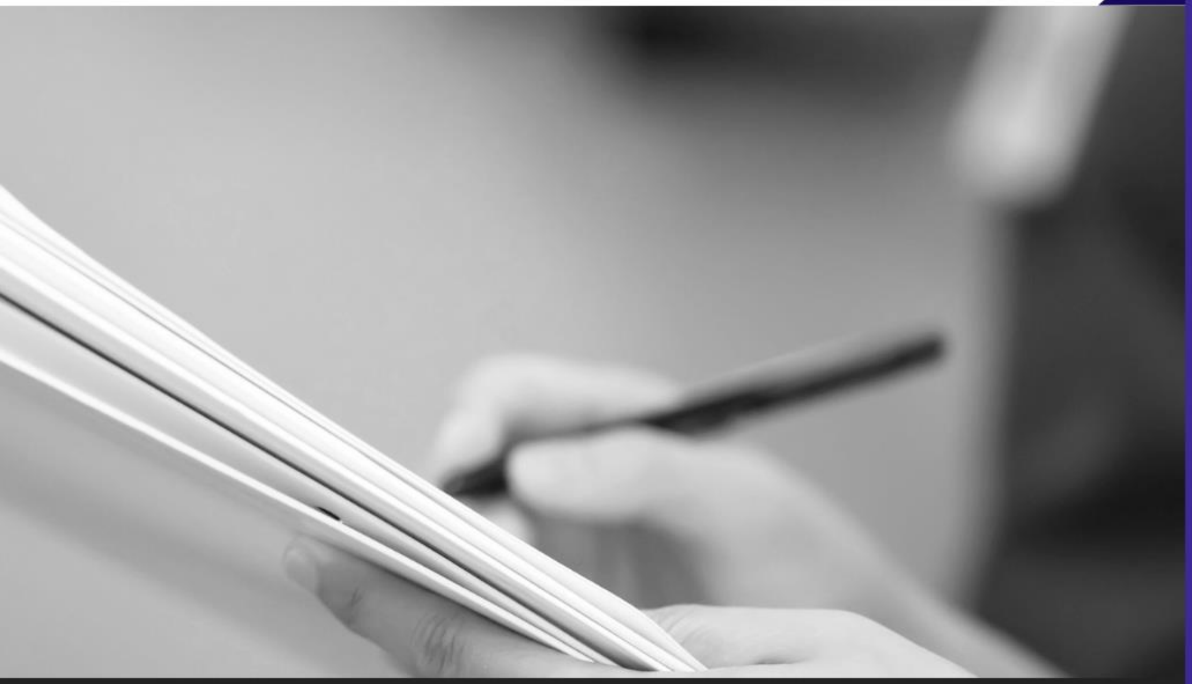

WORK PACKAGE 02

EVALUATION REPORT OF TRAINING INTERVENTIONS

DELIVERABLE D2.2

Work Package 2

Design of effective Teacher Training Interventions for PDC

Deliverable D2.2

Evaluation report of training interventions

Delivery date: 31.04.2026

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Executive summary

Across the EffecTive project as a whole, the consortium developed and implemented more than **30 pilot and intervention training cases** involving approximately **1000 teachers** across partner institutions. This broader implementation effort provided a substantial basis for refining, enacting, and comparing different designs to teacher professional development in the area of pedagogical digital competence. While the wider project learning is informed by both pilot and intervention phases, the present **deliverable focuses specifically on the intervention phase and reports the cross-case synthesis of participants' immediate reactions** (Kirkpatrick Level 1) in the intervention studies. In this sense, the deliverable contributes to an understanding of how the trainings were experienced, but also provides a comparative account of how the project's shared design principles were enacted across diverse educational contexts.

Focussing on the perceived effectiveness of the training interventions, the findings show that the **interventions were evaluated positively across partner contexts**, with generally high levels of satisfaction and perceived training quality. Across cases, participants largely regarded the trainings as **relevant and useful**, despite substantial variation in target groups, formats, and instructional configurations. At the same time, the cross-case analysis also shows that overall satisfaction was a relatively weak discriminator between training designs. Differences between training methods were generally limited and not sufficiently consistent to support the conclusion that one single instructional approach can be identified as universally superior on the basis of participants' immediate reactions alone. Instead, the findings suggest that positive participant experiences can be achieved through a variety of training designs, provided that the training is experienced as meaningful, manageable, and sufficiently connected to teachers' own practice.

More informative differences became visible when examining practical relevance, clarity, and cognitive demands. Across the cases, **cognitive load emerged as the most sensitive dimension** for distinguishing between perceived effectiveness of different training designs, particularly in terms of extraneous load. This indicates that the key issue was often not complexity per se, but whether the complexity of a training design was experienced as productive and meaningful or as an avoidable burden. More complex configurations, especially those combining multiple components or requiring substantial implementation effort, could increase coordination demands and perceived difficulty without necessarily leading to higher levels of deeper cognitive engagement.

The cross-case synthesis further suggests that the most useful unit of analysis is not the isolated training method, but the instructional configuration as a whole. The EffecTive cases do not point to a single "best method" such as Knowledge Instruction, Collaborative Design, or Situated Learning in isolation. Instead it was learnt that the same **instructional principle can function differently** depending on how it is sequenced, combined, scaffolded, and aligned with the local context. In several cases, collaborative design supported clarity and reduced unnecessary cognitive burden, especially when it helped participants jointly interpret concepts or co-construct solutions. Situated and practice-based elements often increased perceived relevance, particularly when teachers could clearly see how the training connected to their own classrooms, but they also introduced additional complexity when expectations for implementation were too demanding or insufficiently scaffolded. Taken together, the findings suggest that teacher professional development should be designed and evaluated as coherent configurations rather than as collections of separate methods.

Beyond the evaluation of reactions, the deliverable also provides a cross-case view of **how pedagogical digital competence were operationalised** across the interventions and thereby presents a wealth of good practices directly applicable in teacher professional development. Across the EffecTive cases, digital competence was treated as a broader professional competence involving pedagogically meaningful, context-sensitive decisions about technology use in teaching. This was reflected in training activities that went beyond introducing digital tools and instead focused on analysing classroom situations, designing or adapting tasks and lesson plans, reflecting on the pedagogical affordances of digital tools, and connecting technology use to student learning processes. DigCompEdu served as an important recurring reference point for framing the professional dimensions of teachers' digital competence, while frameworks such as Self-regulated Learning, ICAP, and TPACK helped translate these dimensions into pedagogically meaningful training activities.

An important pattern was visible in how the **interventions aimed to support teachers in fostering students' self-regulated learning (SRL)**, one of the key skills of successfully navigating technology-enhanced environments for students. Although SRL was not always addressed as an explicit topic in all cases, it was frequently embedded through pedagogical tasks and reflection activities that encouraged teachers to consider how students plan, monitor, regulate, and reflect on their learning in technology-enhanced environments. Across cases, this included examining whether tasks promoted active or constructive engagement, designing activities that required greater student responsibility, reflecting on how digital tools could scaffold feedback or reflection, and considering how classroom practices could better support cognitive engagement and learner agency. Importantly, in several cases the ICAP framework was not only introduced as a conceptual model, but also modelled through the training design itself: teacher learning was structured in ways that moved beyond passive reception towards more active, constructive, and collaborative forms of engagement. In this sense, the project suggests that support for SRL was often enacted not simply by "teaching SRL as theory," but by helping teachers translate SRL-related principles into task design, classroom orchestration, and instructional decision-making.

A central insight of the cross-case analysis is that participants' experience of training was shaped by **motivational appraisals** and contextual fit, which emerged as some of the most consistent predictors of satisfaction and perceived quality in the case-level analyses. This suggests that the practical value teachers perceive in professional development should be understood as an early indicator of whether professional learning is likely to be taken up and carried into practice. In other words, the "benefit" side of teacher training begins not only with later learning outcomes, but already with whether teachers experience the training as relevant, useful, and feasible to apply in their own work. The project also generated findings on several **contextual conditions** which were found not to be secondary implementation issues, but integral to training quality itself. Differences between pre-service, in-service, and whole-school contexts mattered in meaningful ways. Pre-service teachers generally benefited from stronger structure and clearer scaffolding, while in-service teachers often valued close links to their own classroom practice but were also more constrained by time, implementation demands, and competing responsibilities. Whole-school formats could create advantages through shared institutional context and collaboration, but they also required stronger organisational support and had to address challenges such as subject diversity, varying motivation, and uneven participation. Across contexts, it became clear that the same design principle could be experienced as highly valuable in one setting and overly demanding in another. This reinforces the conclusion that effective professional development depends not only on instructional quality in the abstract, but on the fit between design, target group, domain, and institutional conditions.

From this perspective, one of the most important lessons of the EffecTive project is that **more complex or more situated professional development is not automatically better**. Richer combinations of instructional approaches can certainly increase authenticity and potential relevance, but they also increase demands on teachers' time, attention and implementation capacity. The project therefore suggests that an important scarce resource in teacher professional development, besides financial resources spent on training, is teachers' cognitive, temporal and organisational capacity to absorb, interpret and enact new practices. This is particularly important for future scaling discussions: designs that appear strong in principle may still fail in practice if they create too much avoidable burden or rely on contextual conditions that are not realistically available in many institutions.

For this reason, the deliverable D2.2 also offers an important empirical basis for later cost-benefit discussions, The cross-case evidence helps identify feasibility-value trade-offs across different training configurations: some designs appear to generate strong perceived value and meaningful engagement under relatively manageable conditions, while others require greater organisational support, coordination, scaffolding, or time investment to remain effective. This is important because cost-benefit considerations in teacher professional development should not be reduced to financial expenditure alone. They also need to account for whether the design creates enough value for teachers to invest in it, and whether the demands placed on participants and institutions are proportionate to the expected educational benefit. In this sense, the deliverable helps clarify what participants valued and which forms of professional development may be more feasible and scalable under real-world conditions.

As a conclusion, the EffecTive lesson from WP2 perspective is: there is **no single better method for developing teachers' pedagogical digital competence**, but there are identifiable design mechanisms that make different configurations more or less valuable, feasible, and sustainable across contexts. Across the cases, the most meaningful patterns emerged when conceptual input was connected to authentic teaching situations, when teachers were asked to analyse and redesign practice, when collaborative elements supported shared interpretation and sense-making, and when classroom transfer was treated as an explicit design condition rather than a post-hoc expectation.

For policy makers, teacher education institutions, and professional development providers, the main implication is therefore that the future of teacher professional development in digital competence lies in the design of modular, context-sensitive, and pedagogically coherent training configurations that can be adapted to different target groups and institutional realities while preserving the core principles that generate value and feasible uptake. This is particularly relevant for teacher education universities, where digital competence should be embedded not as an isolated technical add-on, but as a core dimension of professional judgement, instructional design, and support for student learning. These insights provide an important empirical foundation for the next stages of the project, including the analysis of **training outcomes and transfer in the intervention studies** (D3.2), the cross-case **meta-analysis** and **cost-efficiency** analysis (D4.3), the development of the project's **cost-benefit framework** (D4.4), and the formulation of more refined **policy recommendations** (D5.4) for teacher professional development in technology-enhanced learning environments.

1. Introduction

This deliverable has a dual purpose. First, it **documents how the teacher training interventions** developed within the EffecTive project **were implemented across partner contexts,** showing how the common design principles and training methods defined in earlier project work (D2.1) were translated into concrete training cases in diverse educational settings (Seufert et al., 2024). Second, it **evaluates how these interventions were experienced by participants**, with a specific focus on Kirkpatrick Level 1 (participants' reactions). In this sense, the report is not only an evaluation of training, but also a cross-case account of how the project's professional development approach was enacted in practice.

This dual focus is particularly important in the context of the EffecTive project. The project aimed to develop and test multiple training configurations based on shared theoretical and design principles across different contexts, including pre-service and in-service settings. As a result, understanding the project's contribution requires attention to how the training was designed, adapted, and experienced under real implementation conditions. Training that is **theoretically well grounded may still vary considerably in feasibility, clarity, or relevance** depending on how it is enacted in a specific context. For this reason, participants' immediate reactions provide an important lens for understanding both the quality of the implementation and the practical viability of different training designs.

Building on this logic, the **report examines how the interventions were experienced across partner implementations in terms of satisfaction, perceived training quality, and cognitive load**, while also analysing how these experiences varied across instructional configurations, target groups, and implementation contexts. The deliverable aims to clarify how different design principles and instructional components functioned in practice, what kinds of participant experiences they supported, and under what conditions they appeared more or less manageable and meaningful.

This deliverable builds directly on the conceptual and empirical foundations established in earlier project outputs. In particular, Deliverables D1.1 (Zabolotna et al., 2024), D1.2 (Wagner et al., 2024a), and D4.1 (Wagner et al, 2024b) define the project's foundational framework, training methods, and key practices for professional development in digital competence, while D2.1 documents the intended design of the training interventions and their implementation plans across partner contexts. The present report complements these earlier deliverables by showing how those principles and designs were realised in practice, and by providing the first systematic cross-case synthesis of participants' experiences across the implemented cases.

The contribution of this deliverable is therefore twofold. It provides, on the one hand, a comparative account of how the EffecTive training approach was operationalised across diverse settings, and, on the other hand, a structured evidence base for interpreting differences in participant reactions in terms of clarity, relevance, and manageability, including the role of cognitive load as an important explanatory mechanism. These insights form an essential foundation for subsequent analyses within the project, particularly the interpretation of learning outcomes and transfer (D3.2), the development of the project's cost-benefit framework, and the formulation of policy-relevant lessons for the design and scaling of teacher professional development in technology-enhanced learning environments

2. From Analysis and Design to Training Development in EffecTive

The design of teacher training interventions in EffecTive follows a structured and theory-informed planning approach. As described in Deliverable D2.1, the project adopts the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) as an overarching framework (Branson et al., 1975) to guide the systematic development of training interventions across partner institutions and national contexts. To further strengthen the conceptual foundation of the planning process, the **Analysis** and **Design** phases are extended through Seufert's Comprehensive Instructional Design model (Seufert, 2002), which differentiates key planning dimensions and links them explicitly to instructional design decisions (see Figure 1). In this enhanced model, the **Analysis** phase defines the foundations of each intervention by clarifying training goals, content, target groups and framework conditions. The **Design** phase translates these analytical decisions into concrete instructional strategies, training methods and activity sequences. The resulting design blueprints serve as the basis for the **Development** of training materials and for the **Implementation** of the interventions in real teacher education contexts. The Evaluation phase provides systematic feedback on training quality and learning outcomes.

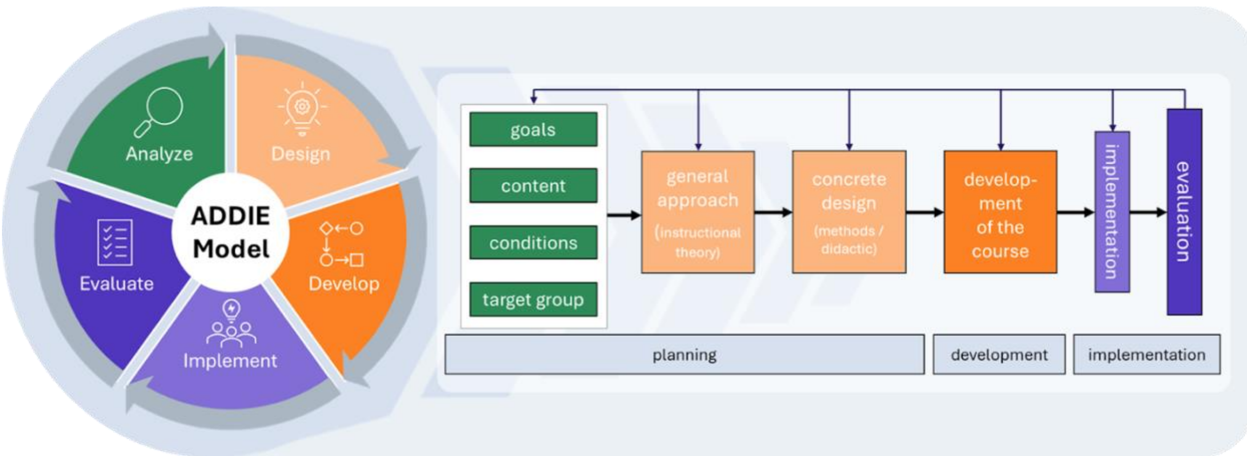


Figure 1: Integrating ADDIE with Comprehensive Instructional Design: A Framework for Teacher Training Development in EffecTive

The purpose of this chapter is to briefly recapitulate the essential elements of the Analysis and Design phases that underpin the Development and Implementation of the training interventions presented in Chapter 3. A detailed account of the theoretical and methodological foundations is provided in Deliverables D1.2 and D2.1. Therefore, this section focuses on the aspects that are necessary to understand how theoretical frameworks and design principles were translated into concrete training formats in the present deliverable. The following subchapters follow the steps of the ADDIE model: Analysis (2.1), Design (2.2), Development and Implementation (2.3) and finally Evaluation (2.4).

2.1 Analysis

In EffecTive, the Analysis phase is organised along four interrelated dimensions: the training goals as learning objectives, the training content, the target group and framework conditions that shape the design of the trainings. This structure is used as a shared analytical checklist across partner institutions and provides the basis for transparent documentation of planning decisions. This planning logic is particularly relevant in EffecTive, where training interventions are implemented across diverse educational systems. It ensures theoretical coherence, transparency of planning decisions and comparability of interventions, while still allowing necessary contextual adaptation.

2.1.1 Training Goals

Training goals are derived from the project's overarching objective to strengthen teachers' Pedagogical Digital Competence (PDC) for technology-enhanced teaching and learning. PDC in EffecTive is understood as a combination of teachers' technological, pedagogical and content-related knowledge (TPACK), their affective-motivational dispositions towards technology integration, and their situation-specific skills of perception, interpretation and decision-making (PID model) (Blömeke et al., 2015; Mishra & Koehler, 2006; Skantz-Åberg, et al., 2022).

Expected benefits of the training are structured along Kirkpatrick's evaluation framework (1998). The present deliverable (D2.2) focuses exclusively on Kirkpatrick Level 1, that is, participants' reactions to the training. This includes indicators such as satisfaction, perceived quality, perceived relevance and usefulness as well as the perceived cognitive load of the training activities. The load perspective is particularly relevant in EffecTive as it reflects on the cost-side of the training.

Learning outcomes in terms of knowledge and attitude development (Kirkpatrick Level 2) and higher-level outcomes related to changes in teaching practice and student learning are addressed in subsequent work packages and reported separately in Deliverable D3.2. This explicit differentiation ensures that D2.2 provides a clear and focused account of training quality from the participants' perspective, forming an essential basis for later analyses of learning effects and cost-benefit relations.

2.1.2 Training Content

Training content is derived from the theoretical and competence frameworks established in D1.2 and D2.1. Across partner interventions, content selection is guided by the aim to foster integrated professional competence for technology-enhanced instruction. Core content domains include:

- **Pedagogical Digital Competence (PDC**) as the overarching competence target with **TPACK** as a framework for integrating technological, pedagogical and content knowledge in teaching practice. Overall, we refer to **Digital competence frameworks (e.g., DigCompEdu; Redecker, 2017)** to align training objectives with established competence dimensions for educators.
- **Self-Regulated Learning (SRL)** as both a content focus and a pedagogical principle to support learner autonomy and equity in technology-enhanced classrooms (Zimmermann, 2000).
- **Cognitive engagement, structured through the ICAP framework** (Chi & Wylie, 2014), to guide the design of learning activities from passive reception towards active, constructive and interactive engagement.
- **Equity and inclusion** as two major goals in education and the role that technology-enhanced teaching and learning can play to reach these goals.

These theoretical constructs inform concrete training topics and practical activities, e.g. participants do not only learn how to teach digitally but also experience how these digital teaching approaches feel from the perspective of a learner.

2.1.3 Target Group

Training interventions in EffecTive address diverse teacher populations, including pre-service teachers, in-service teachers and, in some cases, teacher educators or trainers. The target group analysis considers participants' professional background, prior experience with digital technologies, subject domains and institutional roles.

This analysis informs decisions on:

- the selection of tools and examples,
- the pacing and complexity of activities,
- the balance between individual and collaborative work, and
- the degree of guidance and scaffolding provided
- the profile of the trainer (e.g. in-house peer or external experts etc.)

By explicitly documenting target group characteristics, the project ensures that training interventions remain relevant and feasible in local contexts while preserving alignment with shared training goals and content domains.

2.1.4 Framework conditions

The planning of training interventions is further shaped by contextual framework conditions. These include available time resources, institutional regulations, technical infrastructure and organisational constraints. In the Analysis phase, partners specify:

- training duration,
- delivery mode (face-to-face, online, blended or hybrid),
- interaction mode (synchronous or asynchronous),
- group size and collaboration formats.

Documenting these parameters is essential for interpreting implementation choices and for understanding differences across partner training cases. It also provides a foundation for later analyses of feasibility and scalability.

2.2 Design

Building on the Analysis phase, the Design phase translates training goals, content and contextual parameters into concrete instructional strategies for the intended target group. In EffecTive, design decisions are guided by pedagogical principles for teacher learning and by a shared typology of training methods.

2.2.1 Pedagogical design principles

EffecTive training design integrates evidence-based principles for effective teacher learning. **SRL** is addressed both as a competence goal and as a learning method in terms of a pedagogical double-decker: learners not only learn about the concept like SRL but also experience and apply it throughout the learning process. This is operationalised, for example, by supporting participants in setting learning goals, monitoring their progress and reflecting on their learning experiences. In addition, the ICAP framework is used as a design heuristic for structuring **cognitive engagement** in training activities. This ensures that interventions do not rely solely on passive knowledge transmission but combine guided input with active processing, constructive problem-solving and interactive collaboration. Finally, DigCompEdu informs the design of the training based on the **dimensions of the digital competence model**, making sure that teachers' courses fostered the development of teachers' PDC.

These pedagogical principles are aligned with the project's PDC framework, emphasising that teachers should experience the kinds of learning environments they are later expected to design and apply for their own students in technology-enhanced classrooms.

