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Simulation-based Experiential Assessment Model (SEAM) for Digital Education: An Integrated Model for Experiential Learning, Gamification and Authentic Assessment

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Abstract: The integration of digital technologies has profoundly transformed educational processes, yet a persistent fragmentation between experiential, motivational, and evaluative dimensions remains. To address this critical gap, this paper introduces the Simulation-based Experiential Assessment Model (SEAM), a unitary and data-driven framework designed to support experiential learning and authentic assessment within advanced university and professional training contexts.

The core innovation of the model lies in its multi-level architecture that systematically integrates non-linear simulative scenarios, strategic gamification mechanics, and stealth assessment devices. Grounded in pedagogical paradigms such as Flipped Inclusion and the theory of simplexity, SEAM leverages learning analytics to transform behavioral interactions and learners' "digital footprints" into empirical evidence of competence. This approach effectively overcomes the traditional separation between instruction and evaluation in favor of a dynamic, enactive, and adaptive logic.

The model's validity is demonstrated through the "Global Launch 2026" case study in Project Management, which features the pioneering implementation of intelligent tutors and NPCs managed via Retrieval-Augmented Generation (RAG) systems to provide real-time, situated, and personalized feedback. Results indicate a significant increase in learner engagement (flow), improved observability of transversal competencies, and the successful development of fundamental meta-competencies, including complexity management and systemic thinking. Ultimately, SEAM serves as a comprehensive paradigm for post-digital pedagogy, fostering a new pedagogical contract centered on inclusion, pathway personalization, and learner agency.

Keywords: digital education; gamification; experiential learning; authentic assessment; learning analytics; RAG; stealth assessment.

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1. Introduction

The integration of digital platforms, interactive environments, and e-learning tools has profoundly transformed teaching-learning processes, imposing a rethinking of training methodologies and assessment strategies. In such a scenario, the need to design educational paths that are not limited to the transmission of content, but that promote the development of complex and transversal competencies, such as problem solving, leadership, decision-making ability, and collaboration, which are difficult to observe through traditional evaluative tools, emerges with growing evidence (Garrison & Vaughan, 2008; Shephard, 2000).

Recent scientific debate has progressively oriented itself toward educational models capable of integrating technological, cognitive, and social dimensions in a systemic perspective. Reflections on the so-called fruitful hybridizations between bodies, algorithms, and learning environments (JIMTLT, 2025) are placed in this direction, within which generative artificial intelligence and personalized digital tutors contribute to redefining methods of study support and educational interaction (Di Tore & Todino, 2026). In this context, the evolution of intelligent technologies requires a renewed pedagogical reflection, oriented toward transforming the digital divide into a concrete opportunity for inclusion. This implies the promotion of a critical and conscious use of digital technologies, aimed at reducing inequalities and constructing equitable and accessible learning environments (Di Bari, 2023; Sgambelluri, 2023).

Among the most relevant paradigms is experiential learning which, supported by digital simulations, allows students to immerse themselves in realistic scenarios, take strategic decisions, and observe the consequences of their actions in safe and controlled contexts (Dewey, 1938; Kolb, 1984). Parallelly, the integration of gamification mechanics contributes to sustaining engagement and intrinsic motivation, incentivizing active participation and metacognitive reflection on decision-making processes (Deterding et al., 2011; Hamari et al., 2014; Werbach & Hunter, 2012). Evidence emerged within the research activities of [OMISSIS] confirms the effectiveness of digital simulations and gamification in enhancing student involvement and performance levels. Such results highlight, at the same time, the need to develop integrated models capable of systemically connecting the didactic, motivational, and evaluative dimensions, overcoming the fragmentation still present in many educational contexts (Di Tore et al., 2021; Rocca Comite Mascambruno, 2023; Sibilio & Aiello, 2022; Todino, 2020).

The paradigm of Flipped Inclusion (Todino, 2024) is inserted into this theoretical and empirical framework, understood as a systemic approach oriented toward the construction of inclusive environments through a bottom-up logic, capable of valuing individual differences and promoting processes of active participation. In light of such premises, the present contribution proposes to introduce the Simulation-based Experiential Assessment Model (SEAM) as an integrated, coherent, and scalable model, able to support experiential learning, gamification, and the observable assessment of competencies in university and advanced professional contexts.

2. The Scientific Landscape and Theoretical Foundations of the Model

Contemporary literature on digital learning is configured as a strongly interdisciplinary field, characterized by the convergence between educational technology, education sciences, cognitive psychology, data sciences, and experience design.

In this context, the most advanced models do not limit themselves to describing learning environments mediated by technology, but orient themselves toward the dynamic integration between experience, assessment, and adaptation (Holmes et al., 2019; Luckin et al., 2016). Parallelly, the integration of paradigms like Suggestopedia and the theory of simplexity opens new perspectives for interdisciplinary and creative didactic design (Di Paolo & Todino, 2026). The SEAM framework is placed at the intersection of such directions, reflecting the evolution of educational paradigms toward a processual, situated, and data-driven perspective.

2.1 Digital Teaching and Competency Assessment: From Logs to Learning Analytics

The expansion of digital environments and blended contexts has determined a significant increase in data availability. However, the simple collection of logs and clickstreams is often insufficient for a profound understanding of learning processes (Wang et al., 2013). In response, the field of learning analytics has developed approaches based on the analysis of complex flows and predictive models (Ferguson, 2012; Ifenthaler, 2015; Siemens & Baker, 2012).

