuals, learning environments, and digital technologies. From this perspective, AI is not merely a passive tool but rather an active "node" within the network, capable of generating new content and participating in meaning-making processes. The connectivist paradigm aligns with Pratschke's (2023) concept of the *new hybrid*, which suggests that humans and AI coexist in a dynamic process of co-creation and reinterpretation of knowledge.

- *Computational Intelligence*: represents an adaptive approach to information processing, based on methods such as artificial neural networks, fuzzy systems, and evolutionary algorithms (Zadeh, 1965; Holland, 1975). Unlike traditional artificial intelligence, computational intelligence excels in handling complex, uncertain, and nonlinear problems. In the educational domain, it enables the development of adaptive and personalized systems, fostering dynamic interactions between students, content, and technologies while enhancing situated and collaborative learning (Woolf, 2007).

Building on the theoretical approaches presented, two frameworks emerge as particularly relevant for guiding the integration of GenAI in educational contexts: ESLAI (*Situated Learning Episodes with AI*) and TPAIK (*Technological, Pedagogical, and Artificial Intelligence Knowledge*). Both offer complementary perspectives for rethinking instructional design and promoting a critical and informed adoption of digital technologies in teaching and learning processes.

2.1 *The ESLAI framework*

The ESLAI model aligns with a body of research focused on the construction of *situated learning episodes* (Rivoltella, 2013; 2023), which, starting from real or realistic situations, employ AI as a didactic support tool, a catalyst for engagement, and a stimulus for ethical reflection. The ESLAI framework is structured into three fundamental phases—anticipation, production, and restructuring—which are consistent with socio-constructivist-inspired models.

1. *Anticipation phase*: This stage focuses on context preparation and the definition of disciplinary and transversal learning objectives. Educators can leverage generative AI applications to create resources that stimulate students' interest, such as automatically generated concept maps (e.g., using Xmind) or simulated scenarios that help contextualize problems. The underlying logic is heuristic, aimed at activating prior knowledge and fostering students' hypothesis formulation. A practical example is the use of language models like ChatGPT to introduce and summarize complex content, supporting the development of linguistic and analytical skills.
2. *Production phase*: The core phase of the model, in which students actively engage with AI in authentic scenarios, carrying out activities that require active participation and co-construction of knowledge. AI can be employed to generate multimedia artifacts (e.g., texts, videos, or images) or to solve complex problems using analytical tools. For instance, chatbots can provide immediate feedback during exercises, while video generation applications can visually synthesize complex concepts. The pragmatic logic of the production phase aligns with the learning-by-doing approach, fostering the development of both technical and content-related competencies.
3. *Restructuring phase*: This final phase, crucial for consolidating learning, engages students in critical reflection on the outcomes produced with AI support. Through debriefing activities, educators guide students in analyzing biases, limi-

tations, and ethical implications of the tools used. The goal is to foster critical awareness and promote digital citizenship competencies. For example, by examining AI-generated outputs, students can discuss the impact of data quality on responses or identify potential interpretative errors. This metacognitive phase is essential for cultivating deep and lasting learning.

On the one hand, the anticipation phase emphasizes goal definition, context preparation, and the selection of generative AI tools that stimulate prior knowledge and engagement. On the other hand, in the operational phase, student collaboration—mediated by AI—contributes to the collective construction of knowledge. AI can provide real-time feedback, suggest additional resources or alternative perspectives, and generate a continuous dialogue that supports critical reflection.

This process aligns with the principles of dialogicity outlined in the *Conversational Framework* (Laurillard, 2015), as students are encouraged to critically reinterpret AI-generated content. Finally, in the restructuring phase, once the practical activity is completed, students and the teacher engage in reflective analysis of the outcomes and the potential implications of AI usage. This often-underestimated phase is crucial for consolidating learning, integrating additional disciplinary resources, and assessing the effectiveness of the adopted model.