2.2.2 Co-Design

In addition to pedagogical design principles, the training interventions in EffecTive were developed using a **co-design approach**. This means that EffecTive researchers and trainers collaborated closely in the planning and design of the training formats. In some cases, the EffecTive researchers planned and delivered the trainings themselves (TLU, UULM, TAU). But in many cases, training implementation was carried out by external teacher training institutions, making this collaborative design process essential for aligning theoretical concepts with practical training contexts.

The co-design process involved iterative exchanges between project partners and trainers, in which training goals, content and instructional strategies were jointly developed and refined. Particular attention was given to aligning the interventions with the EffecTive training methods and their associated key practices. This ensured that the theoretical framework of the project, such as PDC, ICAP and SRL, was consistently translated into concrete training activities.

At the same time, co-design allowed for contextual adaptation. Trainers contributed their expertise regarding institutional requirements, target group characteristics and practical constraints, while researchers ensured alignment with the project's conceptual and methodological foundations. This collaboration resulted in training designs that were both theoretically grounded and practically feasible.

Overall, the co-design approach played a central role in bridging theory and practice and contributed to the comparability and quality of the implemented training interventions.

2.2.3 EffecTive Training methods

To ensure comparability across partner cases, EffecTive defines four training methods that serve as shared reference categories for describing and classifying interventions. During the pilot phase, it became evident that partners held partly different understandings of these training methods. Therefore, a shared clarification process was initiated to align interpretations and establish common design principles and key practices.

Since the training methods were implemented differently across partner cases, it was necessary to harmonise how they were described and applied. This ensured that the cases could be compared meaningfully. As a result, the descriptions of the training methods were further refined and operationalised.

The table below presents the key practices that are particularly characteristic of each training method.

Table 1: characteristic key practices for the 4 EffecTive training methods

Knowledge Instruction	Collaborative Design	Situated Learning	Mentoring and Coaching
Instruction **Hands on Learning** Work sample analysis Practice lesson planning	**Shared Understanding** Activating background knowledge Analysing case studies and examples **Joint session Design** Implementation planning	Goal Setting Action planning Practice lesson planning **Rehearsal/field experience (=implementation)** **Reflection/Self-evaluation** Practical Social Support	Modelling **Observation** Practice lesson planning **Continuous individualised feedback**

Knowledge instruction

Knowledge instruction focuses on structured input and guided processing of key concepts related to PDC, and SRL in an either direct or indirect way. It provides a theoretical and conceptual foundation and typically includes presentations, guided analysis tasks and initial lesson-planning activities.

Knowledge Instruction as a method within an Effective project is a structured pedagogical approach in which a trainer purposefully delivers specific knowledge and skills through instructional design. Learners actively engage with the content through discussion, questioning, and the drawing upon prior knowledge and experience, supporting comprehension. The method is designed as a basis to hands-on practice, establishing the knowledge foundation upon which practical application can later be built.

In the following table we define the key practice for knowledge instruction interventions, how these key practices are defined and how the partners applied those key practices in their trainings.

Table 2: key practices of Knowledge Instruction

Key practices	**Definition**	**Implementation examples of EffecTive partners**
Instruction	Teachers learn through the provision of directive advice on how to implement teaching methods.	**TAU**: directive advice and theoretical lectures on how to implement teaching methods **UULM**: Chapter-by-chapter thematic introduction in the form of video or scientific papers

		UAU: explicit conceptual/theoretical instruction on the ICAP model and TEL model (visual theoretical slides)
Hands-on learning	Teachers learn through a process of experiences that holistically allow them to interact with their environment (e.g. technologies) to create knowledge.	**TLU**: participants applied their knowledge by designing or adjusting digital tasks or materials **TAU**: learning through practical interaction with technologies (GenAI), e.g. for lesson planning **UWK**: direct experimental interaction with materials - Hands-on learning is part of the follow-up face-to-face training. Teachers receive a digi.case with all teaching materials and try them out **UULM**: active engagement with tools - completing a quiz or forum post
Work sample analysis	Teachers critique or review practitioner-created materials (e.g. lesson plans) or enacted lessons (e.g. via video analysis) that involve technology-integrated lessons.	**TAU**: reviewing practitioner-created materials or technology-integrated lessons - Work sample analysis to explore theoretical concepts through the use of educational technology **OULU**: reflective analysis of real teaching practice presented e.g. via video
Practice lesson planning	Teachers plan a simulated technology-integrated lesson individually.	**TLU**: teachers were asked to design lesson plans, tasks, materials **OULU**: teachers plan simulated technology-integrated lessons individually or during training **UWK**: teachers plan one lesson using materials from the digi.case

Collaborative design

Collaborative design engages participants in jointly creating instructional artefacts, such as technology-enhanced lesson plans or learning activities. Through iterative design sessions, participants share perspectives, negotiate solutions and co-construct practical outputs, from task descriptions to comprehensive plans of whole lessons for their individual teaching contexts. In courses following this method the designed lesson plans do not need to be implemented either.

Table 3: key practices of Collaborative Design

Key practices	Definition	Implementation examples of EffecTive partners
Shared understanding	Teachers work together to reach a common understanding about the design goals, target group, and role of learning technologies to ensure that everyone is aligned on what needs to be designed.	**TLU**: explicit alignment process, early in the planning phase - agreements on the topic, learning goals, and content with the participants **OULU**: creating a shared view on goals and purpose of the design - goal is to create

		practical, adaptable lesson ideas that can be used in real classrooms **TAU:** explicit alignment on learning goals, target group, and the pedagogical role of digital technologies, with collaborative discussion of pedagogical and ethical considerations in lesson design
Activating background knowledge	Teachers have a solid understanding of the subject matter or instructional content they are designing for as a basis of the shared knowledge construction process	**TLU**: direct activation of prior knowledge - selection of topic and learning goals based on participants' existing knowledge and teaching experience **OULU**: use existing teaching experience - reflect on their current practices, identify what worked or not **UWK**: connecting design or prior classroom knowledge - forum posts about classroom activities related to computational thinking **TAU:** activation of teachers' prior experiences with technology integration and student autonomy, with reflection on previous attempts to support SRL as a basis for collaborative lesson design
Analysing case studies and examples	Teachers analyse case studies or examples of successful technology-integrated lessons and instructional designs to understand effective practices and innovative strategies, while providing inspiration for their own collaborative design efforts.	**TLU**: explicit example-based design progression - worked examples → full lesson design → adaptation based on feedback **TAU**: case-based reflective analysis - group reflection on implemented lessons ("what worked, what didn't")
Joint session design	Teachers collaboratively plan and develop technology-integrated lessons in groups.	**TLU**: collaborative design - participants collaboratively planned and designed a full learning trajectory; collaborative decision-making and development of learning materials **OULU**: collaborative design - teachers co-design lesson/course plans, ideally in teams from the same school **TAU:** collaborative design of technology-enhanced lesson plans, including joint pedagogical decision-making on tool integration, task structure, and scaffolding strategies **UWK:** collaboratively planning and developing lesson plans to support and ensure the quality of inclusive school development

Implementation planning	Teachers devise strategies for applying the designed materials in the classroom and receive guidance on adapting the designs to different classroom environments.	**TLU**: explicit implementation planning - course concluded with group presentation and assessment of the learning trajectory, including analysis of its potential classroom application **TAU:** joint planning of classroom implementation of digital tools, including structured anticipation of implementation challenges and ethical considerations

Situated learning

Situated learning connects training to authentic teaching practice, i.e. with this approach the implementation is crucial. Participants design, implement and reflect on technology-enhanced learning activities in their real classroom environments. This method strengthens the transfer of theoretical knowledge and skills into context-specific instructional practice. To provide a strong theoretical background knowledge this training method is most often combined with Knowledge Instruction.Table 4 key practices of Situated Learning

Key practices	**Definition**	**Implementation examples of EffecTive partners**
Goal setting	Teachers set specific goals for the improvement of their technology integration practices. These goals should focus on students' needs, particularly when making decisions related to classroom implementation.	**UULM**: structured goals - learning objectives have been formulated for each chapter **TLU**: implicit goal orientation - Explicit personal goal-setting was limited, but the training structure encouraged transfer through required implementation tasks and alignment with classroom needs
Action planning	Action planning involves specifying when and how a change in practice will be made in a concrete future lesson.	**OULU**: ongoing action planning - participants work on planning a concrete lesson, which they begin at the start of the course and develop throughout the course **TLU**: Iterative planning for implementation - participants developed full or partial lesson plans for their own teaching practice; adapted them based on feedback **UULM:** teachers plan how and when to implement their lesson plans in their classroom while reflecting on constraints or specific aspects of their teaching context
Practice lesson planning	Teachers plan technology-integrated lessons for their own context.	**TAU**: all participants created lesson plans applying SRL and GenAI knowledge **OULU**: lesson plan developed throughout course **UWK**: teachers plan a lesson using digi.case materials and open inclusive education resources (OIER)

		UULM: teachers plan a lesson in which the SRL phases are supported by means of digital tools
Rehearsal/field experience	Teachers actually implement technology-integrated lessons in their own context with actual students.	**TAU:** only in-service teachers implemented the GenAI chatbot in real classrooms with their students. **TLU:** clear direct classroom implementation - In PT1.5, pre-service teachers implemented their lesson with visiting kindergarten children **UULM:** teachers applied their planned lessons in their usual classroom with their students.
Reflection/self-evaluation	Teachers systematically reflect on and/or self-evaluate their technology integration practices.	**OULU**: teachers reflect on what works and what doesn't **TAU**: reflections included what worked, what didn't, and how to improve **TLU**: reflection with theoretical lenses and evaluating instructional decisions **UWK**: guided reflection seminar after lesson planning for digi.case and reflection on the implantation of OIER created in real classroom. **UULM**: regular reflection tasks, individually and task-related, on theoretical input as well as situated learning chapter
Practical social support	Practical social support involves arranging advice on how to implement a practice from a teacher's colleagues.	**TLU**: participants collaborated on design and analysis, shared peer feedback, and received guidance during case discussions **OULU**: Co-design in teacher teams from the same school → shared experience and peer support **TAU**: peer support structures - peer discussions following lesson implementation **UULM**: individual task feedback from teacher trainer including suggestions for improvements and/or additions as well as feedback from the other participants in a group discussion format

Mentoring and coaching

Mentoring and coaching is the most elaborate approach and provides personalised expert guidance through cycles of modelling, observation and feedback. This method supports differentiated professional development and helps participants refine their individual implementation of technology-enhanced teaching strategies.

Table 5: key practices of Mentoring and Coaching

Key practices	Definition	Implementation examples of EffecTive partners

Modelling	Modelling involves providing an observable example of the target teaching practice, which provides a visual guide for subsequent practice.	**TLU**: worked examples → full lesson design → adaptation based on feedback
Observation	Teachers can watch another teacher effectively integrate technology in the classroom.	**TLU**: indirectly - case discussions and collaborative design
Practice lesson planning	Teachers plan technology-integrated lessons for their own context.	**TLU**: development of full or partial lesson plans
Continuous, individualised feedback	Feedback is the provision of evaluative guidance based on prior observation of the focal practice. It works by identifying and then advising on areas for improvement.	**TLU**: participants collaborated on design and analysis, shared peer feedback, and received guidance from trainers during case discussions

Defining these method categories provides a shared vocabulary for describing the composition of training interventions and supports systematic comparison of implementation and evaluation results across partners.

2.3 Development and implementation

The outcome of the Analysis and Design phases guided the Development of concrete training materials, tasks and resources, and the Implementation of training interventions in partner institutions.

Chapter 3 presents the realised training cases and documents how the shared planning logic was translated into concrete training formats across diverse educational contexts. Subsequently, for each case evaluation results focusing on participants' reactions at Kirkpatrick Level 1 will be reported. The overarching results across partners will be discussed in chapter 4. An overall discussion of implications follows in chapter 5.

2.4. Evaluation

2.4.1 Evaluation logic and alignment with Kirkpatrick's model

The evaluation framework in EffecTive (see Deliverable 3.1; Ley et al., 2024) is structured in alignment with Kirkpatrick's model of training effectiveness (Kirkpatrick, 1998), which differentiates between participants' reactions to the training (Level 1), learning outcomes, in our case these outcomes are differentiated into knowledge skills and attitudes (Level 2), behavioural changes in classroom practice (Level 3) and longer-term results, in our case this would be effects on students' learning and equity (Level 4). This staged model (see Figure 2) provides a coherent structure for linking the design and implementation of training interventions to progressively more distal outcomes.

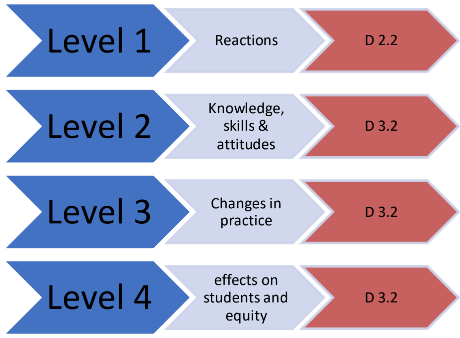


Figure 2: Evaluation Framework with different levels of outcomes based on Kirkpatrick (1998)

The present deliverable (D2.2) focuses exclusively on **Kirkpatrick Level 1**, that is, participants' reactions to the implemented training interventions. Learning outcomes in terms of knowledge and attitude development (Level 2) are analysed separately in Deliverable D3.2. This separation reflects the overall evaluation logic of the project, which distributes evaluation levels across work packages in order to ensure conceptual clarity and analytical depth. Within this broader framework, Level 1 fulfils three complementary functions:

First, it serves as a **quality assurance layer**. Participants' perceptions of satisfaction, clarity, structure and relevance provide an initial indication of whether the training meets basic standards of coherence and usability. While positive reactions do not guarantee learning gains, insufficient perceived quality or relevance may limit engagement and thereby constrain the potential for knowledge development.

Second, Level 1 provides insight into the **implementation fidelity** of the interventions, understood here as the extent to which the intended design is reflected in participants' experience of the training. Given the theoretically grounded and methodologically differentiated design approach of EffecTive (cf. Chapter 2), reaction data indicate whether core design principles - such as the integration of PDC, the modelling of SRL, and ICAP-informed engagement strategies - are perceived as meaningful, coherent and practically applicable.

Third, Level 1 is relevant from an **efficiency and scalability perspective**. Training formats that are perceived as relevant, feasible and beneficial are more likely to be accepted, sustained and potentially scaled. Reaction data therefore provide an important contextual layer for later cost-benefit analyses conducted in subsequent work packages.

Extending the Level 1 perspective: Influencing factors

Beyond the descriptive analysis of reaction indicators, several partner institutions conducted exploratory analyses to examine potential influencing factors of participants' responses to the training. While training satisfaction, perceived quality and cognitive load represent the dependent variables describing the immediate effects of the intervention, these additional analyses aimed to explore under which conditions and for which participant profiles reactions differed.

Regression analyses were used to examine whether individual characteristics such as teachers' SRL skills, age or professional experience predicted variations in perceived satisfaction, training quality or cognitive load. For example, initial findings indicate that teachers' SRL skills can function as a significant predictor of training satisfaction. Such results suggest that participants' prior competences may shape how they experience cognitively activating and practice-oriented training formats.

These analyses follow an exploratory logic rather than testing a predefined structural model. Their purpose is to identify relevant associations and potential moderating or mediating relationships between participant characteristics and reaction variables. This perspective complements the descriptive Level 1 analysis and contributes to a more nuanced understanding of how training designs are received across heterogeneous target groups.

Complementary trainer perspective

To complement the learner-centred evaluation, selected partner institutions also collected data from trainers involved in the implementation of the interventions. This perspective is particularly relevant in cases where training delivery was conducted by external teacher training institutions rather than directly by project partners.

Trainer feedback provides insight into perceived participant engagement, feasibility of implementation, logistical demands and overall intensity of the training. Even in cases where project partners delivered the training themselves, systematic reflection on the implementation process offers valuable contextual information regarding alignment with the original design, organisational challenges and perceived cognitive demands placed on participants.

In line with the co-design approach, evaluation was in several cases conducted in dialogue with trainers, including sharing results and reflecting jointly on implications for future training iterations. This feedback loop not only supported continuous improvement of the interventions but also reflected a collaborative and ethically grounded approach, ensuring that trainers were involved in interpreting and using the findings before their inclusion in this deliverable.

By integrating the trainer perspective, the Level 1 evaluation extends beyond participants' subjective reactions and incorporates implementation-related insights. This dual perspective supports a more comprehensive interpretation of training quality and provides contextual information relevant for subsequent discussions on scalability and efficiency.

2.4.2 Instruments and indicators for the Level 1 -Evaluation

In EffecTive, participants' reactions (Kirkpatrick Level 1) are operationalised in a multidimensional manner. Rather than reducing reaction to overall satisfaction, the evaluation framework differentiates between (1) perceived training satisfaction, (2) perceived training quality and (3) cognitive load with respect to the training. This differentiation reflects the assumption that participants' immediate responses to a training intervention encompass affective, evaluative and process-related components.

Perceived Training Satisfaction

Perceived training satisfaction captures the learner-centred perspective on the intervention and was measured with the instrument of Ritzmann et al. (2014). It reflects how participants evaluate the training in relation to their expectations, professional needs and personal learning experience. The construct includes the following subdimensions:

- **Subject enjoyment**, referring to the degree to which participants experienced the training as engaging and motivating;
- **Perceived usefulness**, capturing the perceived relevance and applicability of the content for participants' professional practice;
- **Attitudes towards the training**, reflecting the overall evaluative stance towards the intervention;
- **Subjective knowledge gain**, indicating participants' self-assessed improvement as a result of the training.

Together, these indicators provide insight into how the training was received from the perspective of the participants and how it relates to their professional context.

Perceived Training Quality

While satisfaction captures the learner's subjective experience, perceived training quality focuses more directly on instructional characteristics of the intervention. This dimension assesses how participants evaluate the pedagogical and structural features of the training with the questionnaire of Richter and Richter (2024). It includes the following subscales:

- **Clarity**, referring to the comprehensibility of explanations and tasks;
- **Structure**, capturing the logical organisation and sequencing of content;
- **Practical relevance**, indicating the extent to which the training was connected to authentic teaching practice;
- **Cognitive activation**, reflecting whether the training stimulated active thinking, reflection and engagement.

These indicators are closely linked to the design principles described in Chapter 2, including the integration of PDC, the modelling of SRL, and the use of ICAP-informed engagement strategies. Perceived training quality therefore provides insight into the extent to which core design principles are experienced as coherent and pedagogically meaningful.

Cognitive Load

In addition to evaluative reactions, the evaluation framework includes **cognitive load** as a process-sensitive Level 1 indicator. Drawing on Cognitive Load Theory, cognitive load is conceptualised as comprising three components: **intrinsic load**, related to the inherent complexity of the content; **extraneous load**, caused by suboptimal instructional design; and **germane load**, reflecting the cognitive resources invested by learners in processing and understanding the material. These aspects of Cognitive load have been measured with the scale of Klepsch et al.,(2017).

In line with more recent conceptualisations (e.g., Klepsch & Seufert, 2021), germane load can be interpreted as **active cognitive effort**, whereas intrinsic and extraneous load represent forms of **passive cognitive load** imposed by task characteristics or instructional design. Well-designed training interventions may intentionally induce higher germane load by cognitively activating participants, while at the same time aiming to minimise unnecessary extraneous load.

By including cognitive load alongside satisfaction and perceived quality, the evaluation framework captures not only how participants evaluate the training, but also how cognitively demanding and activating they experienced it to be. This differentiation is particularly relevant in EffecTive, where training formats vary in intensity and methodological complexity. For example, training designs that require participants to plan and implement their own lessons involve additional phases of preparation, coordination and reflection, and therefore demand higher levels of cognitive engagement and germane load. Distinguishing between different types of cognitive load thus helps to better understand how demanding training activities are experienced and how they support meaningful learning processes.

2.4.3 Data collection procedures and analytical approach

Data collection was conducted using a comprehensive post-training questionnaire administered at the end of each intervention. Items related to Level 1 (reaction) were placed at the beginning of the instrument to capture participants' immediate responses. This comes with the positive side effect that potential fatigue effects from the overall length of the questionnaire would not affect this part of the overall data collection.

All items measuring perceived training satisfaction, training quality and cognitive load were rated on a five-point Likert scale ranging from *strongly disagree* to *strongly agree*. Example items include *"Overall, I liked the training"* (subjective enjoyment) and *"The content was comprehensible"* (perceived clarity) (the overall questionnaires can be seen in Annex 1). .

For all subscales described in Section 2.5.2, composite variables were computed. Means and standard deviations are reported for each training case. In cases where training was implemented in multiple variations (e.g., KI vs. KI+SL), group differences were analysed using independent samples t-tests or, where appropriate, non-parametric alternatives.

To explore potential relationships between variables, regression analyses were conducted with satisfaction, perceived quality and cognitive load as dependent variables and participant characteristics (e.g., demographic variables or prior competences) or context variables (e.g. support by principles, technical equipment in schools) as predictors.

Trainer perspectives were collected in a more flexible and exploratory manner. No standardised interview protocol was applied; instead, partners gathered qualitative feedback to capture initial impressions of training effectiveness and Level 1 outcomes. These insights also provided valuable input for interpreting results and informing subsequent iterations of the training as well as the cost-benefit analysis.

Cross-case synthesis and joint analytical process

Beyond the statistical analyses conducted within individual cases, the cross-case interpretation was developed through a series of structured joint discussions among project partners. In these sessions, preliminary results were visualised, compared, and critically reflected upon across cases to identify consistent patterns, divergences, and context-specific explanations.

This iterative process allowed partners to align interpretations, validate findings against implementation experiences, and integrate both quantitative results and qualitative insights (e.g. trainer reflections). As a result, the cross-case analysis presented in this deliverable reflects not only aggregated data patterns but also a shared, collaboratively developed understanding of how different training designs functioned across contexts.