The use of Retrieval-Augmented Generation (RAG) systems, which allow for the design of digital tutors capable of responding in real time to the learner's needs, enhancing study support dynamics (Di Tore & Todino, 2026), is also placed in this direction.However, as highlighted by Sibilio and Aiello (2022), the value of data does not reside in its quantity, but in the ability to interpret it in light of decision-making processes. The design of evaluative devices in digital contexts therefore requires pedagogical awareness of technological systems and their capacity to generate structured feedback (Faggioli et al., 2024).

Such a perspective integrates with the need to observe competencies in authentic contexts (Dochy et al., 2015; Shephard, 2000). Furthermore, the integration between learning analytics and inclusive approaches favors greater equity, allowing for the valuing of individual differences (Bocci et al., 2022; Ifenthaler & Yau, 2020; JIMTLT, 2022).

2.2 Experiential Learning and Digital Simulations

The experiential learning paradigm finds in digital simulations a privileged tool for the reproduction of realistic contexts in controlled conditions (Kolb, 1984; Sitzmann, 2011).

Immersive technologies allow for the activation of complex decision-making processes and the development of transferable competencies, favoring at the same time reflection and metacognition (Clark et al., 2016; Di Tore et al., 2021; Todino, 2020). Recent studies highlight how simulations can also be used to explore complex cultural and historical contexts through three-dimensional digital environments (Todino et al., 2025).

In this perspective, the concept of embodied education assumes importance, recognizing the central role of the body in cognitive processes, even in digital environments (Gomez Paloma, 2025).

From an inclusive point of view, simulative environments result particularly effective in supporting diverse learning styles, contributing to guaranteeing more equitable access to training opportunities (Florian & Black-Hawkins, 2011).

2.3 Game-based learning and gamification

The SEAM model integrates game-based learning and gamification as levers to sustain engagement and activate complex cognitive processes (Gee, 2007; Landers, 2015). Empirical evidence shows how immediate feedback, progression systems, and structured objectives contribute to improving performance and motivation (Wouters et al., 2013). In the Italian context, the necessity of a pedagogically founded design of gamification has been highlighted, supported by a coherent taxonomy of video game genres (Todino, 2024).

Recent studies furthermore demonstrate how edugames can contribute to the development of executive functions, particularly in inclusive contexts (Campitiello et al., 2022).

In this perspective, gamification does not represent only a motivational device, but a tool for learning regulation, capable of supporting the development and assessment of transversal competencies (Altomari & Valenti, 2023; Rocca Comite Mascambruno, 2023).

2.4 Stealth assessment and dinamic evaluation

A distinctive element of the SEAM model is represented by stealth assessment, which allows for the continuous and non-intrusive collection of data during the activity (Shute & Ventura, 2013).

The integration of intelligent agents within simulative environments allows for transforming the learner's interaction into observable evidence of competence (Di Tore & Todino, 2025).

Although the roots of this approach are traceable to assessment centers (Thornton & Byham, 1982), digital technologies and learning analytics today expand its potential, making learning and assessment interdependent processes (Di Tore et al., 2021; Sibilio & Aiello, 2022).

2.5 Synthesis and Positioning of the Model

The SEAM proposes to overcome the fragmentation of the literature through an integrated framework in which experience, motivation, and assessment operate in a synergistic way. Experience generates data, gamification sustains engagement, and dynamic assessment guides adaptation.

Through the integration of approaches such as Flipped Inclusion (Todino, 2024) and fruitful hybridizations (JIMTLT, 2025), the model offers a perspective capable of grasping the complexity of contemporary learning processes. In such a scenario, the challenge consists in making artificial intelligence a truly inclusive tool, avoiding that digital environments generate new forms of exclusion (Bonavolontà et al., 2023; Cascino, 2025).

3. The SEAM Model: definition and objectives

The Simulation-based Experiential Assessment Model (SEAM) is configured as a theoretical-methodological framework designed to respond to a structural criticality widely highlighted in digital education literature: the persistent fragmentation between experiential learning, motivation, and competency assessment. Such dimensions, while widely studied, result rarely integrated into a single coherent pedagogical architecture.

The SEAM is born with the objective of filling such a gap, proposing a unitary model capable of connecting simulation, gamification, and assessment in an interactive digital ecosystem, oriented toward the production of empirical evidence.The model is founded on a conception of learning as a situated, emergent, and dynamic process, influenced by the interaction between subject, context, and technologies.

Operationally, the SEAM is configured as a digital environment based on realistic simulative scenarios, in which the learner assumes an active role, taking decisions and observing the consequences. The learning experience is designed to generate observable behaviors and analyzable data. Experiential learning represents the organizing principle of the model.

In continuity with Kolb (1984) and Dewey (1938), the SEAM promotes a dynamic based on experience, reflection, and experimentation, implemented in digital environments of high complexity.Gamification is integrated as a structural component of the didactic design. Ludic mechanics do not limit themselves to sustaining motivation, but contribute to orienting behavior, structuring paths, and supporting complex cognitive processes, in line with the most advanced perspectives of the literature (Landers, 2015).

A central element of the model concerns the conception of assessment. In the SEAM, assessment is continuous and integrated into the learning process. Through the collection of behavioral data and the analysis of decisions, the model allows for transforming the learner's interaction into empirical evidence of competence. This integration represents one of the most innovative aspects of the model, as it overcomes the traditional separation between didactics and evaluation, approaching the perspectives of evidence-centered design (Mislevy et al., 2003), but extending them in a dynamic and adaptive key.

