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List of acronyms

Acronym	Description
AI	Artificial Intelligence
AIED	Artificial Intelligence in Education
augMENTOR	Augmented Intelligence for Pedagogically Sustained Training and Education
ATF	Activity Theory Framework
CHAT	Cultural and Historical Activity Theory
EU	European Union
ET	Emerging Technologies
HE	Higher Education
ICT	Information and Communications Technology
LMS	Learning Management System
ML	Machine-Learning
PeDeMET	augMENTOR Pedagogical Design Model with Emerging Technologies
PF	Pedagogical Framework
R&D	Research & Development
SLR	Systematic Literature Review
TEL	Technology Enhanced Learning
TESA	Technology - augmented Educational Scenarios and e-Activities
TPACK	Technological Pedagogical Content Knowledge
WoS	Web of Science

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Executive summary

The deliverable D3.2 "The augMENTOR Pedagogical Framework Final" presents a comprehensive, theory-driven framework that integrates Artificial Intelligence and Emerging Technologies into pedagogical practice. Structured across two levels—PeDeMET (Pedagogical Design Model with Emerging Technologies) at the macro level and TESA (Technology-augmented Educational Scenarios and e-Activities) at the micro level—it offers educators a cohesive model for designing and implementing digitally enhanced, learner-centered instructional scenarios. Grounded in Activity Theory (CHAT), the enriched Pedagogical Triangle, and the extended TPACK model (TETPACK), the framework promotes the development of 21st-century skills, such as creativity, collaboration, communication, and critical thinking. It directly responds to gaps identified in the literature, offering a new approach that bridges conceptual design with classroom-level implementation.

The main goal of deliverable D3.2 is to support the evaluation and validation of the augMENTOR Pedagogical Framework (PF) through a structured and evidence-based approach, inspired by Delphi Method. Building on state of the art presented in D3.1 and on the theoretical and design foundations established in D3.1, this deliverable operationalizes the PF across diverse educational contexts and implementation settings, including real-world pilots such as those in Pilot 1 and Pilot 2. These pilots serve as empirical testbeds where the framework is applied, refined, and critically assessed using a combination of qualitative and quantitative data sources. Central to the evaluation is the use of Cultural-Historical Activity Theory (CHAT) as an analytical lens, coupled with the 4Cs rubric (Creativity, Critical Thinking, Communication, Collaboration), to capture the complexity of learning activity systems and to trace the transformation of pedagogical practice.

D3.2 is directly aligned with the objectives of Task 3.4 – Evidence-based Refinement of the augMENTOR Pedagogical Framework, which focuses on evaluating the impact of the PF through two iterative implementation cycles. This task introduces a dual-layered evaluation design that combines expert validation and field-level feedback. Specifically, pedagogical methods and tools are proposed to assess how the PF influences teaching design, learning outcomes, and technology integration. The feedback loop generated through these cycles enables the dynamic refinement of the framework, ensuring its practical applicability and theoretical robustness. Activity Theory is not only used as a conceptual model for mapping actors, tools, and activities but also serves as a methodological backbone for analysing the pedagogical interactions and outcomes observed during implementation. Ultimately, D3.2 aims to ensure that the augMENTOR PF is not only grounded in solid educational theory but also validated by empirical data, contributing to a sustainable, adaptable, and context-sensitive model for technology-augmented learning.

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The validation process is presented as a feedback loop between theory, design, and practice: scenario-based implementations generate data, which is analysed through CHAT modelling and 4Cs assessment, leading to pedagogical insights that directly inform the refinement of the framework. This iterative mechanism ensures that the final version of the augMENTOR PF is grounded in evidence and capable of supporting AI-enhanced, creative, and learner-centered teaching practices.

1 Introduction

1.1 Identifying the Need for a New Framework

The systematic literature review conducted in D3.1 revealed a critical gap: existing pedagogical frameworks and instructional design models do not adequately support the integration of Artificial Intelligence (AI) and other Emerging Technologies (ET) in classroom teaching and learning. Most are general-purpose, with limited operational relevance at the micro-level (e.g., scenario design, lesson implementation), and lack coherence across levels of design.

This observation provided the impetus for D3.1 to propose an innovative, integrated pedagogical framework that connects macro-level design principles with micro-level educational practice, explicitly accounting for the transformative potential of AI in education. This framework would serve as the analytical and design basis for the evaluation activities now underway, especially those using CHAT to model the interactions among learners, educators, technologies, and tools.

1.2 The augMENTOR Pedagogical Framework: A Two-Level Structure

The augMENTOR PF is composed of two interrelated levels:

- PeDeMET (Pedagogical Design with Emerging Technologies): A macro-level model, encompassing the *why* and *what* of learning within the augMENTOR solution, articulates the the conceptual components of pedagogical activity (learners, tutors, tools, knowledge, strategies, outcomes, and evaluation). It is grounded in Activity Theory and supported by the enriched Pedagogical Triangle and the extended TPACK model (TETPACK).
- TESA (Technology-augmented Educational Scenarios and e-Activities): A micro-level model that explains how learning occurs within the augMENTOR framework, guiding the concrete implementation of pedagogical activities in situ or online, with scenario phases and learning design strategies that align with modern learning science and 21st-century competencies.

This architecture supports iterative refinement, which is essential to the evaluation process defined for WP6. In practice, TESA scenarios serve as units of analysis within CHAT-based evaluation protocols and data collection instruments (e.g., tutor annotations, learner focus groups, observation logs).

This theoretical grounding ensures that the evaluation strategy currently in development (in your forthcoming deliverable) can systematically assess all dimensions of pedagogical activity—including contradictions, mediations, and transformations—across implementation cycles.

1.3 Alignment with Evaluation Activities and Project Objectives

D3.2 aligns with the objectives of Task 3.4 by validating the augMENTOR Pedagogical Framework through a dual-layered evaluation design—combining expert review and pilot-based feedback across two iterative implementation cycles—to assess its influence on teaching design, learning outcomes, and technology integration. Using Activity Theory as both a conceptual and methodological tool, the deliverable ensures the framework is empirically grounded, dynamically refined, and adaptable to diverse educational contexts. The augMENTOR PF is also directly aligned with the evaluation strategy outlined for this deliverable. In particular:

- Qualitative evaluation activities (interviews, focus groups, design reflections, observations) are structured around the key components of PeDeMET and the phases of TESA.
- CHAT is used to model the learning activity system during scenario implementation, capturing tensions, roles, mediating artefacts, and community influences.
- The framework supports both formative and summative evaluation cycles, reinforcing reflective practice, feedback loops, and data-informed refinement of scenarios and pedagogical tools.

Moreover, the PF enables a **cross-WP integration**, informing and being informed by:

- **WP2** (user requirements and pilot settings)
- **WP3** (learner modelling)
- **WP4** (development of critical thinking, creativity, and the 4Cs)
- **WP5** (AI-boosted platform and learning analytics)
- **WP6** (validation and assessment)

1.4 Towards a Human-Centred, AI-Augmented Pedagogy

The augMENTOR PF promotes a human-centred, data-informed pedagogy, wherein AI tools support both learners and educators with personalized recommendations. Its flexible structure is proposed to accommodate diverse educational settings—formal, non-formal, blended, or online—and supports interdisciplinary, inclusive learning grounded in real-world challenges, based on the pilot's needs as described in the DoA.

By embedding TESA scenarios into real-life classrooms and learning environments, the project enables activity-driven pilots, which are now being documented and analysed through CHAT. The results will contribute to the refinement of the framework and the scalability of the augMENTOR solution.

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2 Activity Theory: Socio-cultural Theories and Educational Application

Activity Theory belongs to the broader domain of socio-cultural theories of learning, emphasizing that learning activity is always embedded within social, cultural, and historical contexts. Central to Activity Theory is the focus not on isolated states of knowledge, but rather on the activities individuals engage in, the tools utilized, and the interactions involved in these processes. So the Cultural-Historical Activity Theory (CHAT) is employed to map educational practice as a network of interdependent systems.

The theoretical underpinnings of Activity Theory originate from the seminal works of Vygotsky (1934), Leontiev (1978), and Engeström (1990). According to these, human cognition is fundamentally activity-based, involving mental, physical, and material components. A distinguishing feature of Activity Theory is the mediation through artifacts, encompassing both material and cognitive tools. Vygotsky argued that cognitive development emerges from the interactions between individuals and their surrounding environments, suggesting that external activities become internalized cognitive functions (Bottino et al., 1999). Consequently, learning is viewed as the internalization of socially mediated activities and is inherently collective, facilitated by cultural symbols, language, and tools.

2.1 Key Principles and Structural Elements of Activity Theory

Activity Theory is structured around a triangular model consisting of several interconnected elements: subject, object, tools, community, rules, and division of labor. Each activity is goal-oriented and mediated by cultural and historical contexts, reflecting collective societal influences. The subject, whether an individual or group, engages with objects (goals), mediated by tools (artifacts), within the rules and roles defined by their community. These elements interact dynamically, evolving through contradictions, which are considered drivers for learning and development. Engeström (1990) identifies four levels of contradictions that facilitate the evolution of activities: primary (within elements), secondary (between elements), tertiary (between actual and ideal activities), and quaternary (between activities and neighboring systems).

The hierarchical nature of activities distinguishes between overall activities, specific actions, and automatic operations, each transforming over time based on the subject's competence development (Leontiev, 1978). Crucially, internalization and externalization processes characterize human activity as a constant interplay between external actions and internal cognition.

2.2 Educational Application and Methodological Alignment with augMENTOR

In the contemporary educational landscape, Activity Theory is particularly relevant due to the growing integration of digital and emerging technologies such as Artificial Intelligence (AI). Bonnie Nardi (1996) highlighted Activity Theory's descriptive power in mediating tools' use within activity systems, while Kuutti (1991) emphasized the direct action toward educational objects, such as educational software or conceptual understanding. Engeström expanded Activity Theory, explicitly including society as an additional mediating element between subjects and objects.