3. Training cases in EffecTive project: Implementation and Evaluation

The partners describe the training they provided during the pilot and/or implementation phase below. As these training sessions form a crucial part of the experimental setup of the EffecTive project, most partners delivered their training twice: once using a basic method and once using a more elaborate method. For instance, Ulm University ran an online micro-credential course on digital teaching and learning, once based on knowledge instruction and once based on knowledge instruction and situated learning methods, with the same content, goals, target group and framework conditions. The partners ensured that the only difference between the two training sessions was the training method used, as this is the focus of our overall research questions. An overview of all the training implemented can be seen in Table 6.

Table 6: Overview of the implemented trainings per partner and case

Partner	Case	Case Name	Method	Participants in the evaluation N	Pre-/ In-service teachers	Delivery Mode
TLU	CT 1.1	Cognitive engagement and digital tools in mathematics education	KI	40	pre	Online
	CT 2.1	Whole-school approach for effective technology-integration	KI + SL	13	in	Face to Face
	CT 3.1	Educational technology and digital competence for pre-school	KI+ CD + SL	21	pre	Face to Face
	CT 3.2		KI+ CD + SL + M	10		
	CT 4.1	General Teacher Education Case	KI + CD	31	pre	Face to Face
	CT 4.2		KI +CD + SL	16		
UWK	CK 1.1	Learn to think, solve problems with digi.case	KI	4	in	Blended

	CK 2.1	Open Inclusive Educational Resources (OIER)	KI + CD	3	pre	Face to Face
UULM	CUU 1.1	Self regulated learning: Analogue and Digital Nugget	KI + SL	9	in	Online
	CUU 1.2		KI	9		
	CUU 2.1	Digitalized Teaching and Learning module	KI	12	in	Blended
	CUU 2.2		KI + SL	17		
	CUU 3.1	Digitalized Teaching and Learning nugget	KI + SL	6	in	Online
	CUU 3.2		KI	5		
	CUU 4.1	Digitalized Teaching and Learning University Course	KI + SL	31	pre	Blended
	CUU 4.2		KI	15		
Oulu	PO 2.2	Technology-Enhanced Learning and Working	KI + CD	82	pre	Blended
	PO 2.3		KI	15		
UAU	CA 1.1	Course for teachers on digital skills	KI + SL	15	pre	Blended
	C1 1.2		KI	16		
TAU	CI 1.1	Digital Pedagogy 2.0: Promoting Independent Learner	KI	13	pre	Online
	CI 1.2		KI +CD	16		
	CI 2.1	Engaging with AI: Leveraging a Generative AI (Gen-AI) Chatbot to Enhance SRL	KI + CD	17	in	Blended
	CI 2.2		KI + CD + SL	18		

3.1 TLU Cases

CT1.1 | Cognitive engagement and digital tools in mathematics education

KEY FACTS

Training type	Pre-service teacher course
Format	Fully online, self-paced
Credits	3 ECTS
Participants	47 enrolled (pre–post matched analysis N = 31)
Trainer	1 trainer (expertise in mathematics didactics, educational psychology, and technology-enhanced learning)
Tools	H5P; Teacher Desmos (now Learning Amplify); Moodle
Frameworks	SRL; ICAP; TPACK; DigCompEdu

TRAINING IDEA

The training aimed to strengthen future mathematics teachers' ability to design technology-enhanced learning tasks and lesson sequences that foster learners' cognitive engagement and SRL. Participants analysed existing mathematics tasks and designed their own technology-integrated learning activities by applying ICAP, SRL, and mathematics-specific pedagogical principles.

HOW THE TRAINING WORKED

- Direct instruction on key concepts such as cognitive engagement, SRL, and ICAP, including their application in mathematics teaching
- Structured analysis of mathematics learning tasks and worked examples
- Hands-on design of digital learning tasks and lesson sequences using tools such as H5P and Amplifier
- Explicit focus on designing tasks that support cognitive engagement, SRL, and meaningful technology integration
- Systematic two-layer formative feedback combining individual responses and whole-group synthesis

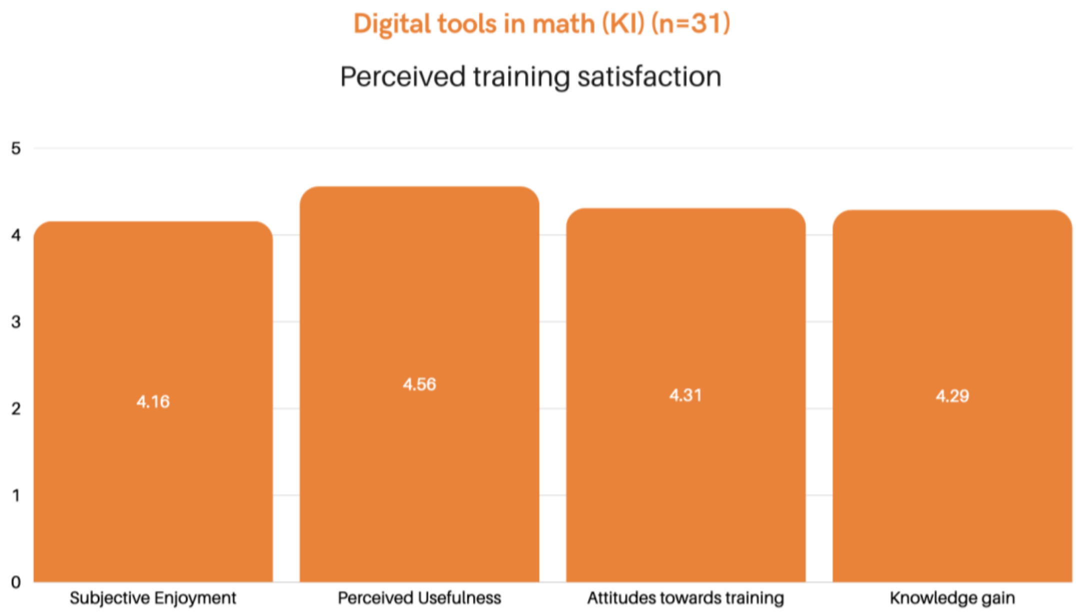
PARTICIPANTS AND CONTEXT

The course was part of pre-service teacher education at the university level and enrolled 47 participants from different study programmes, primarily future mathematics teachers, but also students for whom mathematics was a minor subject. Analyses are based on pre–post matched data from 31 participants.

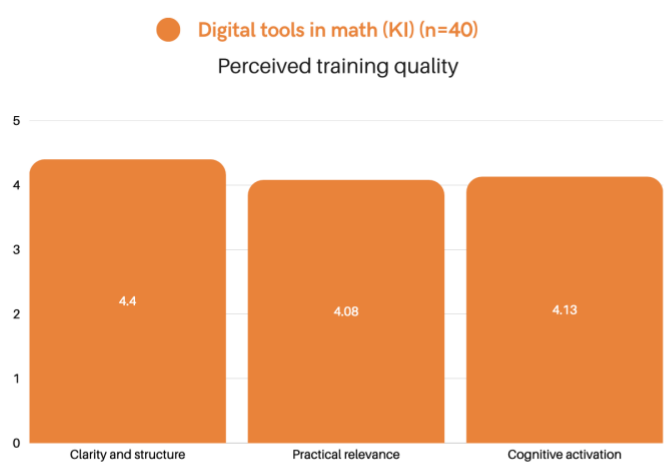
Participants had diverse backgrounds and teaching experience. Their average teaching experience was 2.2 years (SD = 2.85; range 0–13), and their average age was 29.1 years (SD = 9.31; range 19–53).

HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)

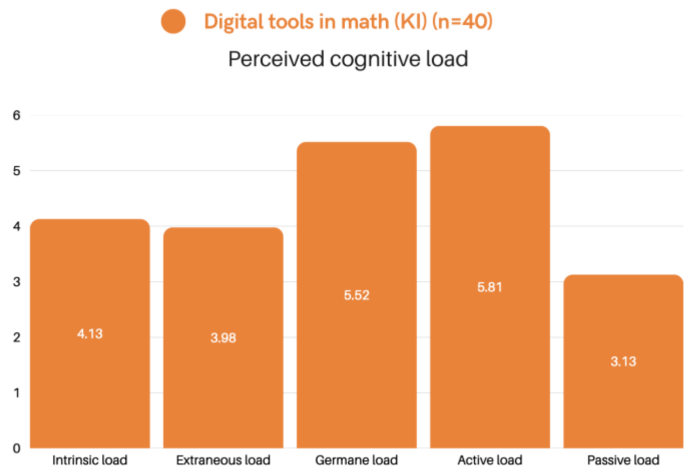
Overall, participants evaluated the fully online, self-paced course positively. **Perceived training satisfaction** was high, with usefulness rated highest, indicating that participants saw clear value in the course content and its relevance to their work. Subjective enjoyment was somewhat lower, but still clearly positive.



Perceived training quality was also positive. Clarity and structure received the highest ratings, suggesting that the organisation of the course and transparency of expectations were well appreciated. Cognitive activation was also rated highly, indicating that participants experienced the course as intellectually engaging. Practical relevance was rated slightly lower, but still positively.



Cognitive load ratings suggested productive learning conditions. Participants reported moderate intrinsic and extraneous load, while germane load and active load were highest, indicating that mental effort was directed mainly toward meaningful learning and active engagement. Passive load was lowest, consistent with the task-based design of the course.



WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Exploratory regression analyses showed that **global SRL skills** significantly **predicted overall training satisfactio**n ($R^2 = .16$, $\beta = .40$, $p = .027$), suggesting that participants with stronger SRL skills tended to report higher satisfaction in the self-paced online format. However, **SRL was not a statistically significant predictor of perceived training quality**, although the association was positive and approached significance ($p = .074$).

Post-training expectancy-value-cost evaluations were more strongly associated with participants' experiences. For **training satisfaction**, both **task value** and **expectancy remained significant independent predictors** in the combined model, while perceived cost was no longer significant ($R^2 = .71$, $F(3,27) = 22.11$, $p < .001$).

For perceived training **quality**, **task value emerged as the only significant independent predictor** in the combined model ($R^2 = .53$, $F(3,27) = 10.25$, $p < .001$).

Overall, participants' experiences in the self-paced online course appeared to depend primarily on whether the training was experienced as valuable and achievable, with SRL skills playing a smaller but meaningful role.

TRAINER REFLECTION

The trainer highlighted several key challenges in implementing the fully online, self-paced course. First, designing a coherent learning trajectory that meaningfully aligned **ICAP, SRL, mathematics didactics, and mathematics content** was conceptually demanding. This required careful sequencing of tasks from theory to worked-sample analysis, learner experience, and design, while ensuring that tasks supported deeper pedagogical reasoning rather than only tool use.

Second, the online self-paced format made it difficult to make participants' thinking visible and to support learning without synchronous interaction. This increased the importance of **clear written instructions, worked examples, modelling, and detailed formative feedback**. The trainer noted that open-ended design tasks could easily become overwhelming, highlighting the need for strong scaffolding while preserving learner autonomy.

Third, adapting **ICAP and SRL to mathematics-specific contexts** required effort. Abstract frameworks had to be translated into concrete mathematical tasks and common misconceptions. Finally, participants differed considerably in their prior pedagogical and mathematical knowledge, teaching experience, and SRL skills, reinforcing the need for **multiple entry points and differentiated levels of support**.

Implications for future training design

- **Strengthen support for situation-specific skills** - include more explicit scaffolds for noticing, interpreting, and deciding, supported by strong vs. weak examples and theory-informed interpretations.
- **Increase the perceived value of the training** - make clearer connections between ICAP, SRL, and everyday classroom challenges so participants see the practical usefulness of the approach for diagnosis, differentiation, and task design.
- **Connect teacher competencies to instructional quality more explicitly** - use teaching examples and classroom episodes to show how teachers' knowledge, beliefs, and design decisions shape instructional quality and, through it, student learning.

Key takeaway: CT1.1 shows that a fully online, self-paced KI-based course can still generate positive training experiences when the design is highly structured, cognitively activating, and supported by strong formative feedback. In this case, participants' motivational appraisals, especially task value and expectancy, were important in explaining positive reactions, while SRL skills appeared relevant for coping with the self-paced format.

CT2 | Whole-school Approach for Effective Technology- Integration

KEY FACTS

Training type	In-service teacher professional development
Format	Whole-school, four-session structured program
Credits	2 ECTS
Participants	24 enrolled; 13 completed (analysis N = 13)
Trainer	2 trainers (experts in learning science and technology-enhanced learning; one with additional mathematics expertise)

Tools	Amplifier; Participants portal
Frameworks	ICAP; SRL; TPACK; DigCompEdu
Effective Training Method	Knowledge Instruction; Situated Learning

TRAINING IDEA

The training was designed as a voluntary whole-school professional learning initiative to strengthen in-service teachers' understanding of cognitive engagement and support the pedagogically meaningful integration of digital technologies, including generative AI. It aimed to help teachers design and implement technology-enhanced learning experiences that foster students' SRL and cognitive engagement in authentic classroom contexts. To support this, the online course CT1 was adapted into a longer, structured in-service format consisting of four sessions.

HOW THE TRAINING WORKED

Teachers engaged with SRL and ICAP both as theoretical content and through the design of the course itself

Knowledge Instruction included theoretical input, worked examples, analysis of learning resources, hands-on work with digital tools, and lesson planning focused on cognitive engagement and SRL

Situated Learning involved action planning, classroom implementation of technology-integrated lessons, structured reflection, and iterative refinement

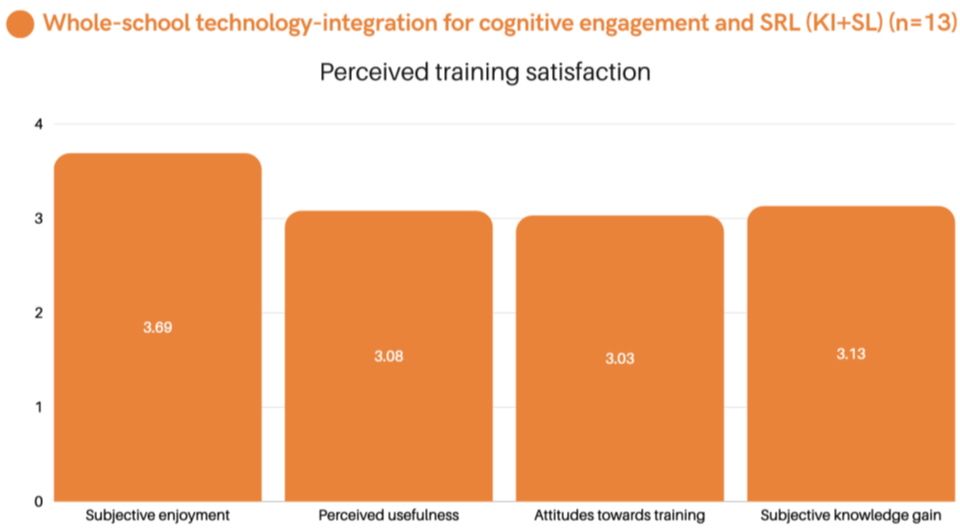
The whole-school format enabled peer discussion, feedback, and practical support, including collaboration within subject-specific groups

PARTICIPANTS AND CONTEXT

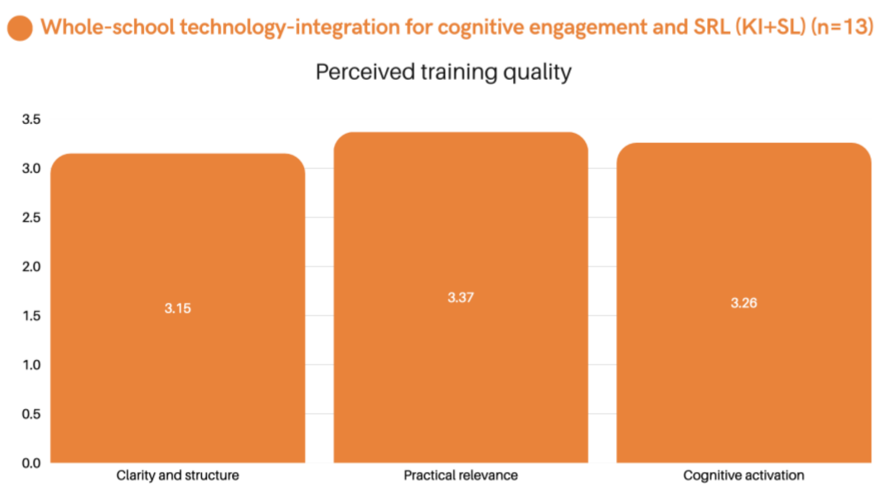
The programme was implemented in one Estonian high school. Participation was voluntary, although school management strongly encouraged teachers to take part. Twenty-four participants initially enrolled, and 13 completed all course requirements. Participants reported between 1 and 44 years of professional experience ($M = 15.8$), and their ages ranged from 22 to 68 years ($M = 45.1$). Teachers represented diverse subject areas, creating both opportunities for collaboration and challenges for perceived relevance.

HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)

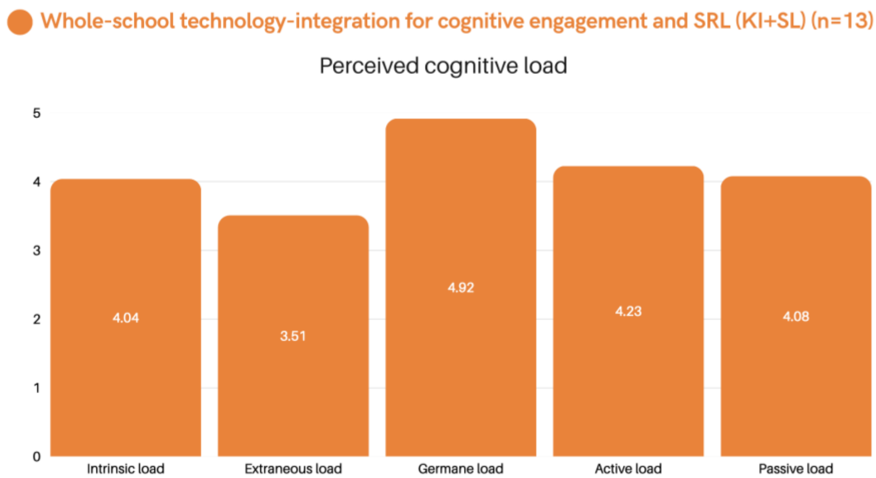
Because no training variations were implemented in this case, only descriptive results are reported for the training group's self-reported experiences.



Overall training satisfaction was moderate to positive. Subjective enjoyment received the highest ratings (M = 3.69), while perceived usefulness (M = 3.08), attitudes toward the training (M = 3.03), and subjective knowledge gain (M = 3.13) were more moderate.



Perceived training quality was rated most positively in terms of practical relevance (M = 3.37), followed by cognitive activation (M = 3.26) and clarity/structure (M = 3.15). These results suggest that teachers experienced the training as meaningful and engaging, although there was room to strengthen structural clarity and perceived utility.



Cognitive load results indicated productive learning conditions. Germane load was highest (M = 4.92), suggesting strong investment in meaningful processing, while extraneous load remained comparatively low (M = 3.51). Intrinsic and active load were moderate, indicating that the training was challenging without being unnecessarily burdensome.

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Given the small sample size in this case, regression analyses were not used because the estimates would have been unstable. Accordingly, only descriptive results and exploratory associations were considered. Overall, participants' experiences appeared to be shaped more by the perceived relevance and meaningfulness of the training than by background characteristics such as age or work experience.

TRAINER REFLECTION

From the trainers' perspective, the whole-school format offered important structural advantages. Teachers shared the same institutional context, were familiar with one another, and could discuss common classroom realities. Professional development time was formally integrated into the school schedule, which reduced logistical barriers and supported participation.

At the same time, the whole-school format introduced pedagogical complexity. Subject diversity made it harder to ensure relevance across disciplines, and some teachers initially questioned how the focus on cognitive engagement and SRL aligned with their own subject-specific practice. Subject-specific working groups proved especially valuable for strengthening relevance and ownership.

The situated learning component was central but demanding. Teachers were expected to engage in iterative cycles of analysing practice, redesigning instruction, implementing changes, and reflecting on outcomes, yet only about half engaged deeply in this process. This suggests that while the model has strong pedagogical potential, it requires clearer expectations, stronger scaffolding, and protected time for consistent participation.

Implications for future training design

- **Strengthen engagement structures in whole-school formats** - whole-school professional development benefits from shared context and scheduled time, but it also requires clearer accountability and follow-up to support sustained participation.
- **Build in subject-specific differentiation -** a shared theoretical focus can provide coherence, but teachers need structured support in translating ideas such as cognitive engagement and SRL into subject-specific instructional strategies.
- **Scaffold situated learning more explicitly - i**terative cycles of analysis, implementation, and reflection are pedagogically valuable, but they need clearer expectations, guided reflection, and timely facilitation to work consistently in practice.

Key takeaway: The whole-school model offered strong contextual and collaborative advantages, but subject diversity and the demands of situated learning required stronger differentiation and implementation support.

CT3.1–CT3.2 | Educational Technology and Digital Competence of Pre-School Teachers

KEY FACTS

Training type	Pre-service teacher course (Master's level, compulsory)
Format	Blended
Credits	6 ECTS
Participants	33 enrolled, 31 completed (analysis N = 31)
Trainer	1 trainer (expertise in pre-school education, educational technology, TEL)
Frameworks	DigCompEdu; ICAP; SRL (mainly implicit)
Tools	WordPress; Wix; Google Sites; SELFIE; eTwinning; LearningApps; Kahoot; Quizalize; Wordwall; TinyTap; various educational robotics tools; e-tool for assessing child development
Effective Training Methods	Knowledge Instruction (KI); Collaborative Design (CD); Situated Learning (SL); Mentoring (M, CT3.2 only)

TRAINING IDEA

The training aimed to strengthen pre-service pre-school teachers' ability to design technology-enhanced learning experiences for early childhood education. Two variations were implemented: CT3.1 combined Knowledge Instruction, Collaborative Design and Situated Learning, while CT3.2

added a mentoring component. The course focused on digital competence, child development, cognitive engagement, and the design of technology-integrated learning activities for authentic pre-school contexts.