4. Multilevel architecture of the SEAM Model: an integrated ecosystem

The Simulation-based Experiential Assessment Model is configured, in its structural articulation (as represented in Figure 1), as a multi-level digital ecosystem designed to guarantee functional integration between didactic design, motivation, assessment, and adaptation.

The adoption of a stratified architecture does not respond exclusively to needs for conceptual clarity, but represents a methodological choice aimed at making explicit the interdependencies between the different components of the system, while simultaneously avoiding functional overlaps or ambiguities.

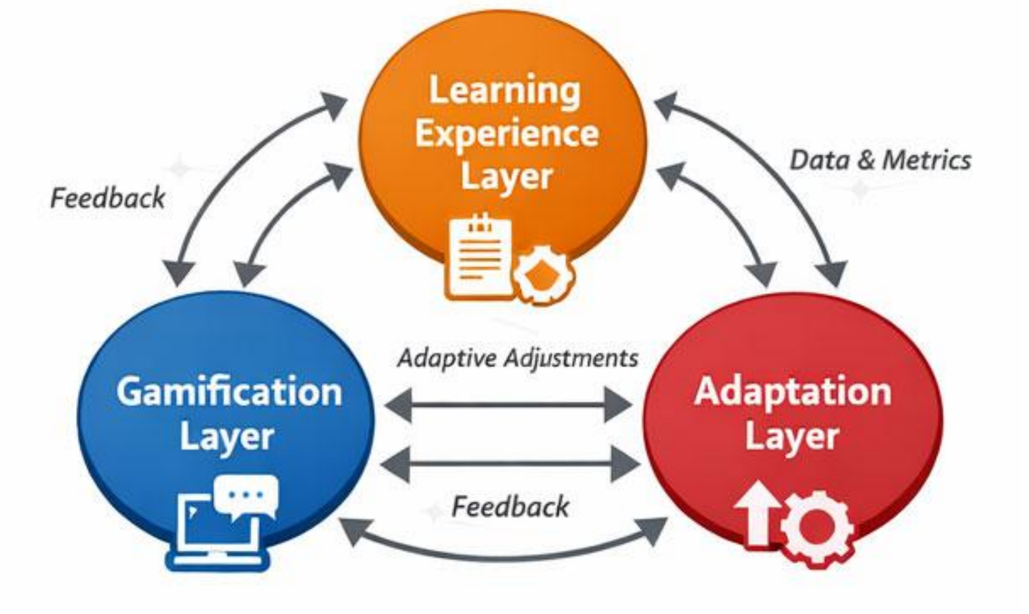
In this perspective, the model is organized around four fundamental dimensions, each of which performs a specific function within the educational process, while maintaining a constant and bidirectional relationship with the others. Such a configuration allows for conceiving the digital environment not as a simple delivery platform, but as a dynamic system in which the learner's actions, design logics, and evaluative processes reciprocally influence each other.

The experiential component represents the ontological foundation of the entire model, configuring itself as the space in which learning takes form through action. In this level, attention is directed toward the design of complex simulative scenarios, capable of plausibly reproducing the dynamics of professional or academic contexts.

The construction of such scenarios requires a delicate balance between realism and controllability, as the environment must be sufficiently authentic to activate significant cognitive processes, but at the same time structured in a way that allows for the systematic observation of behaviors.

Within this space, the learner is called to confront situations characterized by constraints, uncertainties, and interdependencies, which require the activation of articulated decision-making strategies. The presence of dynamic elements, such as unforeseen events or modifications of initial conditions, contributes to making the experience non-linear, favoring the development of competencies linked to adaptability and the management of complexity.

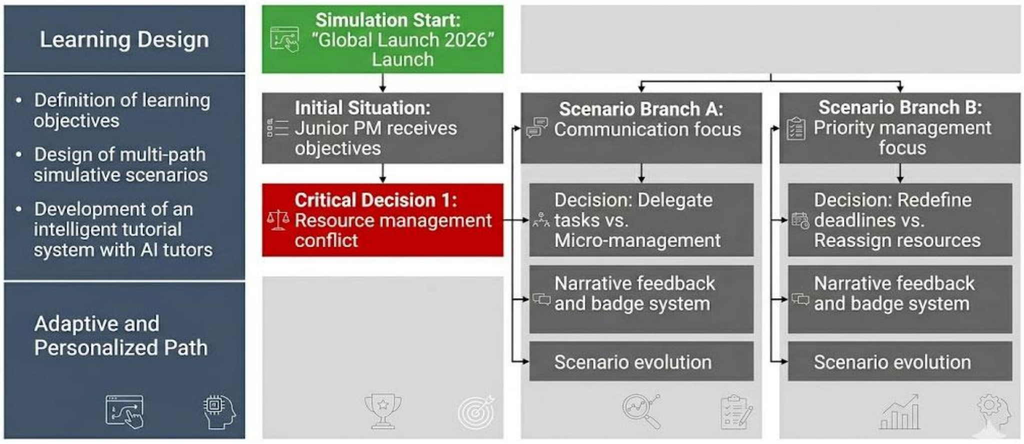
Figure 1. Conceptual schema of the SEAM model (Source: author's graphical elaboration)



The experiential dimension is, furthermore, strictly connected to metacognition processes. Through moments of guided reflection and structured feedback, the model (representation in Figure 2) favors awareness of the strategies adopted and their consequences, in line with reflective learning perspectives. In this sense, the simulative environment is not limited to offering opportunities for action, but becomes a space for the critical re-elaboration of experience.Alongside this dimension, the model integrates a gamification component that performs a function of motivational and regulatory support.