Within education, Activity Theory aids in the design and evaluation of technology-enhanced learning environments like Moodle. Such platforms facilitate communication, collaboration, and personalized learning, aligning with the principles of collective and mediated learning emphasized by socio-cultural theories. The systematic collection and analysis of qualitative and quantitative data—such as interviews, observations, and digital activity logs—support iterative pedagogical refinement, consistent with Activity Theory's emphasis on continuous development and transformation through identified contradictions.

The augMENTOR project explicitly incorporates Activity Theory into its pedagogical framework, guiding both macro (PeDeMET) and micro (TESA) levels of educational scenario design. Through detailed scenario analyses, augMENTOR systematically addresses learners' cognitive needs, content specificity, the mediational role of emerging technologies, and explicit description of objectives to evaluate and study. This integration ensures alignment between theoretical foundations, methodological implementations, and data-informed refinements, ultimately enhancing educational practice and outcomes.

Thus, Activity Theory provides a robust framework for examining complex educational activities within evolving socio-technological environments, enabling educators and researchers to navigate and exploit contradictions to foster deep, meaningful learning experiences.

2.3 Evaluation Design and Methodology

This chapter presents the evaluation methodology of the augMENTOR Pedagogical Framework (PF), structured as an iterative, evidence-based, and theory-informed process. It aims to validate and refine the framework by assessing its pedagogical impact and the integration of AI tools into teaching practices. The methodology incorporates both qualitative and quantitative data collection and aligns with the wider goals of the augMENTOR project through synergies with WP5 and WP6. A key focus is the enhancement of 21st-century skills—specifically, the 4Cs: Critical Thinking, Creativity, Collaboration, and Communication (Trilling & Fadel, 2009).

At this point, we consider it important to describe the steps of the research process—that is, all the actions undertaken to complete the data collection for the project by the pilot and other partners. In the following chapter, we will describe the steps and techniques that will be followed for the data analysis.

Initially, and always following the alignment strategy between the work packages, based on the requirements that emerged from WP2, the corresponding theoretical field study, and the literature review, we designed the pedagogical model.

Subsequently, through workshops and weekly bilateral meetings with the pilots, we supported the pilot teams in designing their courses according to the TESA framework, ensuring its meaningful integration. We then continued to support them in the implementation of these lessons in the Moodle platform.

Special emphasis was placed on ensuring that the pilot teams included all steps of the educational scenario in their courses, incorporated all elements defined by the augMENTOR PF (see D3.1), and designed appropriate activities to foster the development of 21st-century skills. Under the guidance of WP4, significant effort was devoted to the creation of appropriate evaluation tools for these skills using the rubrics presented in the corresponding deliverables.

In parallel, regarding the design of the technical part of the augMENTOR solution, we worked in close collaboration with WP5 to develop the ontology of the technical solution based on pedagogical requirements, ensuring that all elements of the pedagogical model were included in the technological design.

Finally, to ensure technical implementation of the PF, we designed and implemented the student model described in Deliverable 3.3, which was directly integrated into the technical solution.

3 Overall Evaluation Strategy

The evaluation follows a design based research protocol on continuous feedback and data-informed refinement. It combines formative and summative strategies, ensuring that evaluation is ongoing and responsive throughout both design and implementation. The use of Activity Theory (Engeström, 1987; Kaptelinin & Nardi, 2006) provides a rich conceptual lens to model learning processes and examine how tools and practices mediate educational activities. In figure 1, you can see the decision made by all partners during a joint meeting regarding the analysis of the qualitative and quantitative data of the project. The diagram has also been included in the appendix in higher resolution for readers to consult.

Specifically, the overall evaluation of the pilots will be conducted by WP6, which will utilize both quantitative and qualitative data concerning user opinions about the technical solution.

As for Work Package 3 and the evaluation of the augMENTOR PF, given the current timing of this deliverable—at a point when the pilots have not yet been completed—it is not possible to provide an in-depth study and analysis of the data resulting from users' interaction with the Moodle and augMENTOR solution and the courses designed based on the proposed model. Furthermore, the solution is not yet fully developed and functional, and was therefore not comprehensively tested during the pilot implementations, which prevents a full evaluation of the AI components as well as the learner model submitted in D3.3.

Thus, we follow the following plan: at this stage, an internal update of the pedagogical design will be carried out by the pilots, along with an external evaluation focusing on the pedagogical design. A more in-depth evaluation will follow and be presented in subsequent project deliverables, alongside corresponding publications that will be peer-reviewed by the wider scientific community.

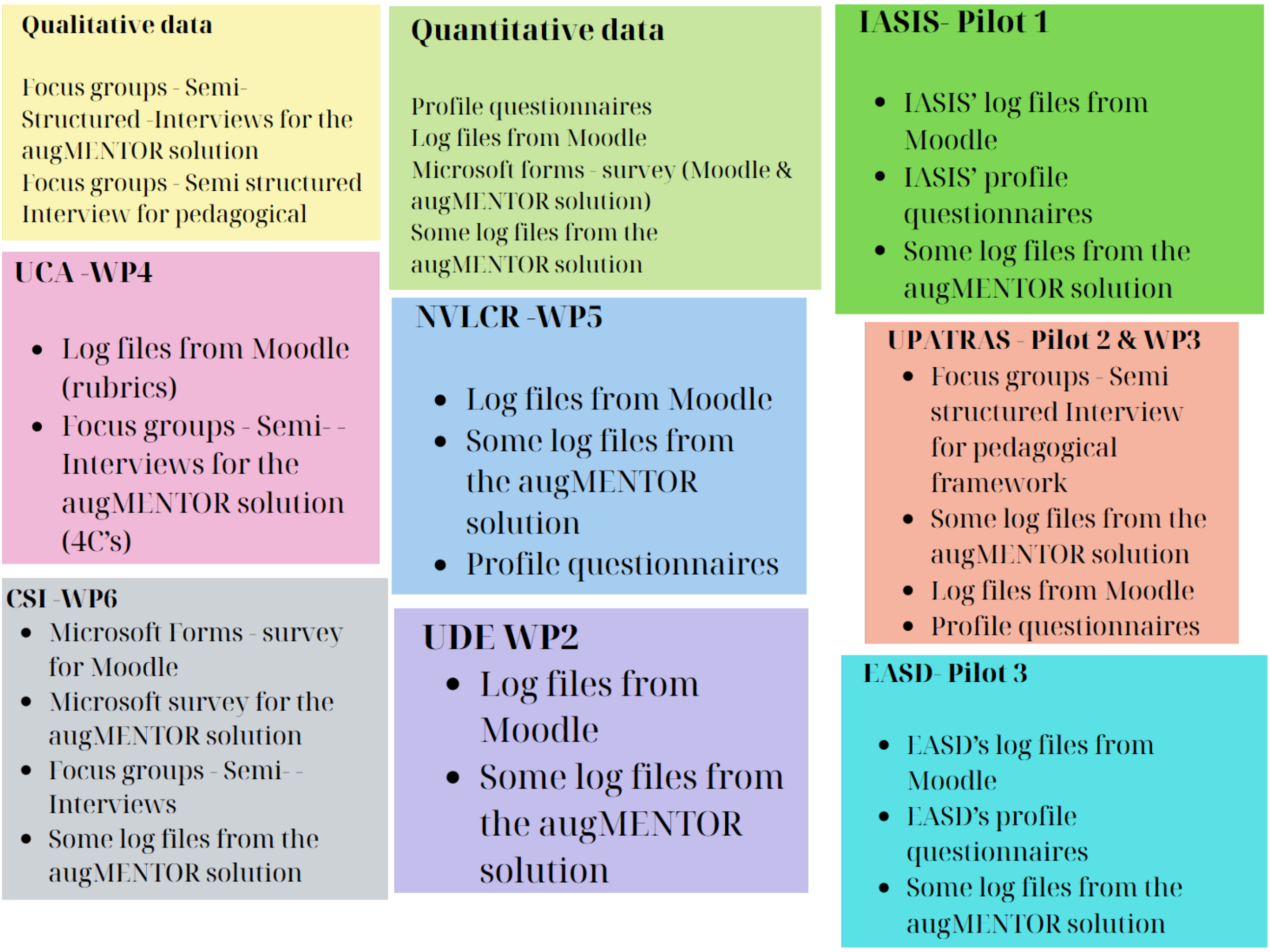

Figure 1. *Presentation of the data analysis process, including a detailed overview of each partner's responsibilities and contributions*

More specifically, The qualitative dimension is particularly critical, as it provides in-depth insights into the lived experiences of educators and learners engaging with the framework. Activity Theory (Engeström, 1987; Kaptelinin & Nardi, 2006) is used to interpret how pedagogical practices evolve through interaction with AI tools and the augMENTOR scenario templates.

- **Qualitative data** will be collected through multiple channels to evaluate the practical and theoretical soundness of the PF:
- **Semi-structured interviews** with educators and tutors after each cycle of implementation, focusing on their experience with PeDeMET and TESA models.
- **Focus groups** with learners to explore their perception of engagement, agency, and support within AI-augmented scenarios.
- **Scenario design reflections** where tutors annotate their design process, explain pedagogical choices, and identify affordances and constraints of the PF.

- **Observation protocols** during scenario implementation to document tutor-learner interaction, use of AI tools, and alignment with 4C competencies.

This qualitative data is used to identify how and to what extent the PF supports transformative pedagogical practices, encourages creative scenario design, and fosters the development of 21st-century competencies.

Quantitative data: Furthermore, the evaluation emphasizes the interplay between technical and pedagogical components by embedding analytics directly into the learning management system (LMS). Dashboards will visualize real-time data on learner engagement and progression across 4C indicators, making the evaluation cycle immediate and transparent.