HOW THE TRAINING WORKED

Conceptual input on child development, digital competence, cognitive engagement, and technology use in pre-school education
Hands-on exploration of digital tools, e-portfolios, and educational robotics
Collaborative design of technology-enhanced learning activities for pre-school children
One-time classroom implementation in participants' own pre-school settings followed by reflection
In CT3.2, an additional online mentoring session provided individualised feedback on lesson plans and implementation

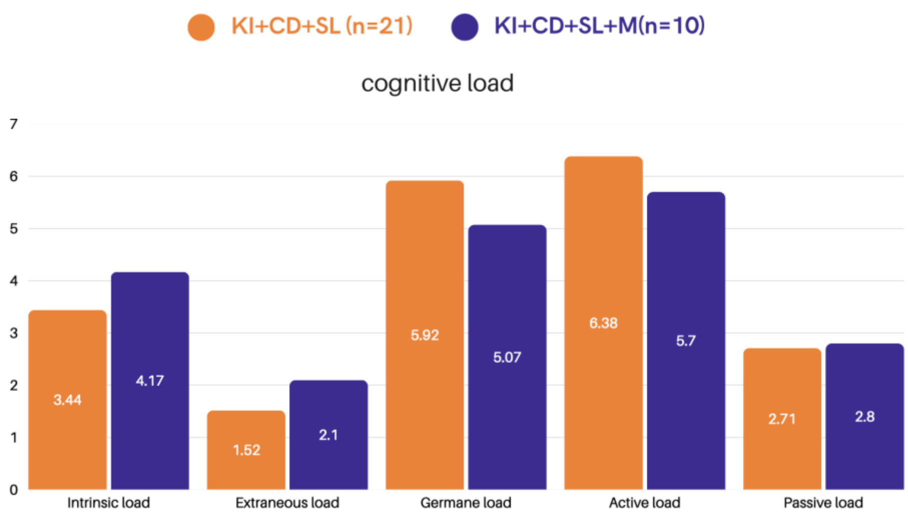
PARTICIPANTS AND CONTEXT

The course was a compulsory master's-level course in pre-school teacher education. Thirty-three participants initially enrolled and 31 completed all course requirements; two participants took academic leave during the semester. All participants were female pre-service pre-school teachers. Their ages ranged from 21 to 45 years (M = 31.3), and they reported between 0 and 21 years of professional experience (M = 5.74). CT3.1 included 21 participants and CT3.2 included 10 participants. All participants implemented technology-enhanced activities in authentic pre-school settings.

LEVEL 1 RESULTS (PARTICIPANT REACTIONS)

Participants evaluated the training very positively in both groups. No statistically significant differences emerged between CT3.1 and CT3.2 in overall training satisfaction or perceived training quality, indicating that the core KI+CD+SL design worked well regardless of whether mentoring was included.

Descriptively, the mentored group rated the training as somewhat more practically relevant, but this difference was not statistically significant.



Cognitive load patterns differed between the two variations. Mentoring did not significantly affect intrinsic, active, or passive cognitive load. However, the mentored group reported higher extraneous load, suggesting that mentoring may have introduced additional information or coordination demands. In contrast, the non-mentored group reported higher germane load, indicating greater self-directed effort in deep sense-making and knowledge construction. Overall, the results suggest that mentoring did not improve overall evaluations, but it did change how participants processed the training experience.

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Age and professional experience were not significantly related to satisfaction or perceived training quality. Exploratory regression analyses suggested that motivational appraisals were more strongly related to participants' experiences than SRL skills.

For both satisfaction and perceived training quality, expectancy and task value were significant predictors in simple models, but only expectancy remained a significant independent predictor in the combined models. Global SRL showed only a weak, non-significant trend-level association with satisfaction and was not related to perceived training quality. Taken together, these findings suggest that participants' confidence in their ability to successfully apply what they had learned was the strongest predictor of positive training experiences.

TRAINER REFLECTION

The trainer evaluated the course positively and highlighted the value of creating training variations, and using domain-specific examples. The trainer noted that early childhood education requires distinctive pedagogical tasks, scenarios, and tools, and that participants engaged more deeply when training activities clearly reflected everyday pre-school practice.

At the same time, the trainer emphasised that both the EffecTive guidelines and evaluation instruments required contextual adaptation for pre-school settings, particularly in relation to the ICAP framework, which was originally formulated more strongly for formal school contexts. The trainer also viewed mentoring as meaningful but demanding: it supported reflection, feedback, but increased coordination and workload. More broadly, the trainer noted that situated learning in pre-school contexts depends on participants' real opportunities to implement activities in practice, which requires time, support, and favourable conditions in the field.

Implications for future training design

- **Use mentoring selectively and purposefully** - mentoring did not systematically improve satisfaction or perceived training quality and was associated with higher extraneous load and lower germane load. This suggests that mentoring may be most effective when targeted to participants who need additional support, rather than added as a generic component for all.
- **Adapt frameworks and instruments to early childhood education** - frameworks such as ICAP and related evaluation instruments require further contextualisation for pre-school settings so that concepts and criteria are meaningful and interpretable for both teacher educators and participants.
- **Design explicitly for authentic pre-school practice** - early childhood education benefits from domain-specific examples, tasks, and implementation scenarios. Situated learning appears especially valuable when participants can connect training activities directly to their own pre-school classrooms and receive support in translating ideas into practice.

Case takeaway: CT3 suggests that the core KI+CD+SL design worked well in pre-school teacher education. Mentoring appeared to add support for reflection and implementation, but it did not improve overall evaluations and was associated with higher extraneous cognitive load. In this case, the added value of mentoring seems to depend on how targeted and manageable it is within the practical conditions of early childhood education.

CT4.1–CT4.2 | Educational Technology and Digital Competence

KEY FACTS

Training type	Pre-service teacher education (master's level elective)
Format	Blended
Credits	6 ECTS
Participants	73 enrolled, 72 completed the course; matched evaluation data were available for 47 participants
Trainer	1 trainer (expertise in learning technologies, TEL, pedagogy)
Tools	Google Drive; e-portfolio platforms (GDrive, WordPress, Google Sites, Padlet); digital tools (H5P, LearningApps, LiveWorksheets, ThingLink, Wordwall etc.); Spatial, ThinkLink, Futuclass, Kunstmatrix, Scratch
Frameworks	ICAP; DigCompEdu; SRL (mainly implicit)
Effective Training Methods	Knowledge Instruction (KI); Collaborative Design (CD); Situated Learning (SL, CT4.2 only)

TRAINING IDEA

The training aimed to strengthen pre-service teachers' ability to design technology-enhanced learning experiences across diverse educational contexts. Two variations were implemented: CT4.1 combined Knowledge Instruction and Collaborative Design, while CT4.2 added a Situated Learning component in which participants implemented a planned lesson in an authentic context and reflected on the experience. The course focused on digital competence, pedagogically grounded use of digital tools, and the design of cognitively engaging learning activities.

HOW THE TRAINING WORKED

ICAP was addressed both explicitly (as a conceptual lens for learner engagement) and implicitly through activity design

SRL was mainly embedded implicitly through planning, performance, and reflection phases rather than taught as a standalone topic

Knowledge Instruction combined theoretical input with hands-on work on digital learning resources

Collaborative Design tasks involved joint development of technology-integrated lesson ideas or learning trajectories

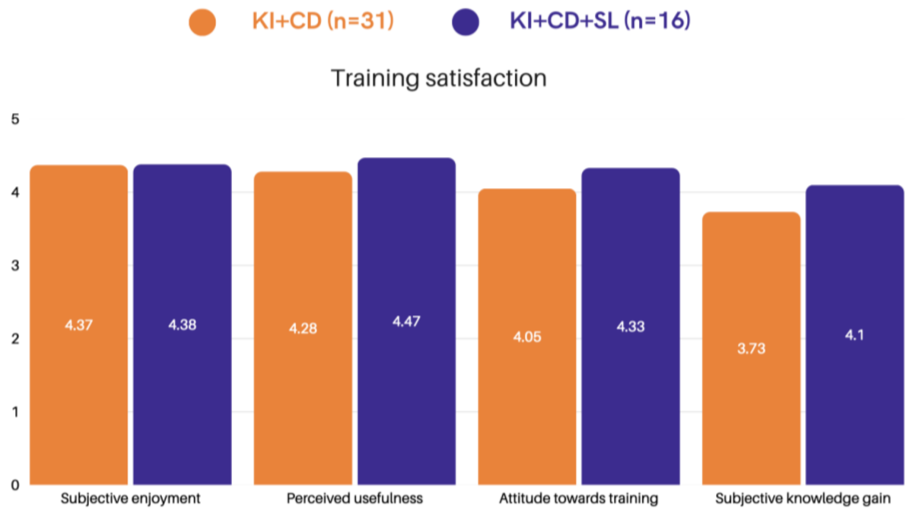
In CT4.2, Situated Learning required participants to implement a planned lesson in an authentic context and reflect on the experience

PARTICIPANTS AND CONTEXT

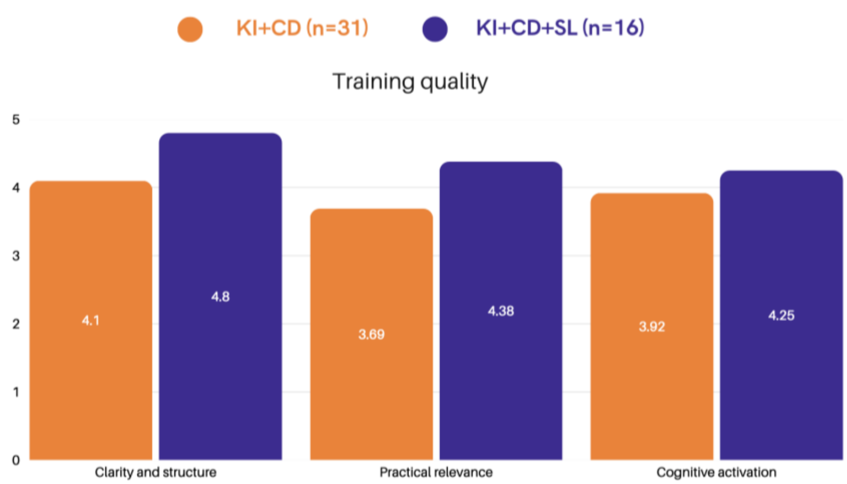
The course was an elective master's-level course for diverse pre-service teachers, including speci education and subject teachers. Of 73 participants, 72 completed the course; data from 47 participant showed varied experience (0–21 years, M = 4.35) and a mean age of 32.6. Of these, 30 were speci education teachers and 17 were different subject teachers. The course was intentionally designed a a broad elective across teacher education programmes, which increased accessibility but also made harder to provide equally relevant examples and feedback across participants from different domain

HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)

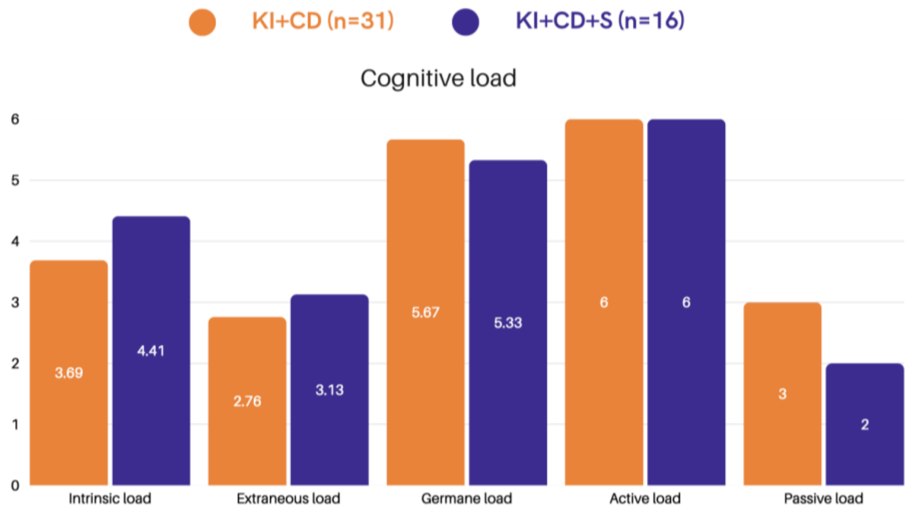
Overall, both training variations were evaluated positively, suggesting that the broad "one-size-fits-all" course design worked well as a general elective format across a diverse pre-service teacher cohort. No statistically significant differences emerged between groups in any dimension of training satisfaction, and participants in both groups reported similarly high levels of enjoyment, usefulness, positive attitudes, and perceived knowledge gains.



Although descriptively the group with situated learning reported somewhat higher satisfaction in usefulness, attitudes, and especially perceived knowledge gains, these differences were not statistically significant.



For training quality, no group differences were found in clarity or cognitive activation. However, the situated learning group rated the training as significantly more relevant to their own practice, indicating that the addition of situated learning primarily strengthened the perceived practical relevance of the course rather than changing overall evaluative judgments.



Perceived cognitive load was comparable across groups. Participants in both conditions reported similar levels of intrinsic, extraneous, and germane load, as well as active and passive load, suggesting that the inclusion of situated learning did not make the training feel more demanding.

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Age and professional experience were not significantly related to satisfaction or perceived training quality. Instead, participants' motivational appraisals of the training were more strongly associated with their experience. **SRL skills** showed a modest but consistent positive association with both overall satisfaction and perceived training quality. Post-training **expectancy and especially task value** were stronger predictors of positive evaluations, while perceived cost showed a weaker negative association. Across analyses, **task value emerged as the most robust predictor**, suggesting that participants' experiences were shaped more by whether the training was perceived as meaningful and applicable.

TRAINER REFLECTION

Overall, the trainer evaluated the course positively, while highlighting challenges related to the large, diverse participant group and the practical demands of blended delivery. The broad elective format appeared to work well as an accessible "one-size-fits-all" solution at a general level, but it also made it difficult to provide equally relevant examples, contextualised feedback, and strong practice connections across participants from different disciplines.

A key strength of the course was the use of flexible task options, which allowed participants to choose a feasible way to meet the learning objectives. Although this required additional preparation, it increased the perceived relevance of the course and enabled some participants to test ideas in authentic classroom settings.

For future iterations, the trainer recommended smaller groups, stronger administrative support, and more differentiated pathways. The experience suggests that broad course designs can work well for generating generally positive engagement in large cohorts, but that stronger contextualisation and more flexible situated learning options may be needed when the goal is deeper practice connection across diverse participant groups.

Implications for future training design

- Keep group sizes manageable and ensure suitable learning environments - Practice-oriented courses require interactive spaces and manageable cohorts (ideally below 30 participants) to support collaboration, meaningful feedback, and smooth implementation.
- Design for diversity, but avoid overly broad "one-size-fits-all" formats - When participants come from varied subject areas and professional backgrounds, course activities should include differentiated examples, flexible pathways, or smaller peer groups to strengthen relevance and contextual fit.
- Situated learning in large groups requires flexible and manageable implementation options - large groups benefit when situated learning is organised through clearly bounded task options, so participants can choose a feasible way to connect course content with their own practice without creating excessive workload for themselves or the trainer

Case takeaway: In this case, the broad elective course design was sufficient to generate positive training experiences across a large and diverse cohort. Adding Situated Learning did not increase satisfaction or cognitive load, but it did strengthen perceived relevance to practice.

3.2 UWK cases

CK1.1-CK1.2 | Supporting Computational Thinking in Primary Education

KEY FACTS

Training type	In-service teacher professional development
Format	MOOC + face-to-face training (with optional situated learning extension)
Credits	Not specified
Participants	8 (analysis N = 4)
Trainer	4 trainers (expertise in media education and technology-enhanced teacher education)
Tools	digi.case media kit; MOOC tools (H5P quizzes, learning snacks, forum tasks)
Frameworks	ICAP; DigCompEdu; SRL (indirect)
Effective Training Methods	Knowledge Instruction (KI); Situated Learning (SL, planned but not implemented)

TRAINING IDEA

The training is directly built on the existing digi.case training structure and adds the element of situated learning. The digi.case training structure aims at supporting in-service primary teachers in fostering computational thinking and problem-solving through the meaningful use of analogue and digital media. It follows an "analogue first" approach, introducing physical materials before digital tools. There were two variations of the training. CK1.1 variation (MOOC plus face-to-face training) was retained without modification. CK1.2 variation included a situated learning component. Due to complications, data was pooled from both conditions and treated as having only the KI condition (CK1.1).

HOW THE TRAINING WORKED

- Teachers completed a MOOC covering computational thinking, pedagogy, and use of digi.case materials, followed by face-to-face training
- Face-to-face sessions focused on hands-on exploration of analogue and digital materials and initial lesson design
- In the extended variant, teachers were expected to plan, implement, and reflect on lessons in their own classrooms (not realised in practice)
- Reflection and discussion were supported through structured activities and an online webinar ("coffee time") (CK1.2 only)

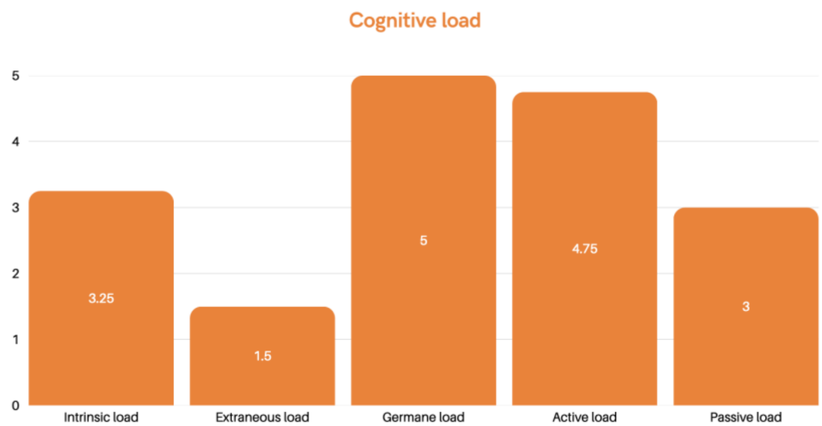
PARTICIPANTS AND CONTEXT

8 teachers participated in the pre-test, but only 4 of them were valid observations for evaluation. All participants were female. Participants were primary teachers with 1–11 years of experience and a mean age of 38.25. Only data from participants of the CK1.1 condition was able to be collected.

HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)

Participants reported very high satisfaction. Enjoyment and attitudes were highest (M = 4.83), followed by perceived relevance (M = 4.75) and knowledge gains (M = 4.67).

Perceived training quality was also very high. Clarity and structure received maximum ratings (M = 5.00), with strong ratings for relevance (M = 4.81) and slightly lower but still high cognitive activation (M = 4.42).



Cognitive load results indicated effective design: low extraneous load (M = 1.50), moderate intrinsic load (M = 3.25), and high germane (M = 5.00) and active load (M = 4.75), reflecting strong engagement without unnecessary burden. Passive load levels were moderate (M = 3.00)

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Sample size was too small to perform inferential statistics.

TRAINER REFLECTION

Trainers reported overall positive reactions, particularly to face-to-face sessions and hands-on engagement with digi.case materials. Initial participant motivation was low after the MOOC but improved significantly during practical sessions, where interaction with physical materials increased engagement and acceptance.

The "analogue first" approach was perceived as effective, supporting conceptual understanding and confidence before introducing digital tools. Hands-on activities and practical relevance were key drivers of satisfaction and perceived quality.

Challenges included high workload, time constraints especially for classroom implementation, and the need to process substantial content, which limited sustained engagement beyond training sessions. Additional barriers included limited school-level support, lack of incentives, and restricted access to materials. Trainers noted that the enhanced training required shifts toward more learner-centered teaching, which some participants found challenging.

IMPLICATIONS for future training design

- **Combine online preparation with hands-on sessions** – Practical, face-to-face activities significantly increased engagement and acceptance compared to the MOOC phase alone.
- **Use an "analogue first" approach for complex topics** – Starting with physical materials supported understanding and reduced barriers to later digital integration.

● **Reduce workload and strengthen contextual support** – Time constraints, limited school support, and resource access hindered sustained engagement and implementation.

CASE TAKEAWAY

This case shows that a KI-based training combining MOOC and face-to-face elements can achieve very high satisfaction and low cognitive load when it is strongly practice-oriented. However, engagement depends heavily on hands-on activities (from analogue to digital), while purely online phases and high workload can limit sustained participation and implementation.

CK2.1-CK2.2 | Enhancing Inclusive Teacher Education through Collaborative Design and Mentoring

KEY FACTS

Training type	Pre-service teacher education
Format	Lecture–seminar with collaborative activities; optional situated learning component (CK2.2 condition)
Credits	2 ECTS
Participants	23 enrolled; 19 in pre-test (analysis N = 3)
Trainer	1 trainer (expertise in inclusive education)
Tools	Open educational resources; collaborative seminar activities; supplementary readings
Frameworks	ICAP; SRL (indirect); DigCompEdu
Effective Training Methods	Knowledge Instruction (KI); Collaborative Design (CD); Situated Learning (SL)

TRAINING IDEA

The training was part of a curriculum that aimed at developing competencies in inclusive education, quality development and reflective practice through a combination of theoretical input and collaborative practice. By adding an additional situated learning component to the original course for CK2.2 it examined whether adding classroom implementation to knowledge instruction and collaborative design enhances learning outcomes.