In this level, the ludic mechanics are designed in such a way as to orient the learner's behavior, sustain participation, and favor persistence in tasks. The introduction of progression systems, recognition, and immediate feedback contributes to structuring the experience in a sequential way, making the learning path visible.

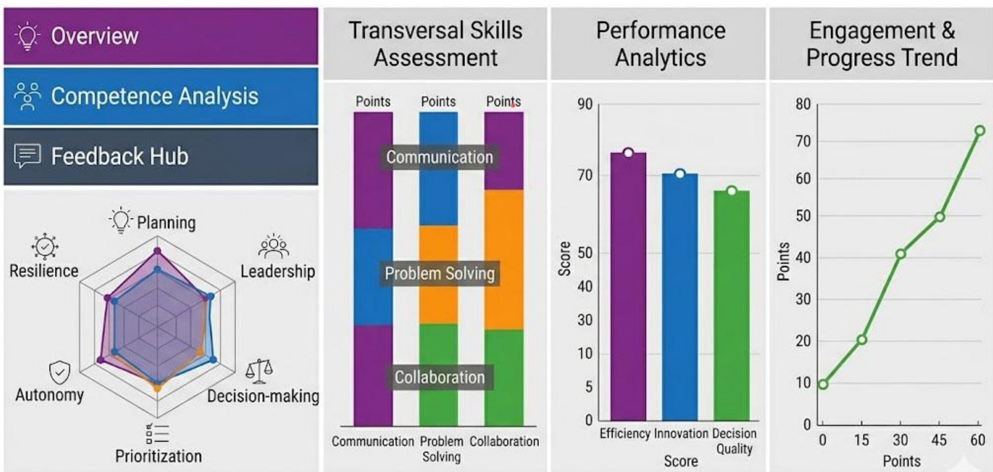
Figure 2 Scenario Design (Source: author's graphical elaboration)



However, what distinguishes SEAM from simpler approaches is the profound integration between gamification and pedagogical design. The ludic dynamics are not superimposed on the experience, but constitute an intrinsic component of it, designed according to educational objectives and evaluative strategies. This aspect is particularly relevant for avoiding phenomena of learning superficialization, often associated with an uncritical use of gamification.

The third element of the architecture is represented by the evaluative component (whose components are represented in Figure 3), which constitutes the analytical core of the model. In this level, the simulative environment is transformed into a tool for the systematic observation of behaviors, allowing for the continuous collection of data relative to the actions of learners. Unlike traditional models, evaluation is not limited to the measurement of final results, but focuses on the analysis of processes, strategies, and decision-making sequences.

Figure 3. Integrated Assessment Metrics (Source: author's graphical elaboration)

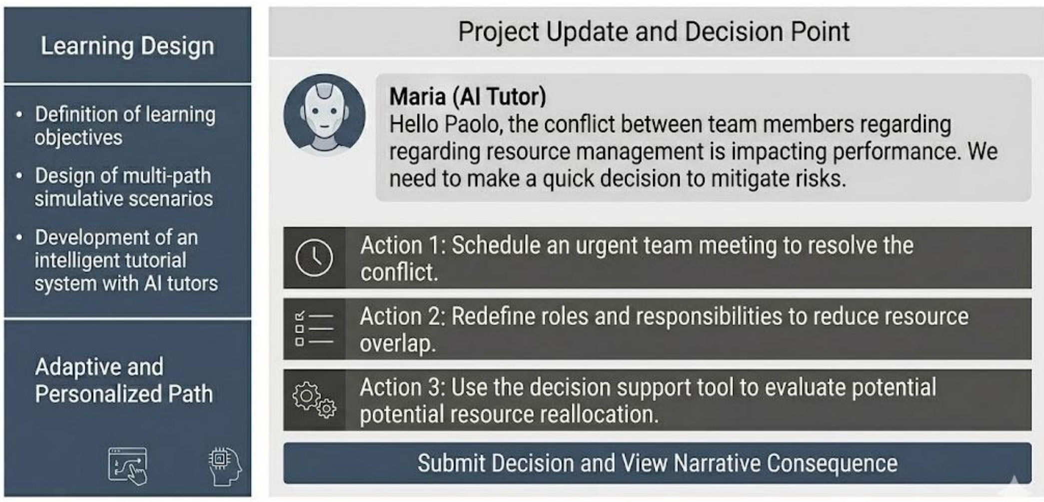


The adoption of the stealth assessment paradigm allows for the integration of evaluation within the flow of experience, making it non-intrusive and constant. This approach allows for collecting detailed information on variables such as response times, methods of priority management, and interactions with the environment and any other participants. Such data are subsequently interpreted through inferential models that connect the observed evidence to the underlying competencies.The evaluative component is based on methodologies consolidated within the scope of competency assessment, including simulation techniques such as the in-basket and the role play, integrated with more recent approaches based on evidence-centered design.

This integration allows for combining methodological rigor and technological innovation, offering assessment tools that are more adherent to the complexity of real contexts.Finally, the model provides for an adaptation and personalization component, which represents one of the most advanced elements of the architecture. Starting from the collected and analyzed data, the system is able to dynamically modify the learning experience, adapting the complexity of the scenarios, the typology of challenges, and the methods of feedback.

This process allows for responding to the individual needs of learners, favoring personalized paths and sustaining the progressive development of competencies.

Figure 4. Feedback and personalized adaptation (Source: author's graphical elaboration)



The integration of learning analytics plays a fundamental role in this dimension, allowing for the transformation of data into useful information for the regulation of the educational process. However, the effectiveness of such tools depends on their integration with solid theoretical models that guide their interpretation and use.