Human-centered methodologies such as semi-structured interviews and focus groups and guided design reflections will be implemented with educators and tutors after each implementation pilot, focusing on how the PeDeMET and TESA models influence planning, delivery, and perceptions of learning outcomes, under WP6.

Simultaneously, robust quantitative data will be gathered through backend analytics from the Moodle LMS and the augMENTOR solution platform. These data include activity logs, interaction patterns, and engagement indicators such as time-on-task and frequency of tool usage. Additionally, surveys distributed as part of WP6 will yield structured feedback on users' experiences, perceived learning gains, and pedagogical alignment. While this quantitative data remains secondary in the current phase, it is critical for triangulating insights and will undergo detailed analysis once pilot activities are completed. These findings are intended to inform upcoming research publications and contribute to the validation of the augMENTOR Pedagogical Framework across diverse educational contexts, reinforcing its empirical grounding and scalability.

To guide the evaluation of the pedagogical framework itself, the following refined questions are posed:

- **EQ1: What is the impact of the augMENTOR Pedagogical Framework on pedagogical practice?**
- **EQ2: How effectively are AI tools integrated into learning activities designed using the framework?**
    - In what ways do educators experience change in their instructional design processes through the use of PeDeMET and TESA?
    - How does the framework support or hinder the integration of AI in pedagogically meaningful ways?
    - How do scenario-based learning designs supported by the framework impact learner engagement and collaboration?

- What shifts in tutor mindset, planning, and instructional adaptability are evident across the two evaluation cycles?

Each of these questions will be addressed through triangulated analysis of the qualitative sources above, with coding schemes based on Activity Theory constructs (subject, tool, community, object, outcome).

The results of this analysis will directly inform iterative modifications of the PF and guide further alignment between theory and practice within the augMENTOR project.

3.1 CHAT-Based Evaluation Model

The Cultural-Historical Activity Theory (CHAT) is employed to map educational practice as a network of interdependent systems. In augMENTOR pilots, each learning activity is treated as a "unit of analysis" comprising:

- **Subjects:** educators and learners
- **Tools:** AI applications, LMS features
- **Community:** class groups, facilitators
- **Rules:** learning objectives, platform constraints
- **Division of Labor:** instructor facilitation vs. system automation
- **Object/Outcome:** intended learning gains and competency development, 4Cs (for more details see ANNEX I)

The evaluation process unfolds over two implementation cycles.

3.2 Integration of the Delphi Method in the Evaluation and Refinement Process

To ensure the scientific rigor and contextual relevance of the augMENTOR Pedagogical Framework (PF), we adopted a methodology inspired by the **Delphi method**. The Delphi method is a structured approach to gathering expert judgment through iterative rounds of feedback, aiming at convergence and consensus. Traditionally used in forecasting and model validation, its principles proved valuable in the context of educational framework refinement, especially in areas influenced by emerging technologies and complex pedagogical dynamics.

In the augMENTOR context, the Delphi-inspired process was implemented in two main layers:

- **Expert Review Cycles**: A panel of external experts outside the consortium and beyond participated in structured review cycles. Following each implementation phase, experts were invited to provide feedback on the applicability, clarity, and theoretical consistency of both the macro-level PeDeMET model and the micro-level TESA framework. Feedback was synthesized across multiple themes (e.g., inclusivity, learning analytics, 21st-century competencies), allowing for iterative refinements to the PF.

- **Pilot-Based Implementation Rounds**: Participating pilot partners (Pilot #1 and Pilot #2) acted as informed respondents in the Delphi process. Each pilot implemented the PF in authentic educational settings (HE), and their experiences were systematically captured through reflective scenario documentation, tutor interviews, learner focus groups, and rubric-based evaluations. The insights from these iterative implementations served as a form of empirical validation and refinement loop, complementing expert feedback.

This two-layer structure reflects the core Delphi principles: iteration, synthesis, and consensus building (Okoli & Pawlowski, 2004). Also, this two-layer structure reflects the core Delphi principles: iteration, synthesis, and consensus building. Rather than relying solely on pre-defined metrics, the Delphi approach allowed for dynamic adjustments based on grounded classroom realities and the evolving interpretations of pedagogical innovation by both practitioners and theorists.

By adopting this methodology, the augMENTOR PF was not only evaluated in terms of usability, coherence, and pedagogical value, but also continuously refined through a distributed, collaborative process. This ensured that the final version of the framework maintains both theoretical depth and practical adaptability across varied educational contexts and levels (see ANNEX III).

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4 Cycle 1: External Evaluation

In the first implementation cycle, the augMENTOR pedagogical framework was presented to external educational experts and independent educators for external evaluation and validation. The experts were engaged to participate in structured focus groups according to a specific protocol to capture detailed feedback and insights on the framework's practical application (ANNEX I). These discussions provided valuable qualitative data, highlighting the framework's strengths and areas for improvement, particularly regarding its usability and relevance across diverse educational settings.

4.1 Data collection from panel of experts

Expert 1

As an initial observation, I would note that the model presented combines elements from distinct theoretical approaches, which, in my view, appear to be harmonized and aligned with the model's core principles.

Given that my area of expertise lies in both non-formal adult education and higher education pedagogy, I believe that this model could serve as a solid foundation for the new program we are designing at the Center for Teaching and Learning (CTL) at the University of Patras, aimed at training faculty who will be teaching in distance postgraduate programs. Furthermore, with regard to the field of university teaching, I believe the model may have broader applicability, especially considering that Lee Shulman, who contributed to the development of PCK, also introduced the concept of "signature pedagogies" for different disciplines.

As for the field of non-formal adult education and the programs commonly referred to as lifelong learning, I believe there is considerable potential for applying the model. The model already integrates core principles of adult education and is inherently oriented in that direction.

Two areas in particular where I would like to explore its applications more thoroughly are:

(a) the potential for active learner participation in the design of educational interventions—not just through participatory teaching techniques, but through involvement in lesson planning, practical applications, and authentic assessment;

(b) the promotion of critical thinking and critically reflective processes. I believe these fall within the model's capabilities, but in the case of adult learners, it is essential to examine to what extent transformative learning activities and the reconsideration of learners' core assumptions on key educational issues can be integrated into an educational intervention.

Expert 2

The PeDeMET and TESA models, as core components of the augMENTOR framework, present a theoretically grounded and methodologically substantiated approach to integrating emerging technologies (such as AI) into educational practice. PeDeMET, at the macro level, combines the TPACK framework with an enriched Pedagogical Triangle and draws from Activity Theory to conceptualize teaching as a tool-mediated activity system. At the micro level, TESA proposes methodologies for scenario design and e-activities aligned with the development of 21st-century skills. Together, the two models constitute a coherent instructional design architecture that bridges theory and practice.

However, their practical applicability requires testing and validation to document their adaptability, generalizability, and pedagogical effectiveness. While the conceptualization is detailed and well-documented, implementation may require contextual adaptations. For instance, although the models offer strong guidance for scenario design and the alignment of learning goals with digital tools, educators with limited digital proficiency may need additional support to apply them. Moreover, the assumption that educators possess high autonomy and design capabilities may not reflect the average case. Therefore, it may be necessary to foresee support strategies, such as training or the dissemination of good practices using TESA scenarios across diverse educational contexts.

Regarding validation, although the models are grounded in best practices of instructional design, empirical testing is a crucial next step. This should include both quantitative indicators (e.g., student progress, use of tools) and qualitative data (e.g., teacher perceptions, student engagement, challenges). Through such a feedback-oriented and reflective process, the models can evolve from theoretical constructs into validated, practical pedagogical tools.

Expert 3

The macro/micro levels are clearly explained and seem useful for the objectives of the project. Activity theory as a theoretical framework and point of analysis is also aligned with the projects' aims and offers useful insights and a strong basis. My main recommendation is to explore further the latest version of Engeström's expansion of the theory where he underlines the ongoing dialectic between what is stable or dynamic. I suggest including in the PeDeMeT model (slide 26) the idea of 'networks' (community), e.g., as one of the 7 ovals, to show this dialogic relationship in learning/teaching which is vital for learners and tutors. Scholars from cultural-historical traditions will surely comment on that dimension. If not possible in the diagram, try to include it in the explanation of the diagram/overall explanation of the theory. Overall, the PeDeMet diagram (slide 26) I think needs some more attention to its visual representation to be easily understood by inservice/preservice teachers.

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The TPACK diagrams (slides 28, 29) are nicely represented and very relevant with your work. I would suggest adding some practical examples in each rectangle. Maybe also add 'prior knowledge' in PCK. One of the limitations of TPACK is its lack of focus on the affective domain. Maybe this is something you would like to touch on to strengthen your contribution. Finally, maybe consider adding to your 'object – outcome' something about teachers/trainers. The European Digital Competence framework for Teachers might be useful here.

Expert 4

I propose the use of Artificial Intelligence (AI) not only in the design but also in the evaluation of the final learning scenario or intervention. Specifically, AI can be leveraged to analyze and assess the scenarios, identifying areas that require revision or enhancement, as well as to provide feedback to educators regarding the pedagogical, technological, and cognitive dimensions of the scenario.

At the same time, I suggest that AI be employed to evaluate student performance, both in terms of knowledge acquisition and in terms of their behavioral responses to the learning scenario or intervention. By collecting and analyzing data from the learning process, AI can offer valuable insights. The outcomes of this evaluation can be used to adapt and continuously improve the scenarios so that they better address students' actual needs and foster learning in a personalized manner.

Expert 5

The models proposed (macro and micro levels) are well established and build upon previously established and validated theories (e.g., TPACK, Activity Theory).

They functionally integrate elements of these theories and synthesise them into new models that make sense and seem to address multiple facets of the theoretical framework and practical design and implementation of activities.