HOW THE TRAINING WORKED

● Lectures and seminars introduced key concepts of inclusive education and quality development, combined with collaborative learning activities

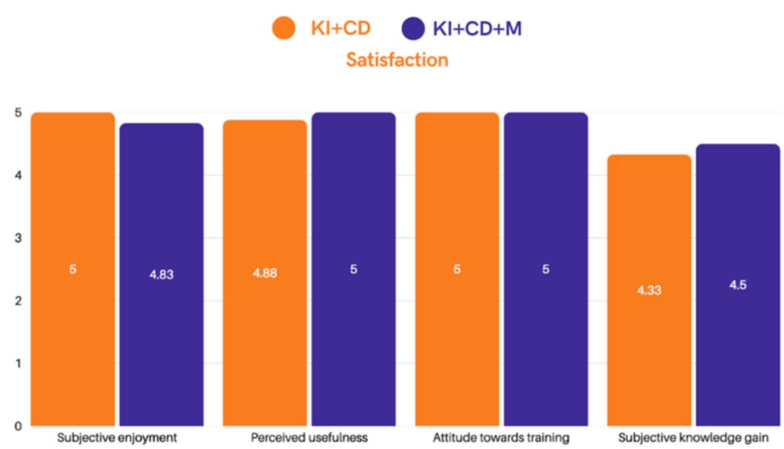
● Participants engaged in hands-on work using tools such as the Index for Inclusion and developed open educational resources (OER) collaboratively

- In the intervention condition, participants tried out the OER created during the course in their classrooms
- The comparison group tried out the OER with their peers in the course.

PARTICIPANTS AND CONTEXT

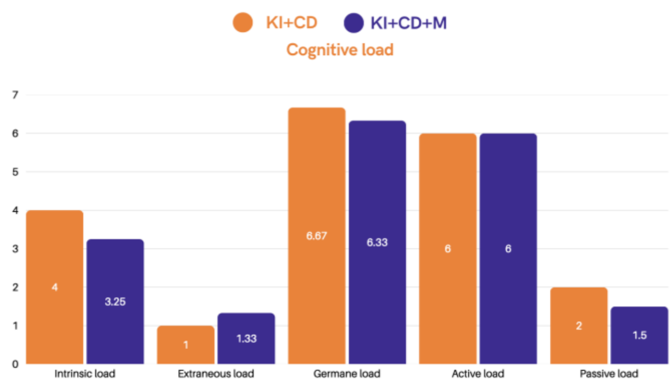
23 pre-service teachers participated in the course. Roughly half was assigned to each study condition. 19 pre-service teachers participated in the pre-test, 2 of these were male and 17 were female. Participants represented diverse subject areas (e.g., English, geography, physics, special education) and averaged a mean age of 25.5. Participation in the study was voluntary, and both training conditions followed the same curriculum with variation only in the support format. Data was collected from a very small sample size (N=1 for CK2.1 and N=2 for CK2.2) which limits generalizability of the findings.

HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)



Overall satisfaction was high in both conditions. Enjoyment, and perceived usefulness were rated very highly with slightly higher scores in the mentoring condition. Perceived knowledge gain was slightly higher in the non-mentoring condition. Attitudes towards the course were given the maximum possible rating by both conditions.

Perceived training quality was high across all dimensions. Clarity, relevance, and cognitive activation were rated positively, with descriptively higher ratings in the mentoring condition.



Cognitive load results indicated effective learning conditions. Intrinsic load was moderate to slightly higher in the mentoring condition. Extraneous load was very low in both groups. Germane load and active load were high, while passive load remained low.

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Due to the small sample size, inferential statistics were unable to be performed.

TRAINER REFLECTION

The trainer highlighted several features shaping participants' experiences. The group was highly diver in background and teaching experience, and the flexible attendance—where few participants attend all sessions—affected both course continuity and satisfaction. Despite this, hands-on activities (e. evaluating OER platforms) and discussions on key topics such as quality, accessibility, and soc inequality were perceived as engaging. The trainer also noted that the enhanced training with servi learning (SL) likely improved participants' experience, as it provided a clear application conte: increased the meaningfulness of tasks, and enabled direct feedback on their work.

IMPLICATIONS for future training design

- Ensure **continuity** in participation – Irregular attendance weakened coherence and may have limited both learning depth and satisfaction.
- Leverage **collaborative design with authentic application** – Working on OER and testing them in real contexts increased perceived relevance and engagement.
- Use **situated learning** to strengthen meaning, not just add complexity – Even in small-scale settings, implementation phases helped make tasks more concrete and valuable.

CASE TAKEAWAY

This case indicates that KI+CD-based training in inclusive education can create highly positive learning conditions with low cognitive strain. Adding situated learning appears to enhance perceived relevance and meaningfulness, although conclusions remain tentative due to the very small sample size.

3.3 UULM Cases

CUU1.1–CUU1.2 | Self-Regulated Learning: Analogue and Digital

KEY FACTS

Training type	Professional development module
Format	Blended
Credits	1 ECTS
Participants	18 (analysis N = 18)
Trainer	Not specified
Tools	Moodle; e-learning tools; collaborative technologies; digital teaching formats; digital assessment tools
Frameworks	ICAP; situated learning (CUU1.1); SRL; DigCompEdu
Effective Training Methods	Knowledge instruction (KI); Situated Learning (SL)

TRAINING IDEA

The module aims to strengthen teachers' competence in fostering SRL within technology-enhanced environments. The module was a six-week professional development module within the UULM initiative and was divided into two groups, one that used knowledge instruction and situated learning (CUU1.1) and another that used knowledge instruction exclusively (CUU1.2).

HOW THE TRAINING WORKED

- CUU1.1 integrated knowledge instruction (KI) with situated learning (SL), including design and implementation of SRL-supportive learning environments

● CUU1.2 included KI only, focusing on the design and implementation of SRL-supportive learning environments

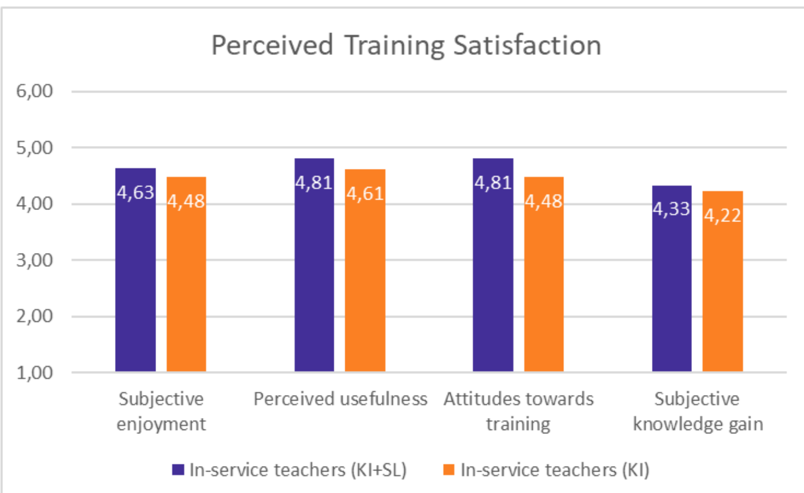
● Engagement followed the ICAP framework, combining passive input, active tasks, constructive application, and interactive peer exchange

● Trainer support provided structured input, feedback on implementation, and guidance for classroom application

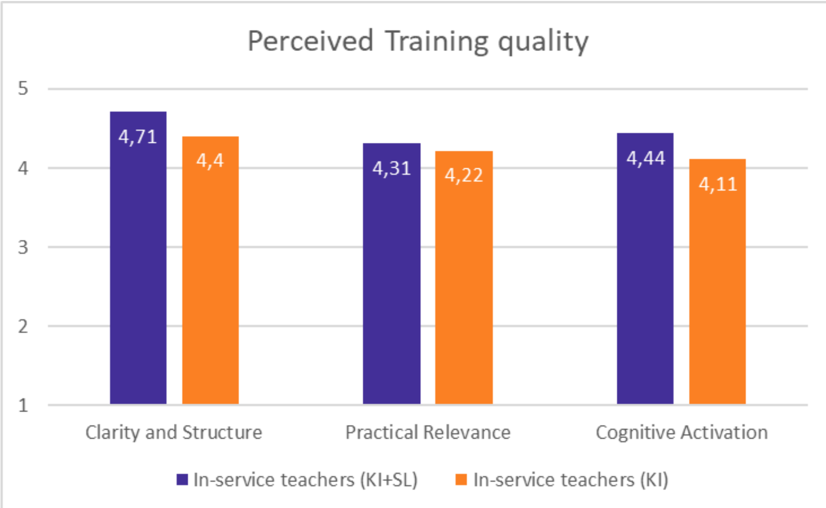
PARTICIPANTS AND CONTEXT

CUU1.1 participants (N=9) were all female, aged 28–50 (M=41.00), with 3–23 years of teaching experience (M=11.56). CUU1.2 participants (N=9) were 88.9% female, aged 30–56 (M=43.56), with 6–30 years of experience (M=17.11).

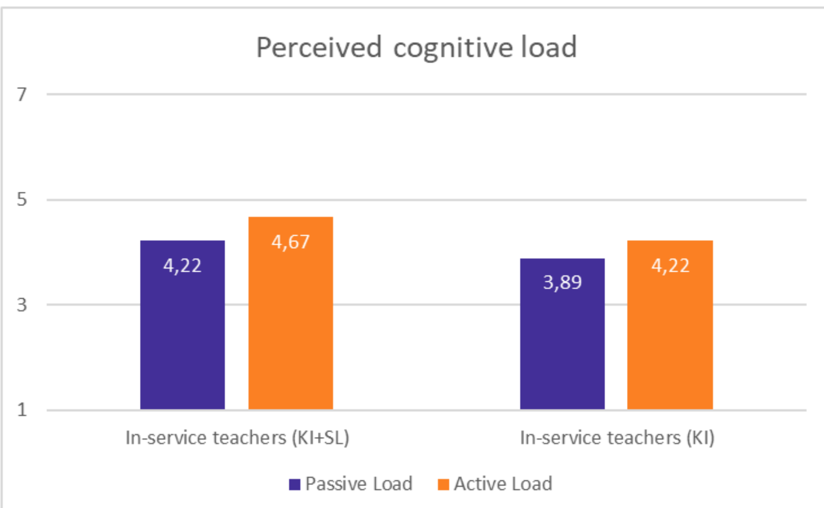
HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)



Satisfaction was high across both formats. CUU1.1 reported slightly higher subjective enjoyment (M=4.63) and perceived usefulness (M=4.81) than CUU1.2 (enjoyment M=4.48, usefulness M=4.61). Attitudes toward the training were similarly positive. Subjective knowledge gains were rated positively.



Training quality was rated highly, with clarity and structure higher in CUU1.1 (M=4.71) than CUU1.2 (M=4.40). Practical relevance and cognitive activation were slightly higher in CUU1.1.



Cognitive load was manageable; passive load was higher in CUU1.1 (M=4.22) than CUU1.2 (M=3.89), while active load was higher in CUU1.2 (M=4.67) than CUU1.1 (M=4.22).

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Background characteristics, SRL skills, and cognitive load indicators were considered but showed no consistent or statistically significant effects.

TRAINER REFLECTION

Trainers reported the training as well structured, demanding, but engaging. Participants were actively involved and valued feedback. Situated learning tasks were challenging and required additional support, but supported connection between theory and classroom practice. Time constraints contributed to participant dropout. Trainers highlighted the combination of theoretical input, practical application, and reflection as a key strength and recommended adding intermediate check-in meetings to support participants.

IMPLICATIONS for future training design

- **Support situated learning with structured check-ins** – Implementation tasks require ongoing guidance to prevent overload and dropout.
- **Balance practical application with manageable workload** – While SL strengthens practice connection, time demands need to be carefully controlled.
- **Maintain integration of theory, application, and reflection** – This combination was perceived as particularly engaging and valuable for SRL development.

CASE TAKEAWAY

This case suggests that adding situated learning to KI can enhance perceived quality and relevance, but also increases demands on participants. Without sufficient support and time, the added complexity may limit sustained engagement, even when overall satisfaction remains high.

CUU2.1–CUU2.2 | Digitalized Teaching and Learning Module

KEY FACTS

Training type	Professional development module
Format	Blended
Credits	6 ECTS
Participants	29 (analysis N = 29)
Trainer	Not specified
Tools	Moodle; digital teaching tools; e-assessment formats; collaborative learning technologies; AI chatbots; portfolio rubrics; various apps for digital teaching
Frameworks	TPACK; ICAP; SRL; DigCompEdu
Effective Training Method	Knowledge instruction (KI); Situated Learning (SL)

TRAINING IDEA

The DLL module aims to strengthen teachers’ pedagogical digital competence and their ability to design SRL-supportive, technology-enhanced lessons. Learning objectives included understanding digital teaching concepts, assessment strategies, collaborative learning technologies and challenges in digital learning environments. There were two variations of the module: CUU2.1

utilized knowledge instruction and CUU2.2 combined knowledge instruction and situated learning.

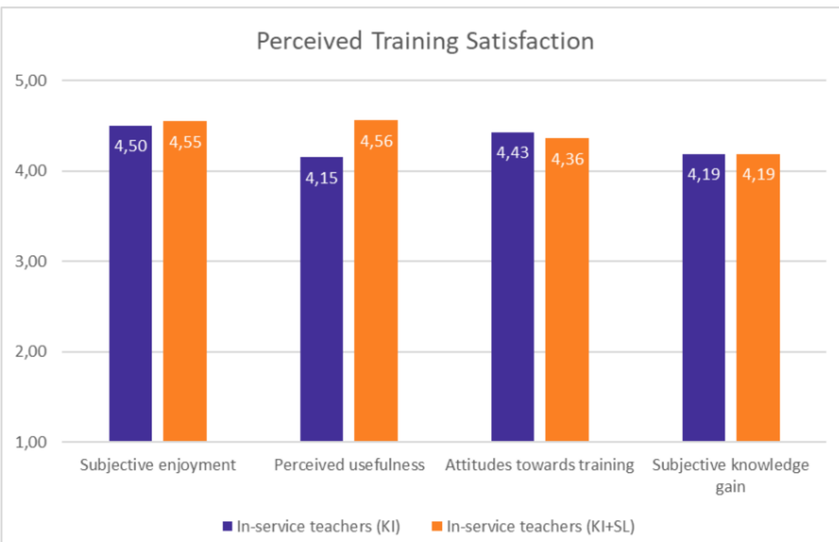
HOW THE TRAINING WORKED

CUU2.1 delivered knowledge instruction (KI) with structured theory-to-practice tasks CUU2.2 combined KI with situated learning (KI+SL), including practice-near tasks to facilitate classroom transfer
Both formats applied the ICAP framework with passive, active, constructive, and interactive engagement, and supported SRL through directly and indirectly
Trainer support included structured input, guidance on digital teaching concepts, tools, e-moderation, assessment strategies, legal aspects, and individual task feedback

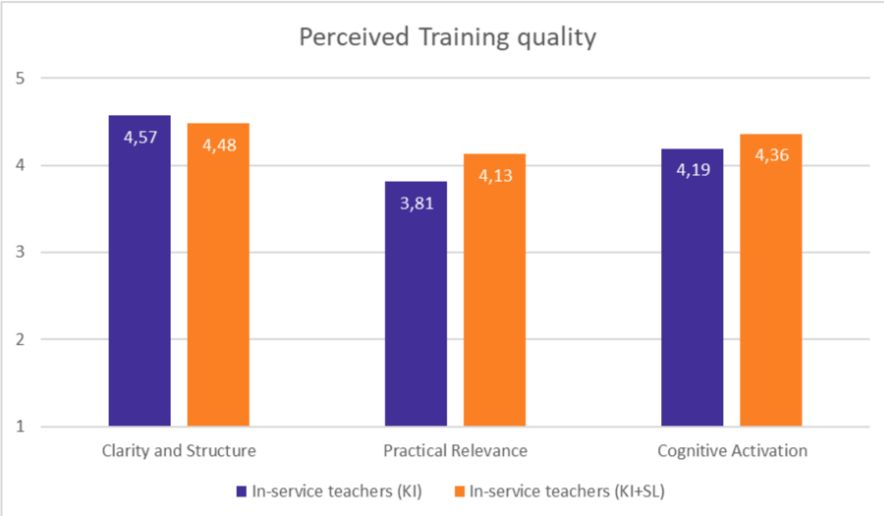
PARTICIPANTS AND CONTEXT

CUU2.1 participants (N=12) were 41.7% female, aged 27–60 (M=45.5), with 2–37 years of experience (M=20). CUU2.2 participants (N=17) were 23.5% female, aged 26–57 (M=40.3), with 3–24 years of experience (M=14).

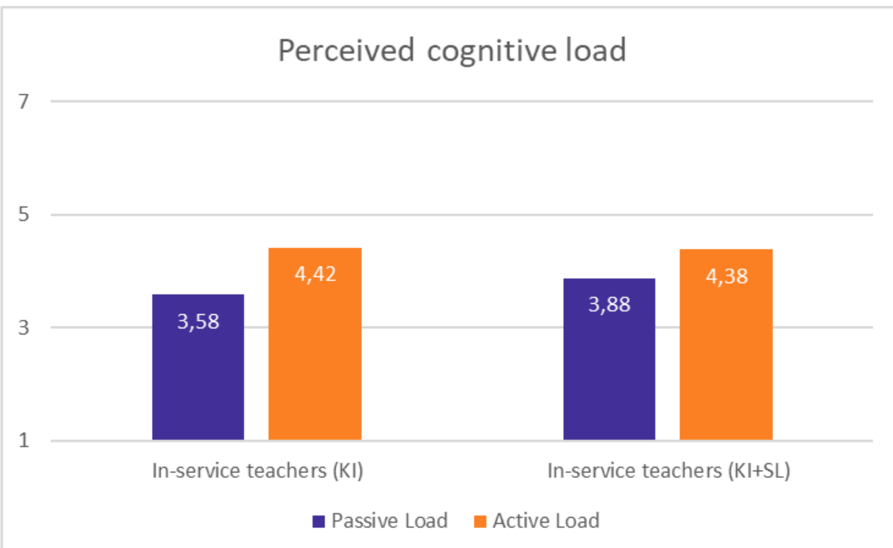
HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)



Satisfaction was high across both formats. Subjective enjoyment was slightly higher in CUU2.2 (M=4.55) than CUU2.1 (M=4.50). Perceived usefulness was rated highly in both formats (CUU2.1 M=4.15, CUU2.2 M=4.55). Attitudes toward training were favorable (CUU2.1 M=4.36; CUU2.2 M=4.43). Subjective knowledge gain was identical (M=4.19).



Quality ratings were very high for clarity and structure (CUU2.1 M=4.57; CUU2.2 M=4.48) and practical relevance was slightly higher in CUU2.2 (M=4.13 vs. CUU2.1 M=3.81). Cognitive activation trended higher for CUU2.2 (M=4.36) than CUU2.1 (M=4.19).



Cognitive load was manageable; passive load was slightly higher in CUU2.2 (M=3.88 vs. CUU2.1 M=3.58), active load slightly higher in CUU2.1 (M=4.42 vs. CUU2.2 M=4.38).

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Background characteristics, SRL skills, and cognitive load were examined as covariates; no significant effects or group differences were found.

TRAINER REFLECTION

Trainers reported the training as well structured, demanding, and engaging. Participant interaction was often indirect due to asynchronous elements, yet engagement was high, especially during face-to-face and feedback sessions. Situated learning tasks were challenging but effectively supported the connection between theory and classroom practice. Time constraints contributed to dropout. Trainers highlighted the combination of theoretical input, practical application, reflective activities, and face-to-face meetings as key strengths for supporting classroom transfer.

IMPLICATIONS for future training design

- **Use situated learning to strengthen practice connection** – Practice-near tasks increased perceived relevance without substantially affecting cognitive load.
- **Retain strong structural guidance in blended formats** – High clarity and structure were central for positive evaluations across both variants.
- **Plan sufficient time for implementation tasks** – Situated learning supported transfer but added demands that contributed to dropout under time constraints.

CASE TAKEAWAY

This case shows that both KI and KI+SL formats can achieve high satisfaction and perceived quality. Adding situated learning primarily strengthens practical relevance and cognitive activation, while maintaining a comparable level of cognitive load.

CUU3.1–CUU3.2 | Two Approaches to Digitalized Teaching and Learning – short version

KEY FACTS

Training type	Professional development module
Format	Blended
Credits	1 ECTS
Participants	11 (analysis N = 11)
Trainer	Not specified
Tools	Moodle; e-learning tools; collaborative technologies; digital teaching formats; digital assessment and course design tools
Frameworks	ICAP; DigCompEdu
Effective Training Methods	Knowledge instruction (KI); Situated Learning (SL)

TRAINING IDEA

The six-week *Masternugget Digital 2* module aims to strengthen teachers' pedagogical digital competence. It focuses on understanding digital teaching concepts, evaluating e-learning approaches, and supporting cognitive and motivational processes in digital learning through appropriate digital tools. There were two variations of the course: CUU3.1 combined knowledge instruction and situated learning elements and CUU3.2 only utilized knowledge instruction.

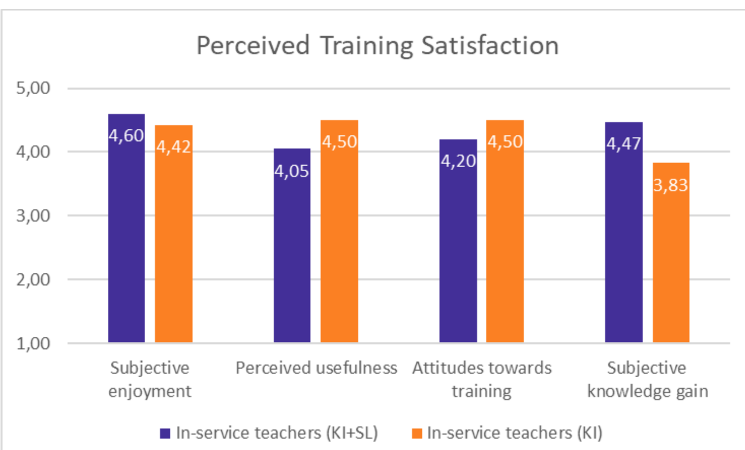
HOW THE TRAINING WORKED

CUU3.1 delivered knowledge instruction plus situated learning (KI+SL) which involved analyzing digital learning concepts, design learning environments and the application of these concepts in practice-oriented contexts . CUU3.2 delivered knowledge instruction only (KI) emphasizing conceptual understanding and learning environment design. Both formats applied the ICAP framework, including passive, active, constructive, and interactive engagement, with SRL supported indirectly through reflection, feedback, and assessment activities. Trainer input included structured theoretical guidance, facilitation of collaborative activities, and feedback on participant work.