Overall, the architecture of SEAM can be interpreted as a complex adaptive system, in which the diverse components operate in a coordinated way to generate a dynamic, personalized, and evidence-based learning environment (personalization and adaptation interact in performance analysis as represented in Figure 4).

This configuration allows for overcoming the limits of traditional models, offering new possibilities for the design of advanced educational experiences.

5. SEAM Application Model: operational dynamics and variables

From an application point of view, the SEAM model must be interpreted as a complex interactive digital environment, in which the traditional distinction between teaching and evaluation tends progressively to dissolve in favor of an integrated structure, dynamic and data-driven.

Such a setting is placed in the furrow of the most recent evolutions of international educational technology (Shute & Ventura, 2013; Luckin et al., 2016; Ifenthaler & Yau, 2020).

5.1 Operational definition and strategic objectives

SEAM is configured as a unitary ecosystem within which authentic learning emerges through the simulation of realistic situations characterized by high decision-making complexity. In this context, the learner is called to interact with human actors or artificial agents, activating cognitive and behavioral processes that reflect real professional dynamics. The objective is not simply the transmission of content, but rather the measurement and development of situated competencies, in line with the authentic assessment paradigm (Wiggins, 1998; Gulikers et al., 2004).

In this perspective, the model simultaneously pursues a plurality of strategic objectives. Firstly, it allows for an authentic assessment of transversal competencies, such as decision-making ability, leadership, and uncertainty management, which are difficult to observe through traditional tools. Secondly, it realizes a total integration between the didactic and evaluative phases, overcoming the sequential logic that characterizes most educational systems. This integration produces an environment in which every learner action simultaneously assumes formative and evaluative value.A further objective concerns the maintenance of high levels of engagement, obtained through the integration of gamification mechanics and immersive narratives, consistently with what has been highlighted by recent literature (Hamari et al., 2014; Deterding, 2021). Parallelly, the model favors the production of structured and traceable data, making rigorous empirical research on decision-making processes and response times possible.

Finally, the contextual flexibility of SEAM allows for its application in different fields, ranging from school and university education to managerial and continuous training, in line with the inclusive and adaptive perspectives promoted by contemporary research (Florian, 2014; Bocci et al., 2022).

5.2 Variables and observable dimensions

The architecture of the SEAM model is founded on the possibility of mapping learning through a system of granular metrics that cover the main dimensions of competence. In particular, the cognitive dimension is analyzed through indicators relative to problem solving, critical capacity, and the quality of inferences produced by the learner.

Parallelly, the social and transversal dimension allows for the observation of phenomena such as collaboration, leadership, and communicative effectiveness, aspects that are increasingly central in contemporary professional contexts.

Alongside these, the strategic dimension assumes a crucial role, as it allows for the evaluation of planning capacity, priority management, and adaptation to conditions of uncertainty. Finally, the motivational dimension allows for the monitoring of the level of engagement, operational autonomy, and the resilience of the learner, which are fundamental elements in self-regulated learning models (Zimmerman, 2002; Panadero, 2017).

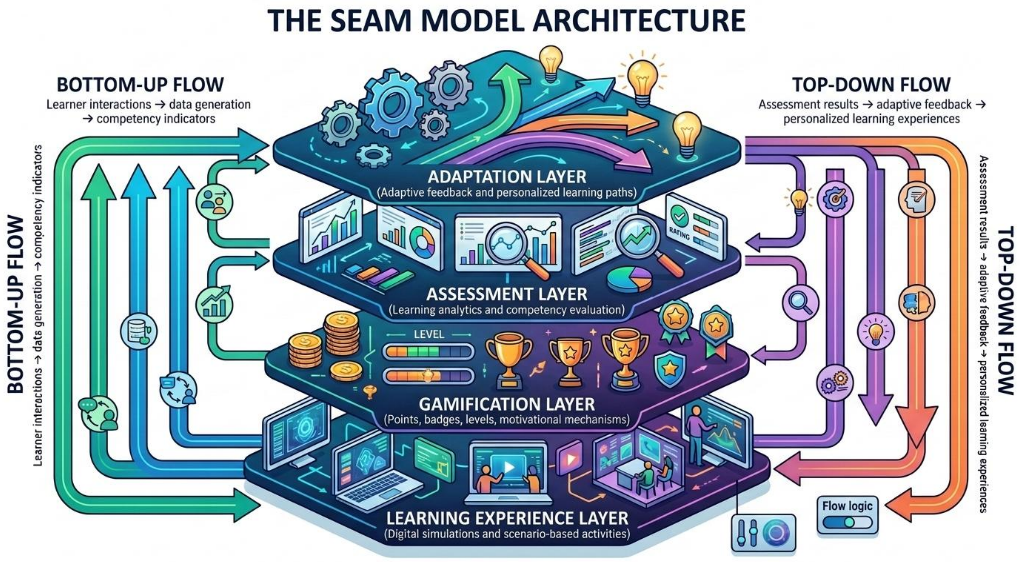
The operational variables tracked by the system include decision-making sequences, response times, and collaboration indices, in addition to performance metrics relative to pre-established objectives. These variables are integrated into an advanced learning analytics system, capable of providing a dynamic and multidimensional representation of competencies, in line with the most recent developments in data-driven education (Siemens & Baker, 2012; Ifenthaler, 2015).