Educators aiming to design technology enhanced educational activities using the augMENTOR model could probably benefit from a graph (slide Technology –augmented Educational Scenarios and e-Activities) showcasing the stages of the design process, the knowledge involved (TPACK) (as it does now), and also the components of relations of the Activity Theories triangles that are involved either for the design or for the analysis of the scenario and activities, maybe through targeted questions (e.g. What are the learner characteristics? What is their relation with the technologies to be used? etc.). Maybe no more than one page to be used as a practical guide.

The relation between Learners and Tutors when mediated by technologies (slide Enriched Pedagogical Triangle with Digital Technologies) in face-to-face (in situ) sessions, was of particular interest to me. Why and how do and can technologies mediate this communication and collaboration when students and teachers are face-to-face in the same classroom? This brought to mind the features of the technologies used and the space they provide for communication and collaboration. A relevant paper could be Palmér, H. (2015). Using tablet computers in preschool: How does the design of applications influence participation, interaction and dialogues? International Journal of Early Years Education, 23(4), 365–381. https://doi.org/10.1080/09669760.2015.1074553 - describing how e.g. closed software (behaviourist) restrict communication and participation among students and teachers, limiting communication only to functional features of the software, rather than open discussions of the topic to be taught afforded by open-ended environments (e.g. simulations).

Expert 6

The augMENTOR Pedagogical Design Model with Emerging Technologies (PeDeMET) that combines the Activity theory with TPACK is interesting and useful in suggesting, at the first level, the main components and their relations of the design process that involves emerging technologies. Then, at the second level, these relations can be used for providing guidance on the steps that lead to the development and implementation of various types of activities implemented in person or online.

The way the Activity Theory may support the design of Technology – augmented educational scenarios and e-activities, needs to be better communicated. Recognizing the triangles that need to be considered (at PeDeMET) and linked with the various steps proposed (at TESA), can help (designers) in identifying the various “parameters” or “relations” that need to be considered and synthesized on each step.

4.2 Expert Analysis of the augMENTOR Pedagogical Framework

This report presents a content analysis of expert statements evaluating the augMENTOR pedagogical framework, specifically focusing on its theoretical grounding, practical application, and potential areas of enhancement. The data were categorized into themes using qualitative content analysis.

1. Theoretical and Conceptual Grounding

Experts affirmed the framework's strong theoretical basis, particularly the integration of TPACK, Activity Theory, and the enriched Pedagogical Triangle. PeDeMET was seen as a meaningful synthesis of these models, making it suitable for diverse educational contexts, including adult learning and higher education. Emphasis was placed on engaging more deeply with Engeström's expanded Activity Theory, particularly the dialectic between stable and dynamic elements in learning.

Contributors: Expert 2, Expert 3, Expert 5, Expert 6

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2. Applicability and Adaptability

The framework was recognized as versatile, with potential applications in university-level teaching, lifelong learning, and distance education. However, the experts highlighted the need for context-specific adaptations, especially in environments where digital skills vary. They advocated for structured training and dissemination of good practices to support educators in applying the models effectively.

Contributors: Expert2, Expert 3, Expert 6

3. Scenario Design and Implementation (TESA)

TESA was praised for its alignment with 21st-century skills and its utility in micro-level instructional design. To enhance its usability, experts recommended the development of one-page practical guides and templates that link PeDeMET's relational components with TESA's stepwise approach to designing technology-enhanced learning scenarios.

Contributors: Expert 5, Expert, 4, Expert 6

4. Learner-Centered Pedagogy

A recurring theme was the model's alignment with learner agency and participatory approaches. Experts proposed incorporating transformative learning elements and more structured support for learners to participate in lesson design, reflection, and authentic assessment. Addressing the role of prior knowledge and the affective domain was also emphasized.

Contributors: Expert 2, Expert 5

5. AI Integration and Evaluation

Experts suggested that AI could be leveraged both in the design and ongoing evaluation of learning scenarios. AI tools could support real-time feedback for educators and learners, identify areas for improvement, and enable personalization based on learning analytics. This was seen as a strategic opportunity to align the framework with adaptive and data-informed pedagogy.

Contributor: Expert 4

6. Visual and Structural Clarity

While the visual representations (e.g., PeDeMET, TPACK) were appreciated, suggestions were made to improve clarity, such as including examples within diagrams, adding 'prior knowledge' in PCK, or integrating community aspects into Activity Theory representations. Affective dimensions were noted as underrepresented in TPACK.

Contributors: Expert 3, Expert 5

4.3 Conclusions of expert analysis

- The augMENTOR framework is theoretically sound, well-aligned with best practices in instructional design, and conceptually ready for broader application.
- Implementation requires context-aware adaptation, enhanced support tools, and capacity building for educators.
- Emphasis should be placed on enhancing learner participation, reflective practice, and AI-supported evaluation.
- Future iterations should focus on empirical validation using mixed-methods approaches and further refinement of visual and structural elements for broader usability.

This expert feedback serves as a foundation for the next phase of testing and refining the framework across diverse educational settings.

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5 Cycle 2: Internal Evaluation

In the second cycle we applied the validation inspired by Delphi method to actual implementations of the PF so partners internally test the PF. The learning activity was observed for and tutors provided debrief reports after the pilot implementation. For the purposes of this deliverable, we focus on two indicative pilot cases, both implemented in Greece, which share a common pedagogical design and operational structure. Their high degree of similarity enables a meaningful comparative analysis and allows for a deeper interpretation of the data collected, enhancing the internal validity of the findings and providing insights into the consistency of the framework's implementation across comparable contexts.

This cycle is mainly formative. It helps identify:

- Whether TESA activities are feasible within institutional contexts
- If the AI functionalities operate as expected
- Which learning indicators show measurable improvement

5.1 Reflective Report on the UPATRAS Pilot for augMENTOR – Moodle Implementation

In this section it is presented tutors reflection based on the protocol created based on CHAT in order to evaluate and validate the actual implementation of the augMENTOR PF and then a thematic analysis was conducted to conclude on the results of the internal validation. TThe data collected stem from authentic reflective statements made by the instructors involved in the pilot implementations, who had participated in both the design and teaching of the course. After the completion of the in-person sessions and before they engaged substantially with the augMENTOR solution, they were asked a series of interview-style questions, based on the ones presented in Annex II. They were invited to document their reflections regarding the pedagogical model and the implementation of the courses.

These texts were analyzed in depth in order to identify thematic categories that explain and describe what took place during the pilots, as well as what exactly needs to be revised in the pedagogical design.

In alignment with the core objectives of the augMENTOR project, the undergraduate course "Information and Communication Technologies in Education" at the University of Patras underwent a comprehensive restructuring during the spring semester of the 2023/2024 academic year. This transformation aimed to foster the development of 21st-century skills and strengthen the digital pedagogical competence of pre-service early childhood educators.

The redesign of the course was conceptually grounded in the Technological Pedagogical Content Knowledge (TPACK) framework and operationalised through the integration of the augMENTOR Educational Scenario Template and the TESA model. The course implementation explicitly targeted the systematic cultivation and assessment of the 4Cs—Creativity, Critical Thinking, Collaboration, and Communication—by embedding these competencies into scenario-based digital activities, formative assessments, and student-designed projects. Rubric-based evaluation strategies, adapted from WP4 of the augMENTOR project, were employed to gauge students' progress across these domains.

Delivered through the Moodle learning management system, the course followed a blended learning model combining asynchronous online engagement with synchronous in-person workshops and peer collaboration sessions. The instructional design placed emphasis on student agency, scenario co-construction, and iterative feedback, closely mirroring the pedagogical vision of the augMENTOR PF. Approximately 200 students enrolled in the course during the semester, exceeding expectations and necessitating the creation of multiple parallel groups to accommodate learner interest and ensure meaningful participation. Platform usage data, learner feedback, and course evaluation responses were systematically collected as part of the pre-pilot evaluation phase, providing valuable insights for the refinement of TESA activities and informing the CHAT-based modelling of tutor–learner interactions (for more detail see ANNEX I). The course prioritised the cultivation of critical teaching skills for 21st-century learning environments.

This implementation serves as a pilot instantiation of the augMENTOR PF, offering a practical example of how emerging technologies, pedagogical frameworks, and AI-informed learning design can converge to empower future educators and inform ongoing evaluation cycles within the project.

It is well known that one of the 21st-century skills is the critical evaluation of offered knowledge. Given that artificial intelligence and the internet more broadly provide immediate access to produced knowledge, the focus shifts from the process of transmitting knowledge to its critical appraisal and its application.

The Moodle platform is structured around 12 workshops, each of which follows a specific core structure. The initial TPACK framework serves as a means to detect prior conceptions, while prerequisite knowledge includes basic computer skills and internet access. The purpose and objectives of each module are explicitly stated and taken into account at the beginning. Then, the material of each workshop (supplementary content, workshop slides, and lecture slides) serves as teaching activities; the problem-based situations addressed during the workshop serve as reinforcement activities; and the homework problem-based situations serve as application and implementation activities of the content—some of which could also be considered metacognitive activities. The embedded quizzes are considered assessment activities, both formative (regarding the semester-long workshop) and summative (for each module individually). Finally, the concluding questionnaire on the integration of ICT in early childhood education serves as the final evaluation of the workshop's overall content. The initial and final TPACK assessments can function as pre- and post-tests for the entire instructional intervention, which is considered to be the semester-long teaching process (lectures and workshops).