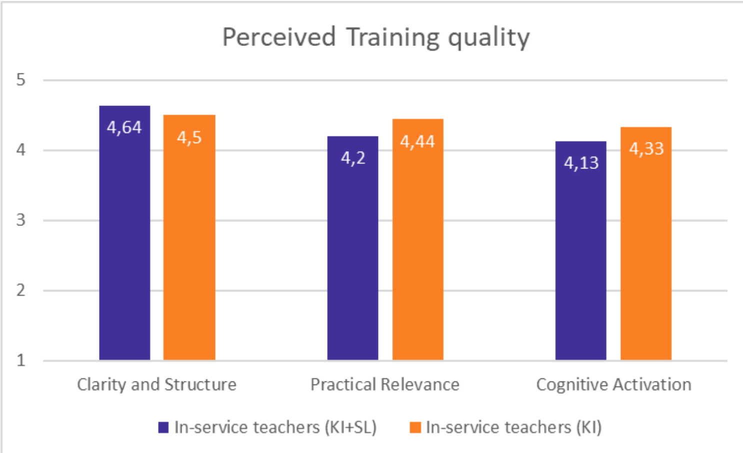
PARTICIPANTS AND CONTEXT

CUU3.1 participants (N=6) were all female, aged 39–50 (M=45.83), with 6–24 years of experience (M=18.20). CUU3.2 participants (N=5) were 60% female, aged 41–60 (M=50.60), with 15–40 years of experience (M=23.60).

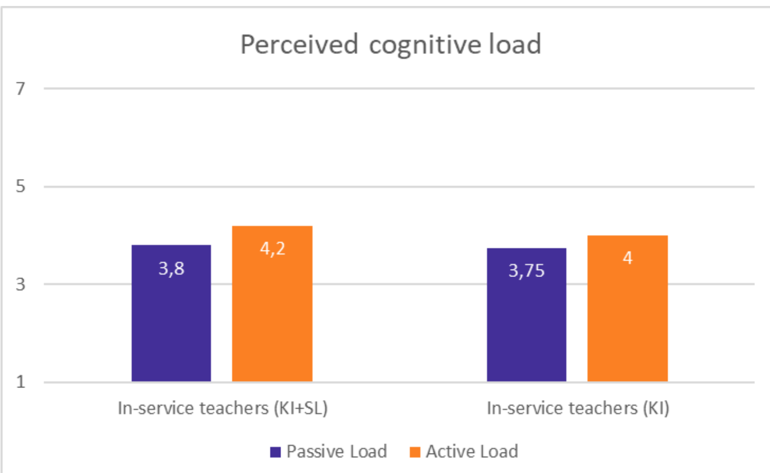
HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)



Satisfaction was high in both formats. Subjective enjoyment was slightly higher in CUU3.1 (M=4.60) than CUU3.2 (M=4.42). Perceived usefulness was rated highly in both formats (CUU3.1 M=4.05, CUU3.2 M=4.50). Attitudes toward training were favorable (CUU3.1 M=4.20, CUU3.2 M=4.50). Subjective knowledge gain was higher in CUU3.1 (M=4.47) than CUU3.2 (M=3.83).



In terms of perceived training quality, practical relevance was rated highly (CUU3.1 M=4.20, CUU3.2 M=4.44). Clarity and structure were rated very high (CUU3.1 M=4.64, CUU3.2 M=4.50). Cognitive activation trended higher for CUU3.2 (M=4.33) than CUU3.1 (M=4.13).



Active cognitive load was slightly higher in CUU3.1 (M=4.20) than CUU3.2 (M=4.00) and passive load was similar (CUU3.1 M=3.80, CUU3.2 M=3.75).

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

The sample size was too small for further analyses

TRAINER REFLECTION

A notably high demand was observed for this training, with both formats filling up quickly. Participant engagement was generally strong, but more complex tasks, particularly group work and portfolio assignments, posed time-related challenges. As a result, commitment was not sustained across the entire course and dropout rates were relatively high. Introducing partial participant funding may help increase commitment in future implementations.

In addition, the extensive evaluation questionnaires in the EffecTive study limited response rates, meaning that while many participants successfully completed the training, fewer contributed to the evaluation data. Both KI and KI+SL formats were effective overall. However, for the situated learning component, more structured support would be beneficial. Breaking down complex implementation tasks into smaller, stepwise activities or embedding them in collaborative formats could improve clarity and reduce extraneous cognitive load.

IMPLICATIONS for future training design

- **Adapt task complexity to short-format trainings** – In compact modules, implementation tasks need to be simplified to remain feasible within limited time.
- **Provide stepwise guidance for practice-oriented activities** – Breaking down design and implementation tasks can support clarity and reduce overload.
- **Prioritise key elements over full implementation cycles** – Short formats benefit from focusing on essential concepts rather than requiring complete classroom transfer.

CASE TAKEAWAY

This case suggests that KI and KI+SL formats can both work effectively in short training formats, with SL supporting perceived knowledge gains and practical engagement. However, in compact modules, the added complexity of implementation tasks must be carefully reduced to maintain feasibility and sustained participation.

CUU4.1–CUU4.2 | Digitalized Teaching and Learning – pre-service teachers

KEY FACTS

Training type	Pre-service teacher course
Format	Blended
Credits	6 ECTS
Participants	46 (analysis N = 46)
Trainer	Not specified
Tools	Moodle; digital learning technologies; e-learning platforms; collaborative learning tools; digital assessment formats; AI chatbots
Frameworks	ICAP; TPACK; SRL
Effective Training Methods	Knowledge instruction (KI); Situated Learning (SL)

TRAINING IDEA

The course aims to develop pre-service teachers' competence in digital teaching and learning. It focuses on enabling teachers to integrate digital tools including AI chatbots into teaching, design e-learning units, support learners in digital environments, and address digital assessment challenges. The course has two variations: CUU4.1 combines knowledge instruction with situated learning elements and CUU4.2 only utilizes knowledge instruction.

HOW THE TRAINING WORKED

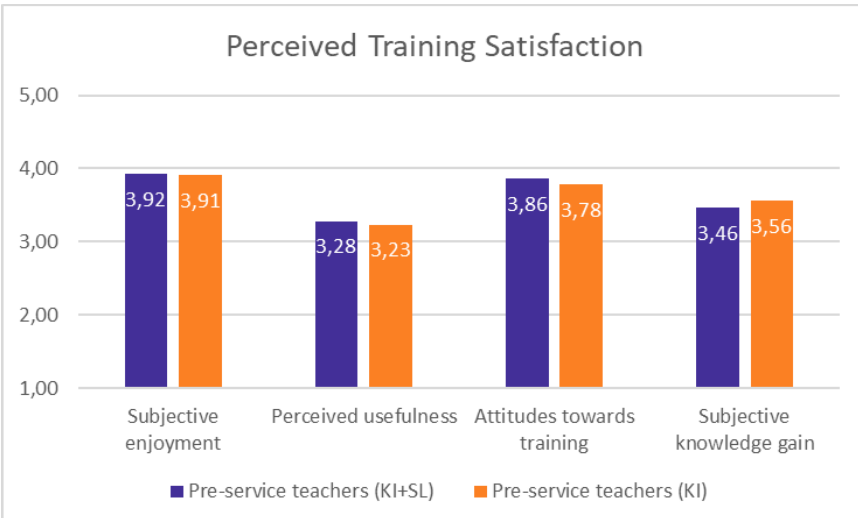
- CUU4.1 combined knowledge instruction, collaborative design, and situated learning, including planning digital learning environments
- CUU4.2 combined knowledge instruction and collaborative design without situated learning elements
- Both formats applied the ICAP framework, including passive, active, constructive, and interactive learning activities, and modelled SRL through instruction, reflection, and feedback

- The trainer supported participants with structured theoretical instruction, facilitation of collaborative learning activities and guidance on digital teaching concepts, e-moderation strategies and digital learning environments

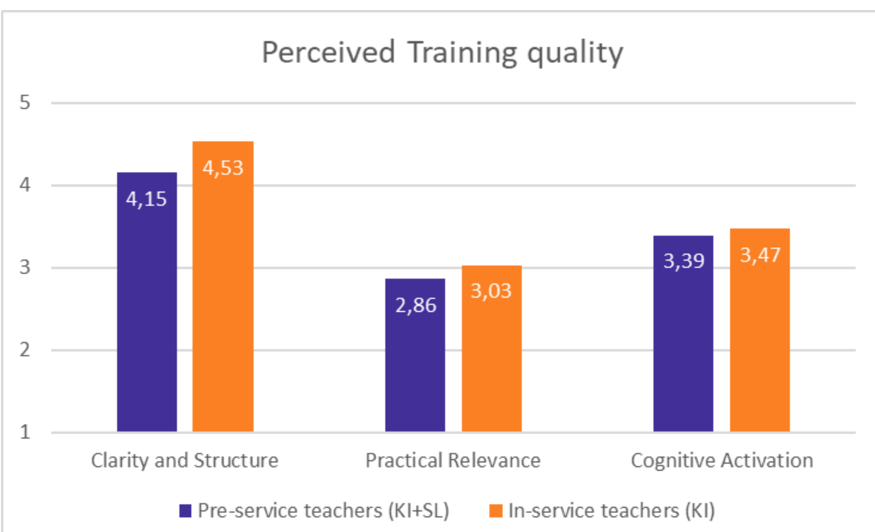
PARTICIPANTS AND CONTEXT

CUU4.1 participants (N=31) had a mean age of 20.81 years and were 75.7% female. CUU4.2 participants (N=15) had a mean age of 21.13 years and were 82.1% female.

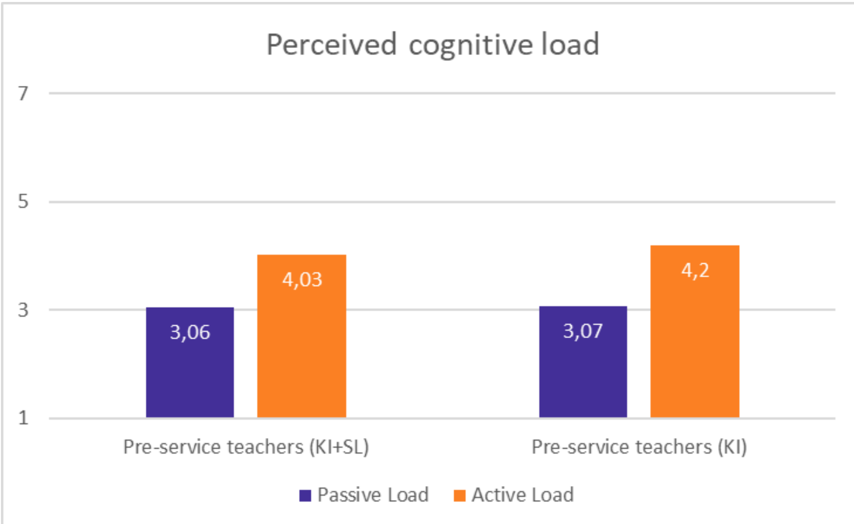
HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)



Satisfaction was moderate to high in both formats. Subjective enjoyment was nearly identical (CUU4.1 M=3.92; CUU4.2 M=3.91). Perceived usefulness and attitudes towards training were slightly higher in CUU4.1 (usefulness M=3.28 vs. M=3.23; attitudes M=3.86 vs. M=3.78). Subjective knowledge gain was slightly higher in CUU4.2 (M=3.56) than CUU4.1 (M=3.46).



Perceived quality was positive overall. Clarity and structure were significantly higher in CUU4.2 (M=4.53) than CUU4.1 (M=4.15). Practical relevance and cognitive activation were also slightly higher in CUU4.2.



Cognitive load was comparable across formats. Passive load was almost identical, while active load was slightly higher in CUU4.2 (M=4.20) than CUU4.1 (M=4.03).

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Background characteristics were examined as covariates; no consistent or significant effects were found beyond their association with perceived training quality.

TRAINER REFLECTION

The DLL module was characterized by a particularly high volume of content, which was reflected in student feedback as both a strength and a challenge. A notably well-received structural element was the resubmission policy, which allowed students to correct and resubmit their work up to a defined point in the course timeline; this mechanism provided additional structure and served as an effective incentive to engage with assignments progressively rather than deferring them to the end of the course. The exercise on developing an AI learning assistant was likewise evaluated very positively, as it enabled students to revisit and apply the module's core content in a practical, application-oriented context. On the critical side, the overall scope of the module was flagged as excessive by a number of participants, with certain content areas perceived as lacking relevance or interest. A further area for improvement concerns the two synchronous course sessions, during which interaction among participants remained limited - a design aspect that warrants reconsideration in future iterations of the module.

IMPLICATIONS for future training design

- **Reduce content volume and prioritise relevance** – Excessive scope can lower clarity and perceived usefulness, even when overall structure is strong.
- **Use structured pacing and resubmission mechanisms** – Progressive deadlines and resubmission opportunities supported continuous engagement and task completion.
- **Design interaction more deliberately in synchronous sessions** – Simply adding live sessions is not sufficient; interaction needs to be actively structured.

CASE TAKEAWAY

This case suggests that adding situated learning does not automatically improve training outcomes and may even reduce clarity when combined with high content demands. A well-structured KI+CD design can achieve higher clarity and comparable engagement, particularly when workload is carefully managed.

3.4 UOULU Case

PO2.2–PO2.3 | Supporting Pre-service Teachers' Pedagogical Digital Competence and Skills to Work in a Digitalizing Educational Environment

KEY FACTS

Training type	Pre-service teacher education
Format	Blended
Credits	4 ECTS
Participants	Approx. 123 enrolled (analysis N = 97)
Trainer	2 university teachers (expertise in technology-enhanced learning)
Tools	Moodle platform; digital tools (e.g., 3D modelling/printing, programming tools such as Beebots, Scratch, Sphero Indy, LEGO Spike); AI tools (e.g., ChatGPT, Copilot, Gemini); Little Language Machine; CASUS; audiovisual and remote teaching tools
Frameworks	ICAP; SRL; DigCompEdu;
Effective Training Methods	Knowledge Instruction (KI); Collaborative Design (CD)

TRAINING IDEA

The training aims to develop pre-service teachers' pedagogical digital competence and readiness to work in digitalized educational environments. Students explore theoretical concepts, phenomena and tools related to digital competence and design and implement technology-enhanced lessons. The training has two variations: PO2.2 which combines knowledge instruction (KI) and collaborative design (CD) and PO2.3 which only utilizes knowledge instruction. A comparison between KI and KI+CD examines the role of collaborative design in supporting learning and engagement.

HOW THE TRAINING WORKED

- Blended course with instruction and demonstration of key concepts, hands-on tasks involving the creation of learning resources, and individual or collaborative tasks, including lesson design
- PO2.2: included collaborative tasks, including developing lesson plans in collaboration with others
- PO2.3: focused on individual tasks without collaborative design
- Integration of theoretical frameworks (ICAP, SRL, DigCompEdu) through instruction, reflection, and application tasks

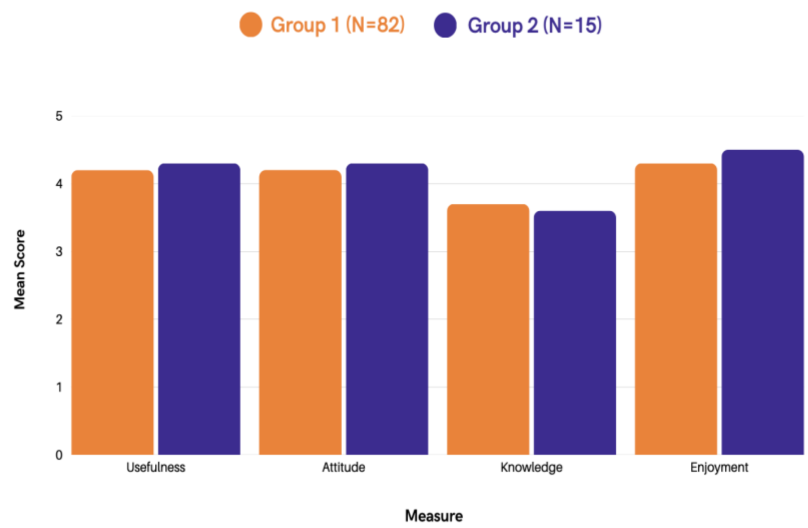
PARTICIPANTS AND CONTEXT

The Training is part of the course Technology Enhanced Learning and Work and is a mandatory component of teacher education at the Faculty of Education and Psychology, University of Oulu for first-year primary teacher education students and students in special education. 123 participants from the primary and special teacher education programs enrolled. 97 participants answered both pre- and post-test, as well as gave their consent to participate.

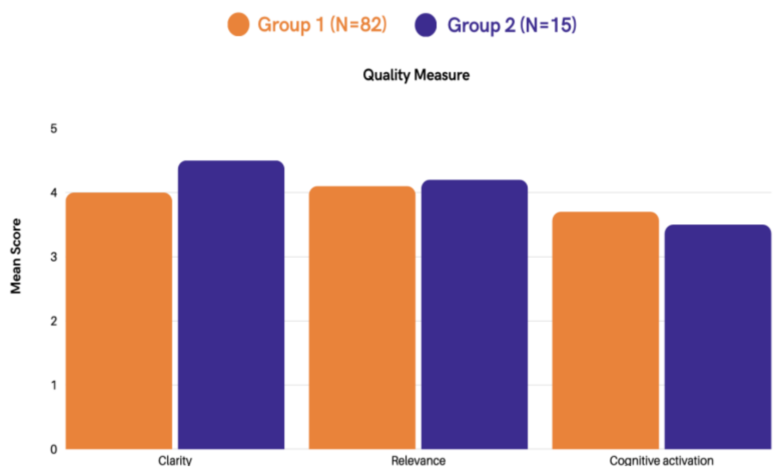
PO2.2: 79 students aged between 18-25, 2 aged between 26-35 and 1 aged between 36-45.

PO2.3: 12 students aged between 18-25, 2 aged between 26-35 and 1 aged between 36-45.

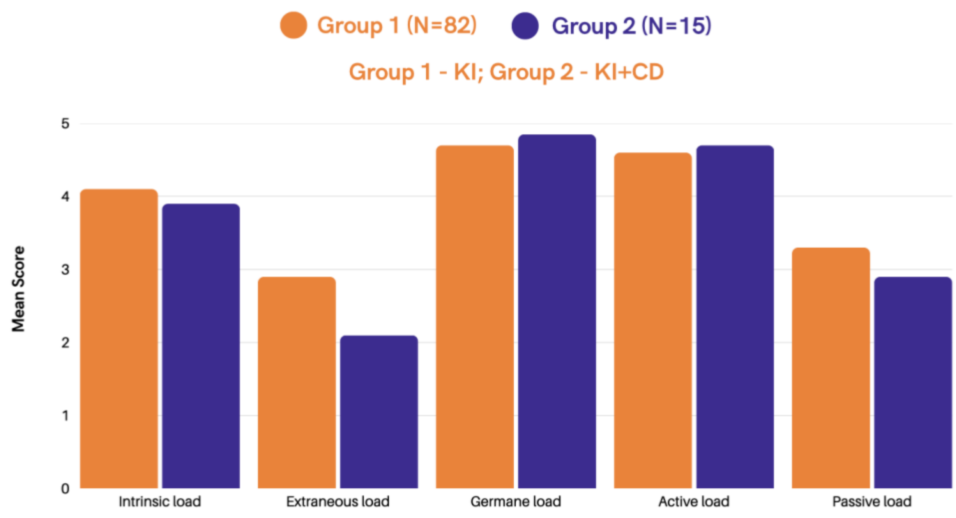
HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)



Satisfaction was rated highly by both groups. Perceived usefulness and subjective knowledge gain were rated comparably high by both groups. Subjective enjoyment and attitudes towards the training were rated highly by both groups with PO2.2 rating both descriptively slightly higher.



The training was rated highly in perceived quality by both groups. Perceived relevance and cognitive activation ratings did not differ significantly between the groups. PO2.2 rated clarity significantly higher.



Group Means Comparison: Cognitive Load Measures

Both groups showed high levels of germane and active cognitive load, as well as comparable levels of intrinsic cognitive load. PO2.2 had significantly lower extraneous load. Passive load was descriptively higher in PO2.3.

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Metacognitive self-regulation significantly predicted perceived quality; motivational SRL showed a marginal effect.

Expectancy and task value beliefs were positively associated with satisfaction and quality; task value was the only significant predictor in regression analyses.

Self-efficacy for digital teaching and training condition did not significantly influence satisfaction or quality.

TRAINER REFLECTION

The trainer described the course as enjoyable and inspiring to teach, emphasizing her role in creating a safe, supportive, and relaxed learning environment that encouraged active student participation. She observed that students learned most effectively during hands-on, STEAM and maker-oriented activities, which were seen as engaging and memorable, while AI-related tasks were perceived as interesting but sometimes cognitively demanding. The main challenge was the overall workload, particularly due to research-related data collection and assessment demands, which also felt heavy for some students relative to the course credits. Despite these challenges, student feedback was highly positive, highlighting the clarity of sessions, the supportive atmosphere, and the teacher's approachability, reinforcing her view that meaningful learning occurred, especially during interactive and well-supported activities.

IMPLICATIONS for future training design

- **Integrate collaborative design to reduce cognitive burden** – Working collaboratively improved clarity and significantly reduced extraneous cognitive load compared to individual formats.
- **Design for high-quality engagement through hands-on activities** – STEAM and maker-oriented tasks were particularly effective in supporting meaningful and memorable learning experiences.
- **Actively shape the learning environment** – A supportive, safe, and well-facilitated atmosphere contributed strongly to participant engagement and positive evaluations.
- **Monitor workload relative to course scope** – High demands, especially from assignments and research activities, risk overloading participants despite otherwise strong design quality.