5.3 SEAM operational flow

The functioning of the model is based on a dual-flow logic that guarantees the cyclicity of the educational process and the continuous interaction between learning and assessment (cyclicity and duality are graphically represented in Figure 5). On one hand, the learner's interactions generate a continuous flow of data that feeds the assessment system, producing competence indicators in real time. On the other hand, these indicators activate adaptation mechanisms that dynamically modify the learning scenario, providing personalized feedback and guiding subsequent experiences.

This double dynamic allows for overcoming the rigidity of traditional models by introducing an adaptive system capable of responding to the individual needs of students. The result is an environment in which assessment assumes a continuous formative function, supporting didactic decisions based on objective and traceable evidence, consistently with the development lines of artificial intelligence applied to education (Holmes et al., 2019; Zawacki-Richter et al., 2019).

Figure 5. Operational flow of the SEAM (Source: author's graphical elaboration)



6. Case Study: Implementation of the SEAM Model in advanced project management training

6.1 Context analysis and definition of target competencies

The adoption of the SEAM model finds its application of choice in the domain of Project Management, a field characterized by a complex intersectionality between technical rigor, uncertainty management, and relational dynamics. The choice of this sector for the validation of the model responds to the need to overcome traditional didactic methodologies, which are often excessively focused on the theoretical-notional dimension, to arrive at situated learning in which competence emerges from the ability to govern complexity.

The case study analyzes an advanced training module designed for Executive Education and Master's degree academic paths, with the objective of transforming the digital environment into an enactive laboratory. In this scenario, error is epistemologically repositioned: it is no longer a deviation to be penalized, but a fundamental heuristic device for the activation of deep reflective processes.

Target competencies were mapped following the international frameworks of the Project Management Institute (PMI, 2021), integrated with the dimensions of didactic simplexity (Di Paolo & Todino, 2026), including adaptive resource management, systemic thinking under pressure, and decision-making effectiveness in contexts of incomplete information.

6.2 Architecture of the simulative scenario: "Global Launch 2026"

The simulative scenario, named "Global Launch 2026", was designed as a dynamic and non-linear digital ecosystem. The learner assumes the role of Junior Project Manager tasked with supervising the release of a complex technological infrastructure in a multinational context. The environment does not present itself as a static sequence of tasks, but as an "onlife learning space" (Gomez Paloma, 2025) in which the distinction between real and virtual blurs through constant information flows. The operational dashboard integrates asynchronous communication systems (email), instant messaging, and system notifications that replicate the cognitive overload typical of real work contexts.

The element of structural innovation is represented by the integration of intelligent Non-Player Characters (NPCs), managed through Retrieval-Augmented Generation (RAG) models. These artificial agents do not follow predefined scripts but interact with the learner in a natural way, providing situated feedback or introducing critical variables (for example, sudden resignations of a team member or delays in supplies). Such dynamism obliges the learner to a constant renegotiation of strategies, favoring the development of cognitive flexibility and adaptability, which are central elements in recent reflections on the "fruitful hybridizations" between pedagogy and technology (JIMTLT, 2025).

6.3 Dimensions of strategic gamification and Cognitive Scaffolding

Within the application model, gamification is not intended as an aesthetic addition, but as an intrinsic component of the pedagogical design aimed at supporting engagement and operational resilience. The ludic architecture of SEAM implements progression mechanics that make competence development explicit through a system of badges linked to micro-objectives. However, the primary function of gamification in this context is cognitive scaffolding: the interface is designed following the principles of Emotional Design (Norman, 2004; Todino, 2023), reducing extraneous cognitive load and maximizing the pertinent one.

Feedback, a key element of the process, assumes a narrative and systemic form. Instead of a simple numerical correction, the learner observes the consequences of their choices reflected in the state of the project: a delay in communication to key stakeholders produces a decrease in team morale (visible through graphic indicators) and a modification of the environmental narrative. This systemic interdependence favors the perception of the learner's agency, incentivizing critical reflection on the decision-making heuristics adopted rather than the mere search for the correct answer.

6.4 Stealth assessment methodology and evidence tracking

The analytical core of the case study resides in the implementation of stealth assessment (Shute & Ventura, 2013; Di Tore & Todino, 2025). The system constantly monitors the "digital footprints" left by the learner during the simulation, transforming every interaction into an evaluative datum. Granular variables are tracked, such as response times to emergencies, the frequency of consulting support resources, the ability to prioritize tasks, and the linguistic and strategic quality of interactions with the AI-managed NPCs.

This data is processed through learning analytics algorithms that connect the observed actions to an underlying competence model. For example, the coordinated management of a conflict between NPCs and an imminent deadline is interpreted as empirical evidence of leadership and stress management. Such an approach allows for overcoming the limits of traditional tests, providing a dynamic and processual representation of competence that also takes into account the self-regulation processes of learning (Zimmerman, 2002; Panadero, 2017).

6.5 Operational cycle: from action to metacognitive reflection

The operational flow of SEAM in Project Management concludes with a reflective debriefing phase, which represents the moment of synthesis between concrete experience and theoretical conceptualization. Leveraging the data collected by the assessment system, the teacher and the learner analyze key decision-making sequences.

In this step, "Flipped Inclusion" (Todino, 2024) finds its maximum expression: the use of data allows for personalizing the reflective moment, taking into account the different cognitive styles and individual paths that emerged during the simulation.

Tabel 1. Comparative analysis between traditional e-learning models and integrated SEAM architecture

Dimension	Traditional Approach (LMS)	SEAM Model (Simulation-based)
Learner Role	Passive fruition of linear content.	Active protagonist in an enactive ecosystem.
Task Nature	Static and decontextualized theoretical questions.	Resolution of dynamic problems in real time.
Assessment	Summative (final correct/incorrect result).	Processual and Stealth (behavior analysis).
Feedback	Deferred and performance-oriented.	Immediate, narrative, and adaptive.
Error Management	Penalizing and lacking processual context.	Formative, oriented toward reflection in debriefing.
Generated Data	Simple quantitative (grades, access).	Behavioral and qualitative (decision patterns).