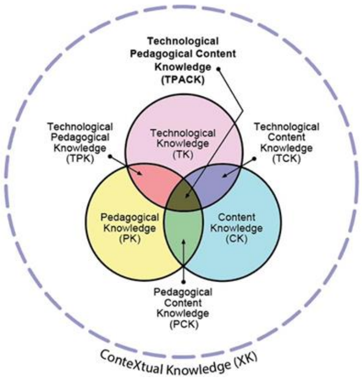
2.2 From TPACK to TPAICK model

Developed by Mishra and Koehler (2006) and introduced in their article published in *Teachers College Record* titled *"Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge"*, the TPACK framework (Technological Pedagogical and Content Knowledge) represents an evolution of the *Pedagogical Content Knowledge* (PCK) concept, originally theorized by Shulman in 1986 (Shulman, 1986). Shulman emphasized the crucial integration of pedagogical and disciplinary knowledge in teacher education to promote effective teaching.

TPACK expands this perspective by incorporating the technological dimension, which is essential for addressing the educational challenges of the digital era.

The framework is based on seven interrelated domains of knowledge, which together provide a theoretical foundation for designing meaningful learning experiences:

1. *Technological Knowledge* (TK): Understanding of technological tools and their applications.
2. *Pedagogical Knowledge* (PK): Knowledge of teaching strategies and instructional methodologies.
3. *Content Knowledge* (CK): In-depth understanding of the subject matter being taught.



With the advent of Generative AI, the need arose to expand the TPACK framework to incorporate a new dimension addressing the specificities of AI. The TPAIK framework (*Technological, Pedagogical, and Artificial Intelligence Knowledge*), proposed by Pratschke (2023), builds upon TPACK to respond to the educational challenges posed by GenAI. It integrates computational intelligence as a core competency, emphasizing the need for educators to develop a deep understanding of AI technologies, their affordances, and their implications for teaching and learning. The framework is thus enriched by the *Artificial Intelligence Knowledge* (AIK) dimension, which refers to specific knowledge of artificial intelligence and its educational implications.

AIK includes:

- *Technical knowledge*: Understanding how AI models work (e.g., neural networks and generative models).
- *Practical applications*: The ability to use AI tools to create adaptive and personalized learning experiences.
- *Critical awareness*: Analyzing ethical implications, algorithmic biases, and the limitations of AI-based technologies.

The dimensions of the original TPACK framework are expanded to include the ways in which AIK transforms not only content interaction but also pedagogical processes and instructional design. The framework is structured around three core dimensions:

- *Technological and Computational Knowledge* (TK): Technological competence is no longer limited to traditional tools but includes advanced computational capabilities, such as natural language processing (NLP), neural networks, and adaptive systems.
- *Pedagogical Knowledge* (PK): Student-AI interaction becomes a means to foster autonomy, critical reflection, and personalized learning. AI is conceptualized as a co-constructor of knowledge, capable of adapting to learners' needs and providing immediate, contextualized feedback.

- *Content Knowledge* (CK): Disciplinary content is reinterpreted through AI affordances. For instance, in social sciences, AI can be leveraged for large-scale data analysis, while in literary studies, it can facilitate comparative text analysis.

2.3 From TPACK to the ESLAI Framework: Perspectives on Integration

The TPAIK model provides a broad interpretative framework for the intentional, reflective, and informed use of AI in the teaching-learning process. However, at an operational level, there remains a need to "translate" this theoretical framework into concrete strategies that guide the design of actual learning environments. This is where the ESLAI framework, in synergy with the principles of TPAIK, finds its practical application.

On one hand, TPAIK helps educators define *what* and *how* to integrate AI technologies, balancing disciplinary, pedagogical, and computational knowledge. On the other hand, ESLAI provides a structured format—organized into the anticipation, production, and restructuring phases—allowing teachers to translate these knowledge domains into situated instructional episodes designed to foster experiential and reflective learning.

In this sense, the two models are complementary: TPAIK ensures the depth of competence by integrating content, pedagogical dimensions, and AI, while ESLAI guarantees its practical, situated, and competence-oriented design, fostering the development of transferable skills.