Tutor 1: "Based on my limited experience participating in this year's workshops, I formed the opinion that the time devoted to knowledge transmission through presentation slides did not spark interest and had a negative impact on student engagement. Student responses, which I solicited as feedback to ensure comprehension, were rare. In contrast, when students had to engage in reinforcement activities—particularly collaborative ones—they had no choice but to actively participate, consult the material, and explore the internet.
In light of this, I am considering completely detaching the workshop from knowledge transmission and instead applying a more constructivist approach framed within sociocultural learning theories. The broad model guiding this restructuring is that of the flipped classroom. Specifically, of the 12 workshops (excluding the first and last, which are for introduction and review/exam preparation), 10 remain. Each of these 10 workshops would be structured as follows: students have full and unlimited access to knowledge, both via the provided material and the internet. For 75 minutes, they collaboratively work on a problem-based task aligned with the workshop's goals, which serves as an application and implementation activity of the content. In the following 30 minutes, they present their work to the entire class and receive feedback from both the instructor and their peers. During the final 15 minutes, they complete an individual quiz that functions as both formative (within the scope of the semester workshop) and summative (for the specific module) assessment. This quiz will consist of 20 questions aligned with indicators from the augMentor solution: 5 cognitive, 5 creativity, 5 critical thinking, and 5 collaboration questions. The quiz will be automatically graded by the augMentor system".

Possible benefits of the augMENTOR PF:

- Active engagement
- Experiential learning
- Peer collaboration
- Immediate and engaging interaction with content and critical evaluation of it
- And most importantly, in my opinion, immediate data from the augMentor system for each indicator, for each student, and for each module—data that could be used both for empirical research and longitudinal quantitative studies.

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Lastly, if the policy of allowing only two absences per student remains, students will know from the beginning that missing a class means non-participation in the problem-based activity and the quiz, and therefore a lower final grade for the workshop.

In conclusion, based on the above, the workshop will function as a true "workshop" experience. It will be disconnected from the obligation to deliver knowledge (which will instead be part of the theoretical course and clearly communicated to students). It will operate within the framework of social constructivism and sociocultural learning theories, and the instructor will no longer need to grade large volumes of assignments. This may also allow for more flexible scheduling of workshops (e.g., more frequent sessions with fewer students in each).

From a broader perspective, as a tutor in the workshops, I had a clear understanding of the instructional scenario stages on which the modules were based. I felt secure both in terms of content and process. Furthermore, my repeated exposure to the material helped enrich my knowledge base in a way that advances my personal academic development.

Additionally, I want to highlight the truly remarkable progress and development of the students, particularly in their creativity (especially through their interaction with creativity-supporting software, visual programming tools, and hypermedia applications), their collaboration (which grew during the workshops), and their critical thinking skills, which evolved through their engagement with problem-based activities both during and outside class.

5.1.1 Thematic Analysis of Tutor's Statement Based on augMENTOR PF

1. Shift from Transmission to Constructivist Pedagogy

Theme: *Pedagogical Framework (TESA) — Learning Strategies*

The tutor criticizes the traditional knowledge transmission model (lecture and slide-based presentation), observing that it fails to maintain student engagement. Instead, he/she proposes a flipped classroom model, grounded in constructivist and sociocultural theory, with problem-based, collaborative activities at its core. This reflects TESA's emphasis on active learning strategies and alignment with Activity Theory where learning emerges through participation in socially mediated activity.

2. Activity-Oriented Design and Engagement with Tools

Theme: *Activity Theory / Digital Affordances*

The design of the workshop embraces the "activity" as the unit of analysis (Engeström, 1987), proposing distinct learner-tutor interactions mediated by problem-based tasks, collaborative work, and digital assessments. The proposed structure (75 mins collaboration +

30 mins presentations + 15 mins quizzes) mirrors the TESA model (micro level), which defines stages of educational scenarios and implementation through in-situ e-activities.

3. Integration of AI-Enhanced Formative Assessment

Theme: *AI-augmented Evaluation – Feedback and Monitoring*

Quizzes aligned with the augMENTOR indicators (5 cognitive, 5 creativity, 5 critical thinking, 5 collaboration) exemplifying how formative and summative assessments are aligned with the augMENTOR PF. This anticipates real-time, automatic feedback using the AI analytics engine, fulfilling the PF's goal of personalised learning and reflective teaching (TESA Phases F, G).

4. Emphasis on the 4Cs and Learner-Centred Outcomes

Theme: *Outcome-driven Scenario Design – Focus on 21st-century Competencies*

The tutor notes observable growth in students' creativity, collaboration, and critical thinking, explicitly linking these to workshop participation and ICT-enhanced tasks. This aligns with augMENTOR's PF (TESA) and its objective to foster transversal competencies using Emerging Technologies.

5. Tutor Development and Professional Reflection

Theme: *Educator Empowerment and Contextual Adaptation*

The tutor's reflection on her own evolving academic knowledge base through iterative engagement mirrors the PF's dimension of "Continuous Improvement and Reflective Teaching." It reinforces the notion that tutors are both designers and learners within the TESA model, in alignment with Phase H (Documentation and reflection).

Table 1. *Results: Alignment with augMENTOR Pedagogical Framework*

Dimension	Tutor's Practice and Observations	Alignment with PF
Pedagogical Approach	Shift from lecture-based to flipped classroom, socio-constructivist & sociocultural orientation	PeDeMET, Activity Theory foundation; Flipped Classroom in TESA (Phase E)
Use of Emerging Technologies	Use of Moodle, AI-powered quizzes, internet-based research and collaboration	Integration of LMS + AI for formative assessment (TESA; PeDeMET - Tools & Evaluation)

Focus on the 4Cs	Measured development in creativity, critical thinking, collaboration	4Cs model and rubrics embedded in PF and TESA implementation
Assessment Strategy	Automatic formative/ summative quizzes per module scored with augMENTOR indicators	AI-based formative/summative evaluation (TESA Phase G; PF analytics layer)
Learner Engagement	Higher engagement in active tasks vs passive lectures; observed peer interaction and autonomy	Learning strategy component in PeDeMET; learner agency emphasized in Activity Theory
Tutor Role and Professional Growth	Tutor confidence through scenario implementation, increased content familiarity	Reflective educator development in PeDeMET and TESA (Phases F–H)
Scenario Design and Flexibility	Plans to restructure all 10 main workshops using problem-based tasks and feedback loops	Educational Scenario design under TESA – Scenario-based teaching
AI Data Utilization	Use of indicators to track individual and class-level progress across modules	Alignment with WP5 & PF's AI-enhanced monitoring model

5.1.2 Conclusion of thematic analysis from group of tutors

The tutor's statement provides a strong, practice-based validation of the augMENTOR Pedagogical Framework. It evidences:

- A deep alignment with PeDeMET principles, particularly in the design of learner-centred activities mediated by technology.
- Implementation of TESA scenarios through flipped classrooms, AI-based formative assessment, and structured collaborative learning.
- A data-driven approach that *aims* to support real-time monitoring, evaluation of the 4Cs, and ongoing professional growth. However, it is important to note that the augMENTOR solution was not fully functional during the majority of the pilot implementation; as such, full-scale validation of its data-driven capabilities remains forthcoming.

5.2 Reflective Report on the IASIS Pilot for augMENTOR – Moodle Implementation

Tutor 2: "As a researcher and active participant in the IASIS pilot for the augMENTOR Project, I had the opportunity to engage deeply during the design and training intervention that combined the potential of artificial intelligence with the principles of adult education in the field of mental health. The pilot targeted the continuous professional development of staff or adult educators working within the Mental Health field, and was delivered through a blended learning model, facilitated by the Moodle platform and supported by AI-driven personalization features from the augMENTOR solution.

From the very beginning, our team designed the course with careful attention to the practical needs of mental health professionals. The aim was to go beyond content delivery and to promote the development of critical 21st-century skills. Based on data collected during WP2 (requirements analysis phase), we identified the core competencies necessary for mental health and adult educators and translated these into four structured thematic units: *communication with service users, time management, inclusion and diversity, and problem-solving*. The selection of these themes was guided by real workplace demands and aligned closely with learners' responsibilities.

Each training unit was developed with both asynchronous and synchronous elements. Moodle supported the delivery of the theoretical sources, while synchronous sessions encouraged active engagement through live discussions, real-life scenarios, and collaborative tasks. My role involved guiding and supervising trainers and learners through the learning journey, offering support during discussions, and interpreting the data provided by the AI system. I was able to track learners' progress, detect cognitive gaps, and respond to their individual learning needs in real time.

One of the most impressive aspects of this pilot was the trial phase of the augMENTOR solution, which is going to conclude in the seamless integration of AI in the instructional process. The augmentor platform generated feedback based on each participant's interaction with the course material, quizzes, and forum activities. This allowed me to tailor my instructional responses and follow-ups without the overwhelming burden of manually reviewing large volumes of data. The continuous and dynamic feedback loop not only enhanced the learners' experience but also strengthened my own instructional planning and time management.

In terms of structure, each thematic area followed a consistent format: introductory materials provided theoretical grounding, followed by practical exercises (such as quizzes, case studies, and forum interactions) that reinforced the content. In the workshops, participants tackled problem-based activities in a collaborative format. They shared solutions, reflected on their practices, and received both peer and instructor feedback. At the end of each unit, an AI-generated assessment evaluated their competencies across four categories: cognition, creativity, collaboration, and critical thinking. These indicators offered detailed insights that were valuable not only for formative purposes but also for long-term assessment and research.

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Throughout the pilot, I observed how learner engagement increased significantly when activities were interactive, contextualized, and socially situated. Participants were particularly responsive during forums and live discussions, where their practical knowledge intersected with structured tasks. Conversely, more passive elements such as reading theoretical content or watching pre-recorded material generated lower engagement, confirming the need to further shift toward a constructivist, activity-based learning model.

In figure 2, it is presented in total, 285 mental health professionals took part in the pilot—surpassing our initial goal of 250 participants. We implemented more than 92 hybrid workshops and collected over 1,000 unique learner queries, which were analyzed and incorporated into the AI system for ongoing improvement. More than 240 participants completed pre- and post-questionnaires, and 146 submitted final evaluations.