6.6 Preliminary results and model transferability

The first implementations of the model have shown a significant increase in the level of flow experienced by participants and a greater capacity to transfer the acquired competencies into real professional contexts. The transferability of SEAM is not limited to Project Management but extends, thanks to its modular structure, to domains such as emergency medicine (triage management), human relations training, and the development of computational thinking in schools. In synthesis, the case study demonstrates how the multilevel architecture of SEAM is capable of supporting a post-digital pedagogy that is inclusive, rigorous, and profoundly centered on human development through technology.

7. Methodological framework for empirical validation

The SEAM model, while configuring itself as a theoretical framework of pedagogical avant-garde, requires a rigorous empirical validation protocol, capable of transforming design hypotheses into verifiable scientific evidence. Consistently with the most recent trends in international educational research, the adoption of a Mixed Methods Research approach is proposed, aimed at integrating quantitative and qualitative data in a concurrent triangulation perspective. Such a methodological choice does not only respond to a need for analytical completeness but reflects the very nature of the model, in which the complexity of experiential learning and the dynamism of stealth assessment cannot be captured through the use of a single investigative paradigm (Creswell & Plano Clark, 2018).

7.1 Research project and experimental planning

The research structure is articulated through a quasi-experimental design with a non-equivalent control group, a choice dictated by the necessity to operate within real academic contexts while preserving a high level of ecological validity. The planning involves a stratified sample of students, divided into an experimental group, exposed to the SEAM simulative environment, and a control group, engaged in traditional didactic activities based on conventional Learning Management System (LMS) platforms.

The intervention is temporarily scanned into phases of pre-test, administration of the treatment (the "Global Launch 2026" simulation), and post-test, integrated by long-term follow-up sessions to evaluate the retention of acquired transversal competencies.

A crucial aspect of the planning lies in the standardization of confounding variables, ensuring that both groups share the same training objectives and basic theoretical content, thus isolating the effect produced by the technological and methodological architecture of the SEAM model on performance and engagement.

7.2 Data collection and multidimensional integration

The data collection protocol is conceived to overcome the limits of unidimensional analyses, drawing from a plurality of sources that converge toward a single analysis matrix. The central core consists of behavioral logs generated by the simulative environment, which provide a continuous flow of raw data relative to the decision-making trajectories of the learners. This data, typical of stealth assessment, includes micro-behavior metrics such as response latency, click sequentiality, and the frequency of interaction with the AI-based digital tutors. Parallelly, validated self-assessment instruments are administered to measure psychometric variables such as perceived self-efficacy, perceived cognitive load (NASA-TLX), and the level of flow (Csikszentmihalyi, 1990).

Integration is completed by observational protocols deriving from debriefing sessions, where the narrative reflections of the learners are recorded and transcribed for qualitative analysis, allowing for the mapping not only of "what" the student learned but "how" they re-elaborated the simulated experience.

7.3 Qualitative and quantitative indicators for inclusive teaching

The definition of indicators responds to the need to monitor the effectiveness of the model across different dimensions of competence. Quantitative indicators

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focus on decision quality (accuracy of choices relative to project constraints), operational efficiency (management of time and resources), and task persistence, analyzed through active participation patterns.

Qualitative indicators, conversely, aim to explore clinical and strategic reasoning processes, the ability to negotiate with intelligent NPCs, and the depth of metacognitive reflection. This indicator structure is particularly coherent with the perspectives of inclusive teaching and "Flipped Inclusion" (Todino, 2024), as it allows for the detection not only of standardized success but also of personalized learning paths and the different modalities with which learners with heterogeneous cognitive styles inhabit the simulative space (Florian & Black-Hawkins, 2011; Inclusive Teaching, 2023).

Tabel 2. Matrice del protocollo di validazione empirica del modello SEAM

Research Phase	**Measurement Instruments**	**Data Type**	**Analytical Objective**
Pre-treatment	Self-efficacy questionnaires and entrance tests	Quantitative	Baseline of competencies and traits
During simulation	Stealth Assessment logs and AI interactions	Quantitative/ Dynamic	Tracking of decision-making processes
Post-treatment	NASA-TLX and Competency assessment tests	Quantitative	Measurement of impact and cognitive load
Debriefing	Semi-structured interviews and focus groups	Qualitative	Analysis of metacognitive reflection

7.4 Advanced techniques for data analysis and modeling

Data analysis adopts an integrated approach that combines the descriptive power of inferential statistics with the interpretative depth of thematic analysis. For the quantitative component, Structural Equation Modeling (SEM) is used to test causal relationships between the use of the SEAM model, the increase in self-efficacy, and the improvement of decision-making performance. The use of Learning Analytics techniques also allows for the identification of behavior clusters through unsupervised learning algorithms, revealing learning patterns not predicted during the design phase.

For the qualitative component, thematic analysis assisted by software (CAQDAS such as NVivo) is applied, following a recursive coding that allows for the emergence of conceptual categories linked to the perception of agency and the management of frustration in error.

The final triangulation of the results allows for validating the internal solidity of the SEAM model, providing an empirical basis for its transferability to other domains of university and professional training.