Aligned with the principles of ABC Learning Design (Young & Perović, 2016), the operative and debriefing phases of the ESLAI framework function as collaborative workshops in which participants—whether teachers or students—co-construct knowledge, prototype resources, and evaluate their relevance to learning objectives. Similarly, the dialogic and cyclical nature of the *Conversational Framework* (Laurillard, 2015) is reflected in the continuous alternation between anticipation, active practice, and critical reflection.

Within this perspective, AI becomes an integral part of the *conversational turns* between students, teachers, and content, acting as a cognitive mediator that provides immediate feedback, stimulates inquiry, and offers new interpretative perspectives.

3. The S.P.Ai.C.E. model (*Synergy between People and Artificial Intelligence for Collaborative Education*)

Complementing the theoretical frameworks described (ESLAI and TPAIK), which respectively provide an operational methodology for designing situated learning episodes and an integrated knowledge system for the informed use of AI, the S.P.Ai.C.E. model (Synergy between People and Artificial Intelligence for Collaborative Education) is introduced. Contrary to what might be assumed, S.P.Ai.C.E. is not an extension or development of ESLAI; rather, it is a model designed to support educators in the identification and validation of AI tools within a landscape characterized by rapid technological obsolescence and replacement.

Recent studies (Holmes et al., 2019; UNESCO, 2021; OECD, 2021; SnowFlake, 2024) emphasize that many AI-driven educational solutions have short life cycles, often due to:

- *Rapid obsolescence*, as they are quickly surpassed by updated versions (e.g., new releases, next-generation AI models).
- *Market competition*, where new tools with similar but more advanced or user-friendly functionalities emerge, prompting users to migrate to other platforms.
- *Changes in policy*, privacy, and licensing conditions, which can significantly alter the accessibility and usability of a given tool.

3.1 The Phases of the S.P.Ai.C.E. Model

1. *Search* – AI Tools Exploration
   In this initial phase, educators (or trainers) conduct a mapping of available technologies by utilizing specialized search engines for educational AI, online directories and repositories (e.g., EdTech directories or review platforms), as well as recommendations from professional and academic communities. The primary objective is to identify applications based on their specific affordances that may be potentially useful for the planned teaching activity, while considering students' age, disciplinary or transversal learning goals, technical constraints, and inclusion and accessibility needs.

2. *Prompting & Guidance* – Querying Chatbots and Obtaining Technical/Educational Suggestions
   The second phase involves the experimentation and direct querying of AI tools, particularly chatbots, to obtain both technical information (e.g., compatibility with the institution's platform, minimum system requirements, licensing) and pedagogical insights (e.g., potential workshop activities, automated assessment strategies, integration with active learning methodologies). Next-generation chatbots and virtual assistants can provide immediate insights on how to structure an educational project, offering suggestions on the tool's capabilities, possible use cases, and even mini-tutorial guides.

3. *Human Testing & Validation* – Final Validation Through Human Testing
   After gathering insights and "use hypotheses" generated by AI, the process moves to field verification, where educators and a small group of users (colleagues, tutors, pilot students) conduct a limited and controlled trial of the selected tool. In this phase, human evaluation plays a crucial role: it is essential to assess the quality of the proposed functionalities (content accuracy, reliability, interface usability, feedback mechanisms) and identify potential critical issues, such as bias in responses, incompatibility with the school's infrastructure, or privacy concerns. Only after this validation phase is completed can a decision be made on whether to permanently integrate the technology into the instructional design or continue the search for a more suitable alternative.