Participants
285 professionals joined
Goal was 250

Workshops
92+ hybrid sessions
Delivered across contexts

Learner Queries
1000+ learner questions
Fed into the AI system

Questionnaires
240+ completed both
pre- and post- surveys

Final Evaluations
146 participants
shared detailed feedback

What It Shows
Collaboration between
humans and AI in action

Figure 2. *Key participation and engagement metrics from the pilot #1*

These numbers illustrate the scale of engagement but also provide a robust dataset for further analysis of learning outcomes.

The development of trainers was equally important. Fifteen professionals were involved in the design and delivery of the pilot. Our repeated exposure to the material, active use of AI analytics, and reflective teaching practices resulted in professional growth that extended beyond the scope of the project.

Personally, I found the AI-generated learner reports to be a transformative tool. They not only helped me better understand individual and group progress, but also offered a new lens through which to assess the effectiveness of my teaching. Moreover, seeing the development in participants—particularly in their critical thinking, creativity, and collaboration—was a strong confirmation of the project's pedagogical success.

In conclusion, this pilot has shown that when AI is thoughtfully integrated into education, it can elevate both teaching and learning. The IASIS pilot was not simply a training course; it was a model of innovation in adult education and specifically in mental health training field, grounded in real needs and enhanced by advanced technologies. For us as educators, it represented a step forward in our ability to offer meaningful, data-driven, and

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impactful learning experiences within the demanding field of mental health, and in parallel, it was an opportunity to adapt AI in mental health training settings."

5.2.1 Thematic Analysis – IASIS Pilot (Mental Health and Adult Education)

1. Learner-Centered Scenario Design

Theme: *Needs-based Pedagogical Design (PeDeMET)*

The IASIS pilot began with a systematic analysis of real workplace needs (WP2), translating them into four thematic modules—communication, time management, inclusion/diversity, and problem-solving. This is consistent with PeDeMET's outcome- and object-driven activity design, where the learners' context and professional challenges guide scenario development.

2. Blended Delivery with Active Engagement

Theme: *TESA Scenario Implementation & Learning Strategies*

Each unit combined asynchronous delivery via Moodle with synchronous, interactive workshops. The use of real-life scenarios, peer collaboration, and problem-solving reflects TESA's structured phases—from content anchoring to application and metacognitive reflection. Activities followed a constructivist model, emphasizing socially situated learning.

3. AI-Enhanced Feedback and Adaptive Support

Theme: *AI-Driven Assessment and Personalization*

The integration of augMENTOR's AI layer allowed tutors to receive ongoing learner data (quiz scores, forum activity, engagement markers), enabling dynamic formative assessment. This aligns with the PF's emphasis on adaptive learning, where cognitive, creativity, collaboration, and critical thinking indicators guide individualized support.

4. Focus on 21st-Century Skills

Theme: *Outcome Orientation and 4Cs Monitoring*

Each unit concluded with AI-generated evaluations across the four augMENTOR indicators—cognition, creativity, collaboration, and critical thinking. The observation of visible growth in these areas confirms the framework's relevance in promoting transversal competencies, especially in a demanding domain like mental health.

5. Tutor Development and Reflective Practice

Theme: *Continuous Improvement and Reflective Teaching*

Trainers used AI reports to guide instructional adjustments and deepen their own pedagogical insights. This recursive model of teaching-as-inquiry reflects TESA Phase H and the broader CHAT-informed vision of professional learning through activity and tool-mediated reflection.

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6. Data-Driven Pedagogical Innovation

Theme: *Scalability and Research-Embedded Practice*

With over 1,000 learner queries, 285 participants, and 92 hybrid workshops, the pilot generated a significant dataset for empirical analysis. This practice aligns with augMENTOR's goal to bridge pedagogical design with learning analytics, enabling evidence-based improvements in future cycles.

Table 2. *Results Summary – IASIS Pilot*

Dimension	Practice in IASIS Pilot	Alignment with augMENTOR PF
Design Orientation	Scenarios built from WP2 needs analysis in mental health	PeDeMET (context-based design, content-object alignment)
Delivery Format	Blended learning: Moodle + synchronous problem-based workshops	TESA (in situ and online e-activities; Phases A–G)
Learning Activities	Forums, real cases, collaborative problem-solving, live feedback loops	Activity Theory-based scenario flow; Social Constructivism
Assessment Approach	AI-generated 4Cs feedback per unit	AI-integrated formative/summative assessment (TESA Phase G)
Observed Competencies	Growth in collaboration, creativity, critical thinking	Outcome-driven learning (PeDeMET outcomes, WP4 indicators)
Scale of Participation	285 learners, 15 trainers, >1,000 queries, >240 questionnaires completed	Broad stakeholder engagement and data-driven evaluation
Tutor Development	Use of AI reports for personalized support and pedagogical reflection	Reflective teaching loop; CHAT-informed continuous improvement
Innovative Value	Demonstrated model for AI-enhanced adult mental health training	Validates PF flexibility and domain adaptability

5.2.2 Conclusion of thematic analysis from group of tutors

The IASIS pilot embodies the augMENTOR Pedagogical Framework in action. It successfully translated contextual needs into structured educational scenarios, enabled real-time feedback through AI, and fostered professional growth in both learners and trainers. It stands as a model of AI-supported, data-informed, and socially grounded adult education—particularly relevant in the complex field of mental health.

5.3 Comparative Case Analysis: IASIS & University of Patras Pilots

Below we present the comparative case analysis with the IASIS & University of Patras Pilots:

Table 3. *Pedagogical Design Approach*

Aspect	IASIS Pilot (Mental Health CPD)	University of Patras (ICT in Education)
Target Group	Adult educators and mental health professionals	Pre-service early childhood educators (Bachelor/MSc level)
Needs Analysis Basis	Based on WP2 findings: workplace competencies in adult mental health training	Based on university course goals, mapped to 21st-century teaching skills
Scenario Structure	4 thematic units (communication, time, inclusion, problem-solving)	12 structured workshops aligned with TPACK and 4Cs
Theoretical Model	Constructivism + Sociocultural Learning + CPD Framework	TPACK, PeDeMET, and Activity Theory
Instructional Framing	Contextualized workplace problems and collaborative scenarios	Gradual cognitive activation via TPACK, quizzes, and scenario design

Table 4. *Integration of Technology & AI*

Aspect	IASIS Pilot	University of Patras
Platform	Moodle (blended delivery) + augMENTOR AI analytics	Moodle (blended delivery) + augMENTOR tools
Use of AI	Personalized feedback per learner, instructor dashboards, 4Cs indicators	Quiz-based 4Cs indicators + AI-enabled auto-assessment

Tutor Role	AI-assisted tracking of individual progress and gap identification	Use of AI analytics to streamline evaluation and adjust teaching plans
Assessment	AI-based unit evaluations on cognition, creativity, collaboration, critical thinking	Similar 4Cs quiz structure, integrated in flipped classroom approach

Table 5. *Learning Activities and Engagement*

Aspect	IASIS Pilot	University of Patras
Activity Format	Real-life case studies, synchronous group sessions, problem-solving tasks	Problem-based collaborative tasks, digital tool integration
Engagement Highlights	High during discussions/forums; lower in passive content	High during workshops and collaborative exploration
Metacognition & Reflection	Peer/instructor feedback loops + final evaluations	Scenario reflections + self-evaluated design annotations
Observed Learning Gains	High in creativity, collaboration, critical thinking	Strong development in same 3Cs + visible tech-integration confidence

Table 6. *Tutor Development and System Impact*

Aspect	IASIS Pilot	University of Patras
Trainer Involvement	15 professionals engaged in co-design and facilitation	Ongoing tutor participation in iterative course implementation
Professional Growth	Enhanced digital competence and AI-supported instructional planning	Strengthened pedagogical design awareness and scenario adaptability
Systemic Value	Scalable model for AI-enhanced CPD in sensitive sectors	Validated integration of augMENTOR PF into formal teacher training

5.4 Summary of Comparative Insights

The comparison of the IASIS and UPATRAS pilot implementations reveals a set of shared strengths that underscore the pedagogical value of the augMENTOR Pedagogical Framework, particularly through its core components—PeDeMET and TESA. Both cases highlight the adaptability of these models across formal and non-formal educational contexts. The use of AI-driven feedback mechanisms consistently contributed to more informed tutor decision-making and enhanced learner outcomes. Furthermore, the application of the 4Cs indicators (critical thinking, communication, collaboration, and creativity) offered a shared evaluative structure that facilitated consistent assessment across diverse settings. Notably, both pilots demonstrated that constructivist, activity-based learning was more engaging and pedagogically effective than traditional content transmission methods.

Despite these commonalities, distinct differences emerged in the goals, design, and application of the pilots. The IASIS pilot emphasized addressing real-world professional challenges faced by mental health practitioners, showcasing the framework's potential for scalability in continuous professional development (CPD). In contrast, the UPatras pilot was centered on the pedagogical transformation of pre-service teachers, focusing on scenario design and experimentation with digital tools in higher education. While AI in IASIS was primarily leveraged to offer real-time personalization and adaptive guidance, its use in Patras was more structured, focusing on feedback aligned with each training module.

These insights affirm the robustness and relevance of the augMENTOR framework across diverse learning environments. They also validate its capacity to support meaningful educational innovation through technology-enhanced pedagogical design. The evidence gathered suggests that the integration of AI into planning and instructional feedback is not only feasible but also beneficial in both pre-service and in-service educational settings. Moving forward, future implementations should continue to foster interactive, socially situated learning experiences. Reflective practices—by both educators and learners—should be further encouraged, reinforcing the transformative potential of the framework in cultivating 21st-century learning competencies.