CASE TAKEAWAY

This case demonstrates that adding collaborative design to knowledge instruction can simultaneously improve clarity and reduce cognitive load, making learning more efficient. At the same time, the overall training experience is strongly shaped by task design, learning environment, and perceived workload rather than by instructional format alone.

3.5 UAU Case

PA1.1–PA1.2 | Course for Teachers on Digital Skills

KEY FACTS

Training type	Pre-service teacher education
Format	Course-based training within regular sessions
Credits	Not specified
Participants	31 (analysis N = 31)
Trainer	Not specified
Tools	lesson-planning templates, reflection prompts, implementation tasks, digital teaching materials/platforms
Frameworks	ICAP; SRL; DigCompEdu
Effective Training Methods	Knowledge Instruction (KI); Situated Learning (SL)

TRAINING IDEA

The training aimed to strengthen pre-service teachers' digital competence and their ability to integrate technology pedagogically. It compared knowledge instruction alone (PA1.2) with knowledge instruction enriched by situated learning (PA1.1) to examine effects on professional learning and transfer to practice.

HOW THE TRAINING WORKED

- Both conditions included structured theoretical input, guided design tasks, and reflection activities
- PA1.2 focused on knowledge instruction with structured design exercises and guided reflection prompts
- PA1.1 added situated learning through authentic or simulated scenarios, extended instructional product development, and collaborative reflection as well as discussions about implementation challenges
- Training materials were developed based on digital competence frameworks, ICAP-based instructional design principles, SRL theory and practice-oriented instructional design tasks with additional scaffolds for PA1.1

PARTICIPANTS AND CONTEXT

31 pre-service teachers enrolled in a teacher education program participated during a single semester. Participation in the study was mandatory, and both groups followed identical learning objectives and course structures, differing only in the inclusion of situated learning. PA1.1 included 15 participants and PA1.2 included 16 participants. Participants were predominantly in the 18–25 age range, with a smaller number aged 26–35.

HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)

Satisfaction was rated high in both conditions. PA1.1 showed slightly higher enjoyment, perceived usefulness, and perceived knowledge gain, while attitudes were similar across groups.

Perceived quality was rated highly in both conditions. Both formats were rated highly in clarity, structure, and relevance. Cognitive activation was somewhat lower, but still positive and comparable across conditions.

In regards to cognitive load, both formats showed moderate intrinsic load, low extraneous load, and high germane load. PA1.1 had slightly higher intrinsic and germane load, reflecting additional application and reflection demands.

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Satisfaction was strongly related to perceived training quality and moderately to intrinsic and germane load, but not to extraneous load.

Regression analysis showed that training quality was a significant predictor of satisfaction, with germane load showing a positive trend.

TRAINER REFLECTION

Trainers reported positive engagement and constructive participation in both conditions. Clear structure and linkage between theory and application supported engagement.

The situated learning component in PA1.1 fostered deeper reflection, more concrete discussions, and stronger focus on implementation, but required additional time and cognitive effort. Some initial uncertainty in applying concepts decreased over time.

The knowledge instruction format (PA1.2) was efficient and well-structured but led to more conceptual and less application-oriented discussions.

Across both formats, structured guidance, practical relevance, and opportunities for application were identified as key factors supporting positive training experiences.

IMPLICATIONS for future training design

- **Use situated learning to deepen reflection and application** – SL supported more concrete discussions and stronger focus on implementation.
- **Balance depth and efficiency across formats** – KI enables structured and efficient learning, while SL adds depth but increases time and effort.
- **Provide strong scaffolding in early implementation phases** – Initial uncertainty in applying concepts indicates the need for guided transition from theory to practice.
- **Link quality explicitly to learning experience** – Perceived training quality strongly shaped satisfaction, highlighting the importance of clear structure and relevance.

CASE TAKEAWAY

This case highlights a clear trade-off: while knowledge instruction provides efficient and well-structured learning, adding situated learning enhances reflection and practical orientation at the cost of increased cognitive effort. Both formats are effective, but serve different instructional purposes.

3.6 TAU Cases

CI1.1–CI1.2 | Pre-Service Teachers

KEY FACTS

Training type	Pre-service teacher training
Format	Fully online
Credits	3 ECTS
Participants	29 (analysis N = 29)
Trainer	1 trainer (expertise in learning and technologies) and 1 teacher assistant

Tools	MotiBot; ChatGPT; Claude; Padlet; Napkin; Mentimeter; Suno
Frameworks	SRL, ICAP
Effective Training Methods	Knowledge Instruction (KI); Collaborative Design (CD)

TRAINING IDEA

The training aimed to develop pre-service teachers' ability to integrate AI-supported learning environments that promote SRL. It combined theoretical instruction on SRL with practical application using Generative AI chatbots in lesson planning, comparing individual and collaborative design approaches.

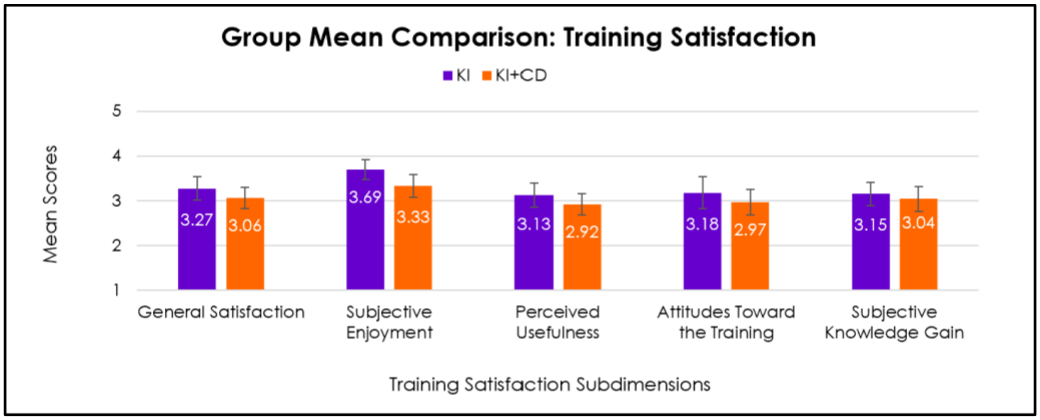
HOW THE TRAINING WORKED

- Participants received structured knowledge instruction on SRL theory and GenAI integration, combined with chatbot-based problem-solving tasks
- Learners analyzed work samples and developed lesson plans integrating GenAI chatbots to support student self-regulation
- In CI1.1, tasks were completed individually; in CI1.2, participants collaborated, including peer feedback and joint decision-making
- Training included online interaction, application tasks, and progression from passive knowledge acquisition to constructive and interactive engagement

PARTICIPANTS AND CONTEXT

Pre-service teachers enrolled in two university courses at Tel Aviv University for teaching humanities and social sciences. Participants had diverse disciplinary backgrounds and limited experience in AI-supported instructional design. There were 13 CI1.1 participants with a mean age of 28.69 years and 16 CI1.2 participants with a mean age of 28.75 years.

HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)



In terms of satisfaction both formats were rated at moderate to high levels across dimensions (subjective enjoyment, perceived usefulness, attitudes towards the training, subjective knowledge gain). No statistically significant differences were found between conditions.

Perceived quality: Not collected .

Cognitive load: Not collected .

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Age, teaching experience, SRL strategies, and digital self-efficacy did not significantly predict satisfaction. Digital self-efficacy showed a moderate but non-significant positive association with satisfaction. Multiple regression analysis found no significant predictors of satisfaction.

TRAINER REFLECTION

Trainers reported challenges in collaborative group work in the CI1.2 format, attributed to the online setting and limited familiarity among participants. Despite this, CI1.2 sessions were perceived as more engaging and enjoyable, with more dynamic active learning.

Across both formats, trainers highlighted the importance of structured guidance, co-teaching, and the alignment between SRL and GenAI. The chatbot was seen as supporting planning, monitoring, and reflection. Course timing and online fatigue were noted as influencing engagement.

IMPLICATIONS for future training design

- **Structure collaboration explicitly in online settings** – Collaborative design can increase engagement, but requires clear guidance and facilitation when participants are unfamiliar with each other.
- **Align tools closely with pedagogical goals** – The integration of GenAI tools was most effective when directly linked to SRL processes such as planning, monitoring, and reflection.
- **Address online fatigue and timing constraints** – Engagement in fully online formats depends strongly on workload distribution and session design.

CASE TAKEAWAY

This case suggests that collaborative design in online environments can enhance engagement, but does not automatically improve overall satisfaction. Its effectiveness depends on structured interaction and participant familiarity, while well-aligned tool use (e.g., GenAI for SRL) remains a key strength of the training design.

CI2.1–CI2.2 | In-Service Teachers

KEY FACTS

Training type	In-service teacher training
Format	Blended
Credits	Not specified
Participants	50 (analysis N = 50)
Trainer	1 trainer (expertise in learning and technologies)

Tools	MotiBot; Padlet; Napkin; ChatGPT/Claude; Mentimeter; Suno; NotebookLM
Frameworks	SRL; ICAP; Cognitive Load Theory
Effective Training Methods	Knowledge Instruction (KI); Collaborative Design (CD); Situated Learning (SL)

TRAINING IDEA

The training aimed to enhance teachers' ability to integrate Generative AI into classroom practices that promote students' SRL. The training was divided into three groups: one control group and two intervention groups. The intervention groups combined Knowledge Instruction and Collaborative Design, with one group adding Situated Learning through real classroom implementation and reflection. The pedagogical focus was on linking SRL theory with AI-supported instructional practice.

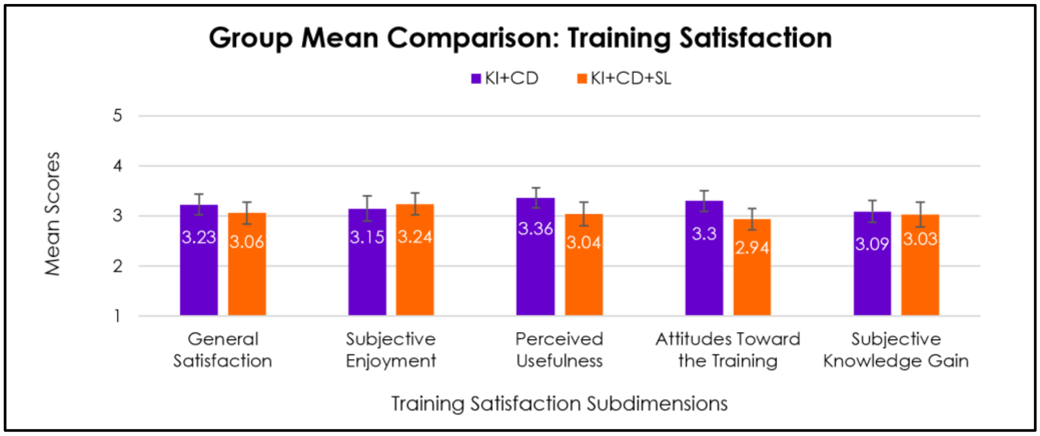
HOW THE TRAINING WORKED

- Participants received structured instruction on SRL and GenAI and collaboratively analysed AI-supported instructional approaches
- Teachers designed AI-enhanced lesson plans using a GenAI chatbot, supported by templates and structured tasks
- In the CI2.2 condition, teachers implemented lesson plans in their classrooms and engaged in structured group reflection
- ICAP was experienced by the teachers through the course design, especially by engaging with the GenAI chatbot and teachers were given direct/explicit instruction on SRL

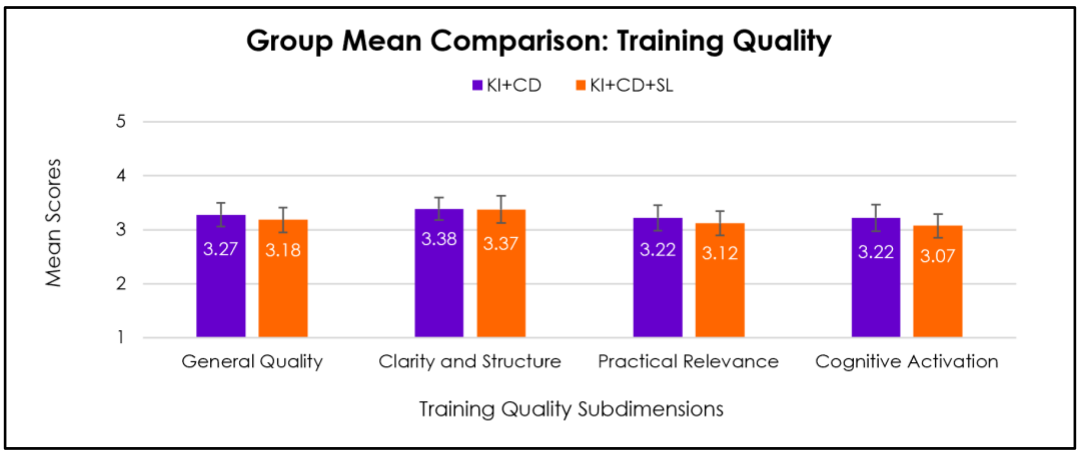
PARTICIPANTS AND CONTEXT

The training was conducted within a single school as part of **a whole-school professional development framework**. Participants were in-service teachers with varying subject areas, professional experience and digital competence. The program was implemented over a six-month period. There were 17 CI2.0 participants and 18 CI2.2 participants. There were 15 participants in the control group. CI2.0 participants had a mean age of 40.18 years and an average of 6.56 years of teaching experience. CI2.2 participants had a mean age of 41.17 years and an average of 10.64 years of teaching experience. Student cohorts were involved in classroom implementation in the SL condition.

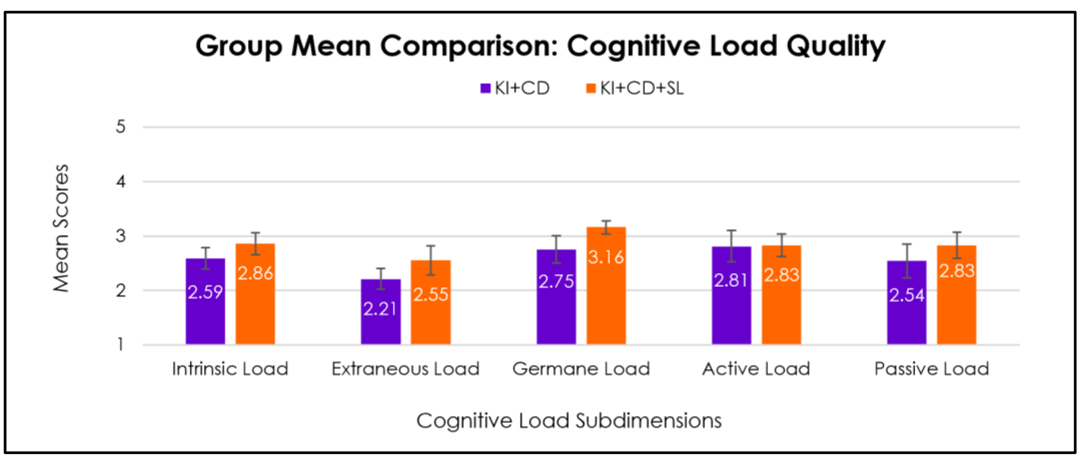
HOW PARTICIPANTS EXPERIENCED THE TRAINING (LEVEL 1)



Satisfaction was rated moderate to high in CI2.0 and moderate in CI2.2 with no significant differences between groups.



Perceived quality was rated consistently moderate across both conditions and clarity and structure were rated highest.



In terms of cognitive load extraneous load was rated low and intrinsic and germane load were rated moderate in CI2.0. Extraneous, intrinsic and germane load were rated slightly higher in CI2.2.

WHAT INFLUENCED PARTICIPANTS' EXPERIENCES

Extraneous cognitive load was a strong negative predictor of both satisfaction and perceived quality. Teachers' own SRL strategies positively predicted satisfaction. In addition, satisfaction and perceived quality were strongly correlated ($r = .92$). Age, teaching experience, group, and digital self-efficacy were not significant predictors.

TRAINER REFLECTION

Training implementation in a school context was complex due to mandatory participation, end-of-day scheduling, and participant fatigue. The CI2.2 condition required substantial time and resources for classroom implementation and support, and some resistance to AI tools was observed.

At the same time, the shared school context enabled professional dialogue, supported by principal involvement and collective participation. The integration of SRL and GenAI was perceived as pedagogically coherent, with the chatbot supporting planning, monitoring, and reflection. Continuity was challenged by infrequent sessions and long intervals between meetings.

IMPLICATIONS for future training design

- **Align training with school conditions and time constraints** – Mandatory participation, scheduling, and limited time reduced engagement, especially for practice-based components.
- **Use situated learning selectively in in-service contexts** – Classroom implementation adds strong practical value but requires substantial support, time, and coordination.
- **Minimise extraneous cognitive load in complex training settings** – External demands (e.g. logistics, workload, coordination) strongly reduced satisfaction and perceived quality.

CASE TAKEAWAY

This case shows that in whole-school, in-service contexts, the effectiveness of training depends less on instructional design alone and more on implementation conditions. While situated learning strengthens practice connection, it also increases demands, making feasibility and workload critical factors for participant experience.

4. Cross-partner comparison and synthesis of results

4.1 Overall patterns across cases

Across the EffecTive cases, a clear common pattern emerged: participants **generally reported positive to highly positive reactions** to the training, regardless of the specific instructional configuration. Across partners, satisfaction, perceived usefulness, attitudes towards the training, and perceived training quality were favourable in most cases, even when the formats differed substantially (e.g. fully online self-paced, blended, whole-school, and practice-based designs). Only a limited number of statistically significant differences between training conditions were observed at this level, and where such differences occurred, they were usually case-specific rather than consistently replicated across implementations.

This is an important finding in itself. It suggests that **multiple training designs can generate positive immediate reactions when they are implemented coherently** and perceived as meaningful by participants. At the same time, the cross-case comparison also indicates that overall satisfaction and general quality ratings are relatively weak discriminators between training approaches. In other words, the Level 1 results do not point to a single universally superior training method.

The more informative differences emerged in **how the training was experienced**. Across cases, variation was more visible in the areas of practical relevance, clarity, and cognitive load, especially when training designs differed in complexity, degree of collaboration, or demands for classroom implementation. This suggests that the value of the Level 1 comparison lies less in understanding how different instructional configurations shape the perceived meaningfulness and manageability of the training experience. An overview of the levels of satisfaction, perceived quality, and cognitive load across all cases is shown in Table 7. Darker orange indicates higher levels of agreement. Statistically significant differences are marked with green frames when they occur in the expected direction and red frames when they occur in an unexpected direction.

Partner	TLU						UWK		UULM								Oulu		UAU		TAU			
Case	CT 1.1	CT 2.1	CT 3.1	CT 3.2	CT 4.1	CT 4.2	CK 1.1	CK 2.1	CUU 1.1	CUU 1.2	CUU 2.1	CUU 2.2	CUU 3.1	CUU 3.2	CUU 4.1	CUU 4.2	PO 2.2	PO 2.3	CA 1.1	C1 1.2	CI 1.1	CI 1.2	CI 2.1	CI 2.2
Method	KI	KI+ SL	KI+ CD+ SL	KI+ CD+ SL+ M	KI+ CD	KI+ CD+ SL	KI	KI+ CD	KI+ SL	KI	KI	KI+ SL	KI+ SL	KI	KI+ SL	KI	KI+ CD	KI	KI+ SL	KI	KI	KI+ CD	KI+ CD	KI+ CD+ SL
N	40	13	21	10	31	16	4	3	9	9	12	17	6	5	31	15	82	15	15	16	13	16	17	18
Pre-In-service teachers	pre	in	pre		pre		in	pre	in		in		in		pre		pre		pre		pre		in	
Satisfaction																								
Enjyoment																								
Usefulness																								
Attitude																								
Knowledge gain																								
Training Quality																								
Clarity																++	++							
Relevance						++																		
Cognitive avtivation																								
Cognitive load																								
Intrinsic																								
Extraneous				++														++						
Germane			++																					
Active																								
Passive																								

Table 7: levels of perceived satisfaction, training quality and cognitive load for all the cases

High scores (> 3.5)

Medium scores (2.5<x<3.5)

Low scores (< 2.5)

Significant – expected direction

Significant – unexpected direction

These findings suggest that Level 1 outcomes in the EffecTive project are best understood as an **early indicator of design quality and design fit**. Across the cases, positive reactions were common, but the strongest signal lay in the **extent to which different training designs were experienced as clear, relevant, and cognitively manageable within their specific contexts**. This provides the basis for the more detailed cross-case interpretation presented in the following sections.

4.2 Cross-case synthesis of how PDC and SRL support were operationalised

Across the EffecTive cases, the training interventions varied in format, target group, and instructional configuration, yet they shared a common pedagogical ambition: to support teachers' PDC as the development of the capacity to make pedagogically meaningful, context-sensitive decisions about technology use in teaching. Across cases, this was reflected in training activities that focused on connecting technology to instructional goals, classroom situations, and student learning processes. In practice, this included, for example, analysing classroom cases, designing or adapting learning tasks and lesson plans, reflecting on the pedagogical affordances of digital tools, and linking technology use to broader frameworks such as the **European Digital Competence Framework for Educators (DigCompEdu)**, **cognitive engagement (ICAP)** and **SRL**. Although the exact conceptual references differed across partners, DigCompEdu functioned as an important common reference point for understanding the professional dimensions of teachers' digital competence, while other frameworks such as SRL, ICAP, and TPACK helped translate these dimensions into pedagogically meaningful training activities. Across the cases, the common pattern was that digital competence was generally approached as a professional competence for designing, interpreting, and improving teaching, rather than as a narrow focus on tool use alone.