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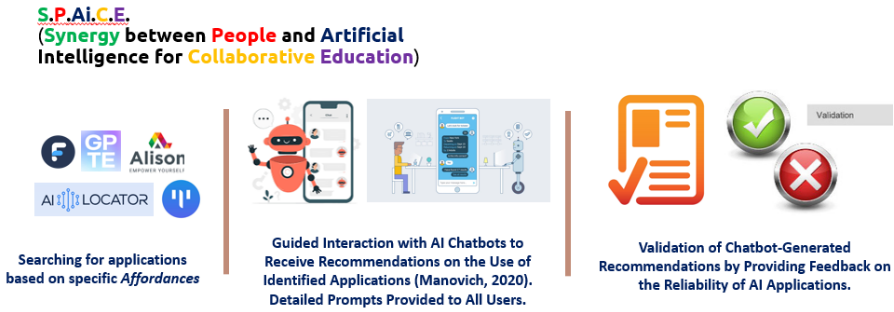

The integration of the ESLAI framework with the S.P.Ai.C.E. model provides a comprehensive approach to instructional design and management, which, on the one hand, is grounded in robust theoretical foundations (situated learning, connectivism, and computational intelligence) and, on the other, offers a practical response to the need for selecting, testing, and adopting AI tools in a constantly evolving landscape. At a macro level, ESLAI structures the entire educational process into three phases (anticipation, production, and restructuring), emphasizing situated participation and knowledge co-construction with AI support. Within this framework, S.P.Ai.C.E. functions as a practical mechanism that guides educators' technological choices, offering a structured protocol for searching, analyzing, and validating AI tools (*Search, Prompting & Guidance, Human Testing & Validation*). This ensures that the situated learning perspective promoted by ESLAI is continuously updated, preventing reliance on tools that may quickly become obsolete. At a micro level, the combination of these two models proves particularly effective. During the production phase, students engage with AI tools that have been carefully selected and validated, generating artifacts and reflections that contribute to a virtuous cycle of experiential learning. At the same time, AI serves as an active node within the connectivist network (Siemens, 2005), providing immediate feedback, highlighting biases, and fostering critical reflection. This dynamic interaction ensures a high degree of responsiveness in the teaching-learning process, aligning with the learning objectives defined by educators.

4. Closing remarks

In this contribution, we have presented the ESLAI framework (Panciroli et al., 2023) as a reference model for designing AI-enhanced instructional activities. Within this framework, we recognize elements of the *Conversational Framework* (CF), particularly in ESLAI's conceptualization of learning as an iterative[2] and dialogic cycle,

[2] The concept of iteration describes a learning process based on deliberate repetitions, where each cycle contributes to reinforcing and consolidating acquired knowledge. Numerous neuroscientific studies confirm the importance of repetition in memory consolidation: Kandel (2013) demonstrate that repetition activates synaptic connections, facilitating long-term potentiation (LTP), a fundamental mechanism for memory retention and deep learning. In the educational domain, Brown et al. (2014) highlight how retrieval practice and spaced repetition strengthen memory traces, making learning more durable and transferable to new contexts. Through an

where reflection, feedback, and clarification play a central role in constructing meaningful knowledge. In AI-supported learning environments, this cycle becomes particularly powerful, as generative AI applications can provide real-time feedback, dynamically adapting educational interventions to the individual needs of each student while fostering active and personalized participation. The affordances of AI further reinforce the cycles of reflection and feedback described in *CF*, enabling educators to adjust learning processes based on the data generated by student interactions with instructional content. Similarly, *ABC Learning Design* is reflected in ESLAI's operational structure, which organizes learning into fundamental activities: Acquisition, Collaboration, Discussion, Investigation, Practice, and Production—all of which align with Rivoltella's (2013) conceptualization of instructional logics and phases, framing both teacher and learner actions. Each of these categories represents a dimension of learning that can be enhanced through AI, offering educators a framework for designing activities that leverage AI's adaptive and personalization capabilities. The ABC model seamlessly aligns with ESLAI's phases of preparation, development, and restructuring, as each ABC category can be mapped onto these phases, thereby optimizing instructional effectiveness.

- In the anticipation phase, AI can be leveraged to adapt acquisition content—understood as introduction and activation in Laurillard's model—and investigation tasks according to students' prior knowledge levels, setting the stage for the more operational development phase.

- During the development phase, collaborative and practice-based activities benefit from AI-driven functionalities that facilitate group formation and personalized exercises.