5.5 Identified Limitations and Proposed Enhancements to the augMENTOR Pedagogical Framework

While the implementation of the augMENTOR Pedagogical Framework (PF) across both the IASIS and University of Patras pilots has demonstrated significant strengths—particularly in its capacity to support learner-centred, AI-augmented educational design—several areas for further refinement have also been identified through tutor reflections, thematic analysis, and implementation feedback.

A key challenge observed across both cases was the initial reliance on content transmission models, particularly in the early phases of implementation. Although the PF promotes active, constructivist approaches through its PeDeMET and TESA layers, it does not provide explicit scaffolding to support tutors in transitioning from traditional delivery methods to fully learner-driven, scenario-based learning. As such, a more structured onboarding or transitional phase is needed to guide this pedagogical shift, especially for educators unfamiliar with flipped learning or activity theory-based design.

Another important consideration concerns the technical readiness of the augMENTOR solution. During both pilots, the full functionality of the AI layer—particularly its real-time feedback and analytics features—was not consistently available. This limited the opportunity to validate the PF's data-driven capabilities in full. Consequently, the framework’s reliance on AI-enhanced personalization and assessment could become a constraint in contexts where the technological infrastructure is not yet fully operational. A revised version of the PF should include a “contingency model” or alternative implementation paths that maintain pedagogical integrity even in low-AI or low-resource environments.

Moreover, the assessment component of the framework remains underdeveloped in its current iteration. While the use of 4Cs-aligned rubrics and AI-generated quizzes was well-received, tutors often had to modify or simplify these tools during implementation. There is a need for a more comprehensive and flexible multi-layered assessment strategy, encompassing formative, summative, and process-based evaluation tools suitable for both online and blended settings.

The pilots also revealed the need to more strongly integrate tutor reflection and learner metacognition into the framework. Although reflective practice is conceptually embedded in TESA’s final phases, structured tools and protocols for both tutors and learners were often absent or informally applied. To address this, the PF should incorporate standardized reflection instruments that align with the CHAT framework, enabling systematic documentation of pedagogical decisions, contradictions, and development over time.

In response to these observations, the following enhancements to the augMENTOR PF are proposed:

- Introduction of a progressive engagement phase in TESA (Phase 0) to support the shift from passive to active learning.
- Development of alternative protocols for formative assessment, learner monitoring, and scenario design in the absence of full AI functionality.
- Expansion of the assessment strategy to include diverse evaluation methods aligned with cognitive, social, and metacognitive outcomes.
- Formal inclusion of tutor reflection protocols and learner metacognitive scaffolds, structured around Activity Theory.
- Provision of differentiated implementation pathways based on the technological readiness of the learning environment.

These revisions will enhance the adaptability, resilience, and usability of the augMENTOR PF across diverse pedagogical and technological contexts, while reinforcing its core objective: to design, implement, and evaluate transformative learning experiences grounded in 21st-century competencies and emerging educational technologies.

6 Framework Refinement Proposals

The evaluation of the augMENTOR Pedagogical Framework (PF), as implemented across the IASIS and University of Patras pilots, affirms its potential to foster learner-centered, technology-enhanced, and 21st-century skills-oriented education. However, the reflective accounts of tutors, alongside the observed practices and thematic analyses, highlighted specific areas where the framework could be further strengthened to enhance its usability, adaptability, and pedagogical robustness.

First, it became evident that educators often required additional support in transitioning from traditional content-delivery approaches to constructivist, scenario-based teaching. To address this, we propose the introduction of a preparatory pedagogical phase (TESA Phase 0), designed to scaffold educators' shift toward activity-based learning. This would include examples, phased engagement strategies, and flexible scenario design models.

Second, the pilots revealed that the full functionality of the augMENTOR AI components—particularly the real-time feedback and learner analytics tools—was not consistently available during implementation. While the pedagogical structure remained functional, this limitation underscored the need for a "contingency mode" within the framework, offering analogue alternatives to AI-based evaluation, such as rubric-based assessments, observation logs, and reflective journals.

Third, the assessment layer of the framework requires further formalisation. Although AI-generated quizzes and 4Cs rubrics were employed effectively, tutors often adapted these tools based on context. A multi-layered assessment strategy should be embedded within the PF, integrating formative and summative elements, self- and peer-assessment, as well as metacognitive components—both in online and blended environments.

Moreover, while reflective practice is acknowledged in the current version of the PF, it is not sufficiently operationalised. Both tutors and learners would benefit from structured reflection instruments, such as guided self-assessment protocols and CHAT-aligned observation tools, that could enhance professional development and promote deeper learning processes.

Finally, it is proposed that a dedicated strand for tutor professional growth be integrated within the framework. This should include iterative design training, collaborative scenario development, and pathways for recognition (e.g., micro-credentialing), aligned with the framework's emphasis on educator empowerment.

In summary, while the augMENTOR PF offers a strong and flexible foundation, these proposed refinements—grounded in empirical observations and tutor experience—will further enhance its impact and ensure its long-term sustainability. They reflect the project's commitment to evidence-informed development, pedagogical innovation, and inclusive access to AI-enhanced learning design.

7 Conclusions and Future Steps

The analysis of data from pilot implementations and expert evaluations confirms that the augMENTOR Pedagogical Framework provides a coherent and adaptable structure for integrating AI into educational design. Across diverse contexts—including higher education and adult learning—the application of PeDeMET and TESA facilitated active, collaborative, and reflective learning experiences. Tutors reported increased confidence in designing technology-enhanced scenarios, while learners demonstrated noticeable gains in creativity, critical thinking, and collaboration. The use of CHAT as an analytical tool allowed for the identification of meaningful contradictions, mediations, and transformations within each educational setting. Moreover, the integration of AI tools into formative assessment processes—such as real-time feedback, learning analytics, and 4Cs-based indicators—was shown to enhance both learner engagement and instructional decision-making. Expert reviewers further validated the framework's theoretical integrity, its practical value, and its scalability across formal and non-formal education.

Moving forward, the next steps focus on the systematic refinement and large-scale deployment of the framework through the second cycle of pilot implementations. Emphasis will be placed on expanding the use of AI analytics for adaptive learning and tutor support, improving the usability of the framework for educators with varying levels of digital competence, and developing training materials and templates to support its adoption. Empirical validation will continue through mixed-method evaluation strategies, including triangulated data analysis from learner artefacts, tutor scenario annotations, AI indicators, and focus group findings. The integration of the framework into the augMENTOR solution (WP5) and its validation through cross-context use cases (WP6) will ensure that it remains responsive to real-world pedagogical needs, ultimately contributing to a robust, human-centered, and evidence-based model for AI-enhanced education.

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ANNEX I

Activity Analysis Model in a blended learning environment

This section briefly presents the analytical model proposed in this deliverable and applied to analyse the activity of students participating in a course mediated by an SEM. The model is presented in seven distinct stages, i.e. as proposed in the analysis of the research data.

Stage 1: Clarifying the purpose of the activity

The purpose of the first stage is to understand the context in which the activity under study takes place and to gain an in-depth understanding of the objectives and motivations of the activity. At this point it is important to record all the objectives and motivations of the participants and to separate the activities that may be carried out in parallel with the main activity. The separation of the activities surrounding the main activity is defined by the different objectives recorded in relation to them. Finally, it is necessary to examine the possible contradictions that arise both in the core activity and in the activities surrounding it.

Stage 2: Analysis of the activity system

The purpose of the second stage is to analyse the activity system. Understanding the subject or subjects involved is central to understanding the activity being studied. It is the participants in the activity who ultimately determine the goal of the activity. In this case, it appears that it is the learner who ultimately shapes the activity. The analysis of this particular stage is driven by the contrasts that arise from how the different subjects of the activity perceive their role in relation to their goals in the system of the activity.

Stage 3: Analysis of the structure of the activity

The analysis of the structure of the activity is an important process for understanding it. Activities consist of separate but interdependent actions and these actions are divided into a series of smaller actions. The levels from the activity structure are linked to the corresponding levels of the subjects' goals and motivation. The activity level has been linked to the motivation of the participants (intentional level). The action level has been linked to the functional level of planning and problem solving (functional level) to complete the activities. Actions are the automated behaviors that participants perform in the activity to complete conscious actions. It is crucial to analyze these two levels and must be done at repeated time points because as time passes some actions turn into functions. Also, the analysis of both the actions and the activities that take place should take into account the different contexts in which the actions are also implemented, so that all the individual contexts and the purposes of the actions analysed can be understood socially (e.g. three different contexts of use). The purpose of this stage is to describe the functions of actions and activities needed to comprehensively describe the problem manipulation space (Jonassen & Murphy, 1999) and to answer the question of how users can manipulate an object simulated on the platform.

Step 4: Analysis of tools and mediation instruments

The elements of the activity: **subject**, **object** and **community** do not interact with each other directly in the activity system. Their interactions are mediated by symbols and tools. Therefore, the analysis of these mediators and the analysis of their evolution can provide important information about the activity system. The most common form of activity mediation is considered, according to Leontiev (1974), to be the use of tools. These tools seem to separate cognitive processes and instrumental properties between the tool itself and the user (Nardi & Miller, 1991). The most common form of tool is computational tools. Computers in general can have the potential to qualitatively change the object of the activity by automating a number of functions. This results in the subjects of the activity giving more weight to the actions and the activity since the functions are automated (Leontiev, 1974). The purpose of the fourth stage is to understand and describe the tools of the activity that act as mediators and influence the patterns and rules of the activity and shape the problem manipulation space (Jonassen & Murphy, 1999).

Step 5: Analysis of the context of the activity

The purpose of the fifth stage is to fully describe the context in which the activity(ies) takes place. A basic principle of Activity Theory, like all socio-cultural theories, is the study of the historical and cultural context in which learning takes place. It is not possible to understand exactly what happens and how subjects learn unless a full description of the context of the activity is made and the relationships and dependent components of the subjects' context to the way they learn are identified. The subjects' previous experience during their studies as well as the use or not of similar tools are some of the elements that will help in understanding the activity being studied.