8. Conclusions and perspectives: the SEAM model as a paradigm of post-digital didactics

8.1 Critical synthesis and overcoming formative dualism

The SEAM (Simulation-based Experiential Assessment Model) model is configured not so much as a simple technological architecture, but as an epistemological proposal coherent with the most recent transformations of digital didactics. In a context where the digitalization of content has often produced a linear transposition of traditional models, without substantially impacting the quality of learning, SEAM introduces a relevant theoretical discontinuity, proposing a structural integration between experience, assessment, and adaptation.

International literature has highlighted how the separation between learning and assessment represents one of the main limits of contemporary educational systems (Boud & Falchikov, 2007; Dochy et al., 2015). In this framework, SEAM overcomes such dualism through a systemic logic in which every action of the learner simultaneously assumes formative and evaluative value. The simulative environment thus becomes an enactive space, in which knowledge emerges from the continuous interaction between individual, technology, and context, in line with the theories of embodied and situated cognition (Varela et al., 1991; Barsalou, 2008).Within this ecosystem, learning is no longer understood as the accumulation of information, but as the ability to mobilize cognitive, emotional, and social resources in complex and unstructured contexts. Such a perspective responds directly to the needs of the knowledge society, in which the required competencies are increasingly linked to the management of uncertainty, the capacity for adaptation, and critical reflection (OECD, 2021; World Economic Forum, 2023).

8.2 Systemic implications: toward a new pedagogical contract

The adoption of the SEAM model implies a profound transformation of roles and practices within educational ecosystems, configuring a true new pedagogical contract. In this scenario, the learner assumes a central position, no longer as a passive recipient of instruction, but as an active actor responsible for their own learning path. The narrative and immersive dimension of simulations, supported by gamification mechanics, contributes to strengthening agency and intrinsic motivation, favoring self-regulation processes and the development of self-efficacy (Zimmerman, 2002; Panadero, 2017).

Parallelly, the role of the teacher undergoes a significant transformation, evolving from a transmitter of content to a designer of experiences and facilitator of reflective processes. Didactic design is oriented toward the construction of complex environments capable of activating cognitive conflicts and promoting reflection, while the moment of debriefing assumes a central role in connecting concrete experience to theoretical conceptualization, in line with the experiential learning cycle (Kolb, 1984; Schön, 1983).

At the institutional level, SEAM favors the shift toward data-driven education models, in which didactic and curricular decisions are supported by empirical evidence deriving from learning analytics. This transformation allows for greater flexibility and adaptability of training paths, making them more consistent with the emerging needs of students and the labor market (Ifenthaler & Yau, 2020; Zawacki-Richter et al., 2019). In this perspective, the principles of inclusive teaching also find full integration, as the availability of granular data allows for the design of more equitable and personalized interventions (Florian, 2014; Bocci et al., 2022).

8.3 Limits, criticalities, and conditions of sustainability

Despite its innovative potential, the SEAM model presents a series of criticalities that must be addressed to ensure its sustainable diffusion. Firstly, the design of high-fidelity simulative environments requires interdisciplinary competencies and significant resources, with the risk of accentuating inequalities between institutions endowed with advanced infrastructures and less equipped contexts.

This aspect calls for the need to develop scalable models and open frameworks that can reduce barriers to access.An additional critical element concerns the management of cognitive load. The combination of simulative complexity, time pressure, and multiple stimuli can generate overload, compromising the effectiveness of learning if not adequately designed. In this sense, the principles of Cognitive Load Theory (Sweller, 1988; Sweller et al., 2019) must be integrated into the design of SEAM environments, in order to guarantee a balance between challenge and cognitive sustainability.

Particular attention must also be dedicated to the ethical implications linked to data collection and analysis. The use of stealth assessment techniques implies the necessity to guarantee transparency, informed consent, and privacy protection, avoiding drifts toward excessive control or improper use of data (Slade & Prinsloo, 2013; Holmes et al., 2021). Data governance therefore becomes a central element in the design and implementation of the model.

8.4 Future perspectives: artificial intelligence and immersive environments

The development perspectives of the SEAM model are strictly connected to the evolution of emerging technologies, in particular artificial intelligence and immersive environments. The integration of adaptive AI systems allows for automating the generation of dynamic scenarios and providing personalized feedback in real time, significantly improving the system's ability to respond to the individual needs of students (Holmes et al., 2019; Luckin et al., 2016).

At the same time, extended reality (XR) technologies, including virtual and augmented reality, open new possibilities for the creation of highly immersive learning environments, in which the perceptual-motor dimension becomes an integral part of the cognitive process. In such contexts, learning assumes an increasingly embodied dimension, consistent with the theories of embodied cognition (Johnson-Glenberg, 2018).

A further area of development concerns the longitudinal validation of competencies, with the objective of verifying the transferability of skills acquired in simulative contexts to real situations. This line of research appears fundamental to consolidate the validity of the model and to demonstrate its effectiveness over the long term (Sitzmann, 2011; Clark et al., 2016).

8.5 Final cconsiderations

As a whole, the SEAM model represents a theoretical and methodological proposal that places itself in continuity with the tradition of pedagogical pragmatism, reinterpreting it in light of the challenges of digital transformation. Recalling Dewey's (1938) intuition, according to which learning derives from reflective experience, SEAM offers a framework capable of integrating action, reflection, and assessment in a coherent and scientifically founded system.

In a context characterized by the rapid obsolescence of knowledge and increasing complexity, the value of the model lies in its ability to promote meta-competencies, such as adaptability, critical thinking, and the ability to learn from experience. In this sense, SEAM represents not only a response to current needs but a possible evolutionary direction for the educational systems of the future.

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