- The restructuring phase consolidates and synthesizes learning, guiding discussions that help students reorganize and apply acquired knowledge, transforming it into concrete and reusable outputs.

The synergy between ESLAI and the AI tool selection model S.P.Ai.C.E. operates on two complementary levels: on the one hand, ESLAI provides a robust theoretical and methodological foundation, grounding instructional processes in situated learning principles (Lave & Wenger, 1991) and dialogicity (Laurillard, 2015); on the other, S.P.Ai.C.E. offers operational flexibility, allowing for the rapid identification and implementation of AI tools aligned with pedagogical requirements. This integration addresses both the need for meaningful and collaborative learning and the challenges posed by a rapidly evolving technological landscape (Holmes et al., 2019; UNESCO, 2021). When well-structured, the two models, reinforced by TPAIK (Pratschke & Islam, 2023), can foster an educational approach that enhances both disciplinary and meta-reflective competencies, ensuring an ethically responsible and critically informed use of AI in educational settings. At the same time, they promote the creation of dynamic, inclusive learning communities that are attuned to emerging socio-technological contexts.

iterative process, learning not only improves information retention but also becomes more robust and flexible, progressively adapting to students' needs (see Hadji (2022), in relation to feedback cycles and types of regulation).

References

Adamoli, M., Messina, S., Panciroli, C. & Rivoltella, P.C. (2024). Generative AI for Decision Making: Reliability of LLMs in Supporting Educational and Instructional Decisions. *Scholè*, 2/2024.

Brown, P. C., Roediger, H. L., & McDaniel, M. A. (2014). *Make it stick: The science of successful learning.* Harvard University Press.

Hadji, C. (2022). *La valutazione delle azioni educative*. La Scuola.

Holland, J. H. (1975). *Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control, and Artificial Intelligence*. Bradford Books.

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning.* Center for Curriculum Redesign.

Kandel, E. (2013). Kandel E. The new science of mind and the future of knowledge. *Neuron*. 2013 Oct 30;80(3):546-60.

Laurillard, D. (2015). *Insegnamento come scienza della progettazione. Costruire modelli pedagogici per apprendere con le tecnologie*. Franco Angeli.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge University Press.

Manovich, L. (2020). *Cultural analytics.* The MIT Press.

Mishra, P., & Koehler, M. J. (2006). *Technological pedagogical content knowledge: A framework for teacher knowledge.* Teachers College Record, 108(6), 1017–1054.

OECD (2021). *AI and the Future of Skills*. OECD Publishing.

Panciroli, C., Allegra, M., Gentile, M., & Rivoltella, P. C. (2023). Towards AI literacy: A proposal of a framework based on the Episodes of Situated Learning. In *Ital-IA 2023: 3rd National Conference on Artificial Intelligence.* Pisa, Italy: CINI

Pratschke, M. (2023). The new hybrid: Human-AI interactions in learning environments. Routledge.

Pratschke, M., & Islam, M. (2023). Technological, pedagogical, and artificial intelligence knowledge (TPAIK): A framework for AI literacy in education. *AI & Society*, 38(4), 987–1003.

Rivoltella, P. C. (2013). *Fare didiattica con gli EAS*. La Scuola.

Rivoltella, P. C. (Ed.). (2023*). Gli EAS tra didattica e pedagogia di scuola: Il metodo, la ricerca*. Scholé.

Siemens, G. (2005). *Connectivism: A learning theory for the digital age.* International Journal of Instructional Technology and Distance Learning, 2(1).

Snowflake Inc. (2024). *Data Trends 2024: 7 Ways Leading Organizations Are Building Toward Advanced AI Success*. Snowflake Research Institute.

UNESCO (2021). *AI and education: Guidance for policymakers*. UNESCO Publishing.

Woolf, B. P. (2007). *Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning.* Morgan Kaufmann.

Young, C., & Perović, N. (2016). *ABC Learning Design: A rapid curriculum development methodology.* University College London Press.

Zadeh, L. A. (1965). Fuzzy sets. *Information and Control*, 8(3), 338–353.