Stage 6: Internalisation - externalisation

The purpose of this stage is to record changes in the activity's actions and possible transformations of the activity over time . The activity of learning subjects according to Activity Theory is a living organism that is constantly evolving and changing over time. As subjects become familiar, for example, with the tools that mediate the activity, the ways in which they use them change, with a direct result in changing subjects' goals, which may become more demanding.

Step 7: Analysis of the history of the activity

The purpose of this stage is to record the historical phases of the activity and the changes observed over time in relation to the use of mediated technology and the views of the subjects involved in the activity. It is the recording of the historical phases that will lead to the recording and understanding of the changes recorded in the activity. These changes may come either from changes in the actions of the subjects or from the contradictions identified in the activity being studied. In either case, they are the ones that lead to a complete understanding and description of the activity being studied over time.

Version 1: For Pedagogical Experts – Evaluating the Full augMENTOR Framework (PeDeMET & TESA)

Purpose: To guide expert reviewers in validating the pedagogical soundness, internal consistency, and CHAT-aligned design of both the macro (PeDeMET) and micro (TESA) components of the augMENTOR framework.

A. Understanding the Object and Purpose

1. What are the core pedagogical goals addressed in the PeDeMET and TESA frameworks?
2. How clearly are the learning objectives articulated in connection to digital and emerging technologies?
3. Do the proposed frameworks align with the development of both knowledge and transversal skills (e.g. 4Cs, 21st-century competencies)?

B. Subject Analysis – Actors and Roles

4. How well are the roles of learners and educators specified across macro (PeDeMET) and micro (TESA) levels?
5. Does the framework consider learners' prior knowledge, needs, and representations in the instructional design?
6. Are the educators' actions within the scenarios supported by adequate guidance and role clarity?

C. Mediation – Tools and Technological Integration

7. How are the technological tools (AI, LMS, ET) used to mediate pedagogical activity?
8. Are the tools pedagogically justified and embedded meaningfully in both scenario design and implementation?
9. Does the framework distinguish between tools as cognitive tools versus delivery instruments?

D. Rules and Ethical Considerations

10. Are the pedagogical rules, social norms, and constraints clearly identified in the scenario design?

11. How is inclusivity, accessibility, and responsible technology use integrated into the framework?

E. Community and Collaboration

12. How does the framework support the formation of a learning community (teacher-learner, peer-peer)?
13. Are collaborative learning principles and strategies adequately represented and supported by technology?

Division of Labour and Teaching Strategies

14. Are the roles and responsibilities of each participant (learner, educator, facilitator) clearly defined?
15. Does the PeDeMET propose an effective balance between teacher guidance and learner autonomy?

Assessment and Outcomes

16. How does the framework evaluate both cognitive and non-cognitive outcomes (e.g., rubrics, logs, artefacts)?
17. Are there mechanisms to assess the added value of technology and the scenario implementation itself?

Contradictions and Iterative Improvement

18. Are possible contradictions (e.g., between learning objectives and technology use) identified and addressed?
19. Does the framework support revision and improvement cycles based on reflection and data?

Version 2: For Tutors – Evaluating the TESA Framework (Classroom Level Only)

Purpose: To collect tutor feedback on the applicability, clarity, and effectiveness of the TESA model as implemented in real classroom scenarios.

A. Goals and Relevance

1. Were the objectives of the educational scenario clear and achievable for your class context?
2. Did the activities help learners achieve the intended learning outcomes (subject knowledge and transversal skills)?

Learner-Centred Design

3. Did the scenario take into account learners' prior knowledge and cognitive difficulties?
4. Were learners actively engaged and motivated by the activities and digital tools used?

Use of Technology

5. Were the technological tools (e.g., LMS, AI tools, apps) easy to integrate into your teaching practice?
6. Did these tools enhance student learning or collaboration? In what ways?

Teaching Strategies and Flow

7. Were the scenario phases (preparation, teaching, consolidation, assessment, metacognition) clear and practical?
8. Did the teaching strategies (problem-solving, inquiry, collaboration) work well in your class?

Collaboration and Classroom Dynamics

9. Did the scenario foster collaboration among learners or between you and your students?
10. Was the scenario flexible enough to adapt to the specific needs or conditions of your class?

Assessment and Reflection

11. Did the scenario include useful tools or methods for assessing student progress?
12. How did the evaluation phase help you understand student learning or improve your teaching?

Improvement and Feedback

13. What worked well and what would you change in the scenario?
14. Would you feel confident reusing or adapting the TESA model for future lessons?

ANNEX II

I. Content Analysis: Thematic Categorization

1. Theoretical and Conceptual Grounding

Codes: TPACK, Activity Theory, signature pedagogies, adult learning, theoretical synthesis

Contributors: Tsiotakis, Xatzigianni, Voulgari, Papanikolaou

Key Points:

- The framework effectively synthesizes multiple theories (TPACK, Activity Theory, Pedagogical Triangle).
- PeDeMET is praised for aligning with adult learning principles and higher education pedagogy.
- There's a call to explore **Engeström's expanded Activity Theory** and its dialectic dimensions.

2. Applicability and Adaptability

Codes: Educational contexts, higher education, adult learning, digital competence, contextualization

Contributors: Tsiotakis, Xatzigianni, Papanikolaou

Key Points:

- The framework is considered promising for university teaching, lifelong learning, and distance postgraduate programs.
- Some concerns arise about the practical implementation across diverse contexts, especially where digital literacy varies.
- Adaptation strategies (e.g., teacher training, sharing practices) are recommended.

3. Scenario Design and Implementation (TESA)

Codes: Scenario-based learning, TESA, 21st-century skills, micro-level design

Contributors: Voulgari, Athanasopoulos, Papanikolaou

Key Points:

- TESA is viewed as a strong methodology for activity design, especially when aligned with 4Cs.
- Visual representations and practical guides (e.g., one-page summary, targeted questions) are encouraged for usability.

4. Learner-Centered Pedagogy

Codes: Learner agency, participatory design, reflective practice, prior knowledge

Contributors: Tsiotakis, Voulgari

Key Points:

- The model's potential to support active participation and critical reflection is highlighted, especially for adult learners.
- Suggestion to embed transformative learning and opportunities for learners to co-design.

5. AI Integration and Evaluation

Codes: AI in design and assessment, personalization, learning analytics, adaptive feedback

Contributors: Athanasopoulos

Key Points:

- Strong suggestion to embed AI tools not only in design but also for formative and summative assessment.
- AI can enhance feedback mechanisms, monitor engagement, and support personalized learning.

6. Visual and Structural Clarity

Codes: Diagram clarity, usability, practical tools, scaffolding

Contributors: Xatzigianni, Voulgari

Key Points:

- The PeDeMET and TPACK diagrams are informative but need visual improvements and clarification of key relations.
- Suggestions include integrating community/network aspects, examples in diagrams, and a stronger affective component.

II. Summary Conclusions

1. Validation of Theoretical Soundness: Experts widely agree that the augMENTOR framework presents a robust synthesis of pedagogical theories and models, with PeDeMET and TESA offering a structured approach to instructional design with emerging technologies.
2. Need for Contextual Adaptation: While the framework is well-received conceptually, its applicability varies depending on institutional readiness, educator experience, and digital infrastructure. Training and scaffolding will be essential.
3. Recommendations for Improvement:
    - Strengthen learner agency and transformative processes, especially in adult and non-formal learning.
    - Improve visual communication of theoretical models (e.g., adding community in Activity Theory diagrams).
    - Provide practical guides and example-based representations.
    - Incorporate AI meaningfully in both design and evaluation stages.

4. Path Forward for Empirical Validation: Experts emphasize the need for empirical studies to validate the framework, using both quantitative (progress, engagement) and qualitative (perceptions, reflections) data under the lens of Activity Theory.

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ANNEX III

Definition of the Delphi Method

The Delphi Method is a structured communication technique used primarily for systematic forecasting and group consensus building among a panel of experts. It involves multiple rounds of questionnaires sent anonymously to experts, with aggregated feedback provided between rounds. Experts revise their answers in subsequent rounds, allowing for convergence toward a shared agreement or a reliable estimate. The process minimizes the influence of dominant individuals and promotes thoughtful, evidence-based input.

Key characteristics include:

- Iterative process with controlled feedback.
- Anonymity to prevent peer pressure.
- Expert-based responses to complex issues.
- Use in situations with incomplete knowledge or emerging fields.

It is widely used in educational research, technology forecasting, and policy development when empirical data is scarce or when expert opinion is essential for model validation and refinement.

Mapping the Delphi Method to Deliverable D3.2

Deliverable D3.2 in the augMENTOR project focuses on the evaluation and refinement of the Pedagogical Framework (PF) using evidence from pilots and expert feedback. Integrating the Delphi Method is highly aligned with our dual-layer validation approach, where internal (pilot-based) and external (expert-driven) evaluations are used to refine the framework.

Delphi Method Element	D3.2 Implementation in augMENTOR
Panel of experts	External reviewers and consortium pedagogical experts involved in WP3, WP4, WP5, and WP6.
Iterative rounds	Two iterative implementation cycles, with expert input after each to refine the PF.
Controlled feedback	Structured thematic summaries, feedback loops, and synthesis of reflective protocols (e.g., tutor reflections, focus group insights).
Anonymity (optional)	While not anonymous, feedback is systematically synthesized to ensure balanced representation without dominance.

Consensus building	Convergence of expert feedback on pedagogical dimensions, technological integration, and applicability across learning contexts.
Forecasting/refinement	Used to refine PeDeMET and TESA components to ensure generalizability, scalability, and theoretical consistency.