A similarly shared pattern could be seen in how the interventions aimed to support teachers in fostering students' SRL. While **SRL was not always addressed as an explicit stand-alone training topic** in all cases, it was frequently embedded through the design of pedagogical tasks and reflection activities that encouraged teachers to consider how students plan, monitor, regulate, and reflect on their own learning in technology-enhanced environments. Across cases, this was operationalised through activities such as analysing whether learning tasks promoted active or constructive engagement, examining how digital tools could scaffold student reflection or feedback, designing learning activities that required students to take greater responsibility for their learning process, and reflecting on how classroom practices could better support regulation, participation, and cognitive engagement. Importantly, in several cases the **ICAP framework** was introduced as a conceptual model, but in several other cases also enacted through the training design itself: teacher learning was structured through activities that moved beyond passive reception towards active engagement, constructive reflection, collaborative design, and discussion. In this sense, the cases suggest that SRL support was often enacted indirectly but meaningfully, not simply by teaching SRL as theory, but by helping teachers translate SRL-related principles into task design, classroom orchestration, and instructional decision-making.

4.3 Cross-case tendencies of instructional configurations

At Level 1, the comparison of training methods does not identify a single better approach; rather, it clarifies the different roles that instructional components can play in shaping participants' experiences of clarity and relevance. While overall satisfaction and perceived quality remained largely unaffacted by the particular format, selected statistically significant differences, observed at the level of individual cases, provide useful insight into how different instructional components function within training designs. These findings should therefore be interpreted as cross-case tendencies rather than as stable effects of isolated methods.

Knowledge Instruction (KI) appeared to function as a foundational structuring component. Across several cases, KI-based training supported high levels of perceived clarity and provided a manageable entry point into new concepts, frameworks, or pedagogical approaches, particularly in less complex or more strongly scaffolded formats. At the same time, when used in isolation, KI offered fewer opportunities for application, collaborative interpretation and contextualised sense-making. This suggests that KI is particularly valuable as a basis for learning, but often benefits from being complemented by more active or practice-oriented elements.

Collaborative Design (CD) emerged as a particularly important **sense-making and complexity-stabilising component**. Across cases, its inclusion appeared to support shared interpretation and the translation of abstract ideas into concrete pedagogical decisions. In some comparisons, CD was associated with higher perceived clarity than KI-only formats, and in at least one case, it was associated with significantly lower **extraneous cognitive load**. Similar tendencies were also reflected in trainer accounts from other implementations. Rather than indicating a universally "better" method, these patterns suggest that **collaborative processes can help participants manage complexity** by distributing cognitive demands, reducing ambiguity, and supporting joint problem-solving. At the same time, the effectiveness of CD depended on facilitation, structure, and the composition of the participant group, especially in larger or more heterogeneous settings.

Situated Learning (SL) most consistently **strengthened the perceived relevance and practical meaningfulness** of the training. Across several cases, configurations that included situated elements were more likely to be experienced as closely connected to participants' own teaching realities and therefore as professionally meaningful. In some comparisons, combinations such as KI+CD+SL were associated with significantly higher relevance than KI-only formats. However, SL did not function as a uniformly positive add-on. In individual cases, more open-ended or implementation-intensive SL formats were associated with lower perceived clarity, likely reflecting the greater interpretive and organisational demands of authentic practice-oriented tasks. This suggests that SL is particularly valuable when it is bounded, scaffolded, and feasible within participants' contexts, rather than when it is treated as a stand-alone method without sufficient support.

Mentoring and Coaching (M) did not systematically improve satisfaction or perceived training quality. In the most complex training condition (KI+CD+SL+M), individual cases showed significantly higher extraneous cognitive load and lower germane load, indicating that the **addition of mentoring may introduce further coordination and processing demands** without necessarily increasing deeper cognitive engagement. At the same time, qualitative reflections suggest that **mentoring may still be valuable for participants who require additional support,** particularly in more demanding or less structured formats. The findings therefore point to mentoring as a targeted support mechanism, rather than as a universally beneficial enhancement layer that should automatically be added to already complex training designs.

Overall, the findings suggest that combining methods can enhance specific aspects of training quality, such as clarity, relevance, and practical meaningfulness, but can also increase design complexity and implementation demands. Across the cases, the **key issue is therefore not method choice alone**, but how instructional components are combined, scaffolded, and aligned with the target group and context. More structured configurations (combining clear conceptual input with collaborative or bounded practice-oriented activities) appeared particularly feasible in pre-service settings, where participants generally benefited from stronger scaffolding and structured progression. In contrast, in-service settings often benefited more strongly from situated and practice-based components, as these enhanced perceived relevance and transfer to classroom practice. At the same time, these configurations were also more **sensitive to implementation challenges**, including time constraints, coordination demands, and contextual variability across teaching domains. Whole-school formats amplified both the potential and the complexity of such designs, offering strong relevance through shared context while requiring greater organisational support, differentiation, and leadership alignment. Taken together, these patterns suggest the **value of specific method combinations depends on how well they match the realities of the target group and implementation context.**

4.4 Role of contextual factors

Across the cases, participant reactions were shaped not only by the instructional approaches used, but also by the **conditions under which these approaches were implemented**.

Across the **pre-service cases,** participants generally **responded positively to well-structured and clearly scaffolded training formats**, even when the content was conceptually demanding or the participant groups were relatively diverse. In these settings, **Knowledge Instruction** often functioned effectively as a foundation for introducing theoretical frameworks and design principles, while collaborative and situated-learning components added value when they were clearly bounded and well supported. In several pre-service cases, situated learning strengthened perceived relevance, but full classroom implementation was not always necessary for positive evaluations; worked examples, and design-based tasks were often sufficient to create meaningful engagement.

In contrast, the **in-service cases suggest that participants evaluated training more strongly through the lens of immediate applicability and feasibility** within their professional context. In these settings, situated components were often perceived as especially valuable because they connected directly to participants' own classroom realities. At the same time, in-service formats were more vulnerable to contextual constraints such as limited time, scheduling issues, competing work demands, and the practical complexity of classroom implementation. As a result, the same instructional components that enhanced relevance could also increase extraneous cognitive load or reduce sustained engagement if implementation demands exceeded what was feasible within participants' working conditions.

Whole-school approaches represented a specific contextual configuration with both clear strengths and important challenges. Their main advantage lay in the **shared institutional context**, which supported collaboration, common language, and relevance to school-level development. In several cases, whole-school formats also benefited from protected professional development time and stronger opportunities for peer exchange. At the same time, these formats introduced challenges related to **subject diversity, uneven motivation, differing levels of prior knowledge, and uneven participation**, which made sustained engagement and consistent implementation more difficult. This suggests that whole-school formats can be particularly powerful when organisational support is strong, but they require careful structuring, differentiation, and leadership support to realise their potential.

Trainer reflections further emphasised that contextual factors strongly influenced implementation quality across all settings. Large and heterogeneous groups required **differentiated tasks, flexible methods and multiple entry points** to maintain relevance. Similarly, the degree of **domain specificity** appeared to matter: when training activities aligned closely with participants' own subject area or teaching context, the training was more often experienced as relevant and manageable. By contrast, cross-disciplinary or highly heterogeneous groups often required greater translation effort from participants, increasing the risk that otherwise well-designed tasks would feel less immediately applicable.

Across cases, **expectancy-value appraisals** emerged as one of the most consistent explanatory patterns for training **satisfaction** and **quality**. Participants evaluated the t**raining more positively** when they perceived it **as valuable for their professional practice** (task value) and when they felt that they would be able to engage successfully with the tasks and **apply what they learned** (expectancy for success). This pattern was reflected in several case-level analyses, where task value and expectancy-related appraisals were more consistent predictors of satisfaction and perceived quality than demographic variables or prior experience. In particular, participants' belief that the training was meaningful and that they would be able to apply it in their own teaching context appeared to be closely linked to more positive evaluations. At the same time, several recurring contextual constraints (mandatory participation, weak alignment with participants' subject areas, unfavourable scheduling, and demanding implementation requirements) reduced the likelihood that otherwise strong instructional designs would be experienced positively. These findings suggest that participants' reactions were shaped by the balance between perceived value, expectancy for successful transfer, and the practical demands associated with participation and implementation.

These results suggest that participants' perceptions of training do not depend only on instructional design, but also on the **fit between the design, the target group, the domain, and the institutional conditions**. The cross-case evidence indicates that contextual factors should be understood as integral to training quality itself. In this sense, the cases suggest that successful teacher professional development requires appropriate instructional methods and careful alignment between training design and the realities of the context in which participants are expected to learn and apply new practices.

4.5 Cognitive load as an explanatory mechanism

Cognitive load provides an important **lens for interpreting differences between training designs.** While satisfaction and perceived quality were consistently high across most cases, variations in **extraneous** and **germane load** reveal more clearly how participants experienced the demands of different formats. In this sense, **cognitive load differentiated training designs** more sensitively than global reaction measures alone.

More complex training designs, particularly those **combining multiple methods,** were associated in some individual cases with increased extraneous load, reflecting additional coordination demands, task complexity, and organisational burden. At the same time, such designs did not consistently lead to higher germane load, suggesting that **increased complexity does not automatically translate into deeper cognitive processing**. This indicates that the key issue is not complexity per se, but whether complexity is experienced as meaningful and manageable or as an avoidable burden.

At the same time, cognitive load did not emerge as a stable method effect that could be attributed straightforwardly to specific instructional approaches such as KI, CD or SL. Rather, across the cases, participants' experience of load was shaped by the interaction between instructional components and contextual conditions. In particular, cognitive load appeared to depend on how clearly tasks were structured, how feasible implementation demands were, how strongly activities were aligned with participants' own teaching domain, and whether the format matched the realities of pre-service or in-service participation.

Within this broader pattern, **some cross-case tendencies can nevertheless be observed**. The inclusion of **collaborative elements** was associated in some cases with **reduced extraneous load**, indicating that shared problem-solving and structured interaction can help participants manage complexity. **Situated learning** increased perceived relevance and, in some cases, **did not increase cognitive load**, provided that tasks were clearly structured and feasible within participants' contexts. This suggests that the same instructional principle can be experienced as manageable and productive in one case, but as unnecessarily demanding in another, depending on scaffolding, pacing, group heterogeneity, time constraints, and the extent to which participants must translate training tasks into real classroom practice.

Trainer reflections support this interpretation. Across partners, trainers reported that more complex or practice-oriented formats require stronger scaffolding, clearer task design, differentiated entry points and sufficient time for implementation and reflection. Without such support, participants may experience tasks as demanding without achieving deeper engagement. This was particularly evident in contexts where participants faced strong practical constraints, such as in-service or whole-school formats, or where the training required substantial transfer into diverse subject domains.

Overall, these patterns indicate that **cognitive load is a key mechanism linking training design to participant experience**. However, in the EffecTive cases, it is best understood not simply as a consequence of method choice, but as an **indicator of design fit and manageability**. The findings suggest that effective teacher training depends on achieving **a careful balance between cognitive activation and feasibility,** so that challenging learning experiences remain productively demanding rather than unnecessarily burdensome.

4.6 Other Variables influencing reactions to training

Across cases, the most consistent pattern was that participants' evaluations were **more strongly related to their motivational appraisals** of the training than to stable background characteristics. In several cases, variables as particularly perceived task value, expectancy of success emerged as more consistent predictors of satisfaction and perceived quality than demographic variables or prior teaching experience.

In other words, **participants tended to evaluate the training more positively when they experienced it as professionally worthwhile**, achievable, and applicable within their own context. This pattern reinforces the interpretation that Level 1 reactions in the cases were shaped not only by instructional design itself, but also by whether participants saw a realistic pathway from training activities to meaningful use in their own practice.

By contrast, **demographic variables and prior experience** showed no stable cross-case pattern. Age, teaching experience, and other background characteristics were not consistently associated with more positive or more negative evaluations. While such factors may matter in individual implementations, the overall evidence suggests that they were less informative than participants' own appraisals of relevance, feasibility, and expected benefit. This is an important finding for the interpretation of the project as a whole: positive or critical reactions were not primarily a function of who the participants were, but of how well the training design connected with their perceived professional needs and opportunities for use.

The **role of teachers' own SRL skills was more differentiated**. In some cases, SRL-related variables were associated with more positive evaluations, particularly in formats that required greater autonomy, self-pacing, or independent transfer into practice. In these settings, participants with stronger regulation skills appeared better able to manage the demands of the training and to maintain engagement. However, this pattern was not consistent across all cases. Rather than functioning as a universal predictor, **SRL therefore appears to operate as a conditional resource**: it becomes more relevant when the design places greater responsibility on participants to organise their learning and translate ideas into practice under less direct support.

Trainer reflections further support this interpretation and help explain **why similar instructional components could be experienced differently across cases**. Across implementations, trainers repeatedly highlighted the importance of clear structure, practical relevance, manageable task framing, and timely feedback. They also noted that participant heterogeneity, in prior knowledge, subject area, motivation, influenced how training tasks were perceived. In more open or practice-based formats, participants often needed additional scaffolding to connect abstract frameworks with their own teaching realities. Conversely, when tasks were clearly structured and visibly connected to authentic professional challenges, participants were more likely to report positive experiences even in more demanding formats. These qualitative reflections align closely with the quantitative patterns: what mattered most was not simply the formal method used, but whether the design supported participants in seeing the training as valuable, feasible, and worth the effort.

At the same time, **the case-level analyses should be interpreted with caution**. In several cases, relatively small sample sizes limited the statistical power of regression models and reduced the robustness of predictor patterns. The analyses of influencing factors are therefore best understood as exploratory and hypothesis-generating, rather than as definitive tests of causal relationships. Nevertheless, the convergence between quantitative tendencies and trainer reflections strengthens the overall interpretation. The case-level evidence suggests that participants' reactions at Level 1 were shaped less by isolated design features or participant demographics than by the **interaction between instructional design, contextual fit, and participants' motivational appraisals** of the training.

5. Implications and lessons learned

5.1 Implications for future teacher training design

The cross-case findings suggest that effective teacher training design is primarily a question of **alignment rather than method selection**. No single instructional approach consistently outperformed the others at Level 1. Instead, positive participant experiences emerged when training designs were coherently aligned with the **target group, the intended learning processes, and the realities of implementation**.

A first implication concerns the importance of **balancing structure and authenticity**. Across the cases, training was generally experienced most positively when the content and tasks were provided with clarity and transparency regarding the goals, while also being able to connect the training to their specific authentic professional situations. This suggests that effective training design should combine **conceptual clarity** with **practice-oriented relevance**. In practical terms, this means that theoretical frameworks and pedagogical principles should be translated into concrete tasks, examples, and decision-making situations that help participants see how ideas can be applied in their own professional contexts.

A second implication concerns the importance of **scaffolding in more complex training designs**. The findings indicate that situated and multi-component formats can create highly meaningful learning opportunities, but they also place greater demands on participants. Without sufficient structure, time, and support, these formats risk being experienced as demanding rather than productive. Future training designs should therefore treat **structured support as a central design principle**, especially when participants are expected to engage in collaborative design, classroom implementation or reflection on authentic teaching situations. This includes clear task instructions, implementation support, opportunities for feedback, and sufficient time for interpretation and reflection.

A third implication concerns the value of **collaboration as a mechanism for managing complexity**. Across cases, collaborative elements appeared particularly useful. Collaborative work should be designed not as an add-on, but as a **purposeful sense-making process that** supports shared interpretation and application. At the same time, collaborative formats require careful facilitation, clear roles, and appropriately composed groups, particularly in large or heterogeneous cohorts.

The findings also highlight the importance of **differentiation and flexibility**. Participants entered the training with different levels of prior knowledge, teaching experience, self-regulation skills, and subject-specific needs. As a result, the same design could be experienced as appropriately challenging by some participants and unnecessarily demanding by others. For participants with different backgrounds, needs, and skill levels, training should offer multiple entry points and varied tasks so the challenge fits each person., especially in larger, cross-disciplinary, or whole-school formats. This is particularly important in digital competence training, where participants may differ substantially in both technological confidence and the relevance of specific examples to their own teaching domains.

A further implication concerns the role of **practice transfer as a design condition rather than a post-hoc expectation**. The findings suggest that participants evaluated training more positively when they could see a realistic pathway from the training activities to their own classroom practice. This means that transfer should not be treated as something that happens after training, but as something that must be designed into the training itself. Future interventions should therefore make explicit how new ideas, tools, or strategies can be adapted to participants' own contexts, and should ensure that implementation expectations remain feasible in relation to time, institutional constraints, and participants' professional responsibilities.

Results suggest that effective teacher professional development in digital competence should be designed as a **coherent, context-sensitive learning process** that balances **clarity and relevance**. Future training should combine instructional components in ways that support both engagement and realistic transfer into practice. In this sense, the most important design lesson is on **how to create training configurations that are sufficiently structured to support learning, sufficiently authentic to support professional meaning, and sufficiently feasible to be sustained in real educational contexts**.

5.2 Implications for policy and scaling of teacher training

Scaling training designs across varied education systems and trainer profiles requires more than replicating a fixed model. From a policy perspective, the findings point to the importance of **enabling conditions rather than prescribing specific training methods**. The effectiveness of teacher training depends not only on instructional design, but also on how it matches institutional, participants and trainer factors.

In particular, scalable implementation requires attention to **time, organisation, and coordination**. Training that involves different methods, like classroom implementation, collaboration, or mentoring cannot be effectively realised without careful planning, dedicated time, alignment with school schedules, and support from leadership.

The results further suggest that **modularity is an important principle for scaling**. Instead of promoting fixed training models, it is more effective to support flexible combinations of components (e.g. conceptual input, collaboration, authentic tasks) that can be adapted to different contexts and trainees' profiles. This allows training providers to adjust complexity and resource requirements depending on target groups and institutional conditions. This modularity also supports differentiation, allowing the same components to be recombined for participants with different backgrounds, skill levels, and subject needs.

Another important consideration concerns **participation and engagement**. The findings indicate that training is more effective when participants perceive it as relevant to their domain-specifics and connected to their professional practice. From a system perspective, this raises questions about how participation is organised and incentivised. Overall, the results suggest that on a policy level there might be a need for prioritizing **flexible infrastructures for professional learning**, within which different approaches can be implemented, adapted, and sustained. Therefore we suggest a wider set of indicators for effectiveness that could be monitored and used to adapt the programs regarding the specific needs.

5.3 Implications for cost-benefit trade-offs

The results provide a basis for understanding cost-benefit relations in teacher training by highlighting **trade-offs between design complexity, cognitive demands, and implementation effort**.

One key observation is that differences between training formats are more visible in terms of **cognitive demands than in overall evaluations**. While satisfaction and perceived quality were consistently high, more complex designs were associated in individual cases with increased extraneous cognitive load. Importantly, these additional demands did not consistently lead to higher levels of productive engagement. This suggests that increasing complexity can raise participant "costs" without proportionate gains in perceived benefit.

At the same time, certain design elements appear to contribute to more efficient configurations. Structured formats that combine clear input with collaborative processing were able to maintain positive evaluations while keeping cognitive demands relatively manageable. In contrast, elements such as mentoring or extended implementation phases introduced additional coordination and effort, both for participants and trainers, and should therefore be considered more selectively.

Trainer reflections further highlight that cost considerations extend beyond participant experience. More complex formats require increased effort for planning, feedback, and coordination, and depend on favourable conditions for implementation. These factors affect the feasibility and sustainability of training designs and should be included in any comprehensive cost-benefit consideration.

As the project is developing the final version of the Cost-Benefit Framework (D4.4, see D4.1 (Wagner et al, 2024b) for the initial version), the findings indicate that the framework and how it is used should not focus on isolated components, but on the **balance between perceived value, cognitive demands, and implementation effort**. Training designs that achieve strong relevance and engagement while remaining manageable in terms of effort and resources are likely to offer the most favourable profiles. Moreover, discussing cost-benefit trade-offs needs to be embedded into a good understanding of the contextual implementation factors of the training, including national, regional and organisational conditions (see section 4.4).

5.4 Methodological reflections and limitations

The evaluation approach adopted in this study combines several strengths, but also entails important limitations that need to be considered when interpreting the results.

A key strength lies in the **comparative multi-case design across diverse contexts**, which allows for identifying patterns that go beyond individual implementations. The use of a shared evaluation framework across partners ensured a common basis for comparison, while still allowing adaptations to local conditions. In addition, the integration of **participant data, trainer reflections, and exploratory analyses of influencing factors** provides a more comprehensive understanding of training experiences than a purely quantitative or standardised approach.

At the same time, this design also introduces limitations.

1. The analysis is based primarily on **self-reported measures of Level 1 (reaction)**. While these provide important insights into perceived quality, satisfaction, and cognitive demands, they do not allow conclusions about actual learning outcomes or behavioural change. As such, the findings should be interpreted as indicators of training experience rather than effectiveness in a broader sense.

2. The **comparability across cases is necessarily limited**. Although a shared framework and common instruments were used, training implementations differed in terms of target groups, duration, formats, and contextual conditions. These variations are an intentional feature of the project design, but they also mean that observed differences cannot be attributed to single design elements in a strictly causal sense.

3. The **statistical analyses of influencing factors are exploratory in nature**. In several cases, sample sizes were relatively small, limiting statistical power and the robustness of regression results. Consequently, findings regarding predictors such as SRL skills or motivational beliefs should be interpreted as indicative rather than conclusive.

4. Another important aspect concerns the **co-design approach** adopted in the project. Training interventions were developed and implemented in close collaboration with trainers and institutions. While this strengthens ecological validity and ensures relevance to practice, it also means that implementation fidelity varies across cases. Rather than strictly controlled conditions, the study reflects real-world adaptations and constraints, which both enrich the findings and limit standardisation.

5. The evaluation itself formed part of the training context. The use of **extensive questionnaires** may have influenced participants' experiences, for example by increasing perceived workload or affecting engagement. While efforts were made to structure the instruments carefully, such effects cannot be fully excluded.

Overall, the methodological approach prioritises **ecological validity, contextual sensitivity, and practical relevance** over strict experimental control. The findings should therefore be understood as providing **robust cross-case insights and design-oriented evidence**, rather than generalisable causal effects. This perspective is consistent with the project's aim to inform practice, policy, and further research in a complex and heterogeneous field.

5.5 Conclusion

This deliverable provides a comparative overview of how **teacher training interventions carried out within the Effective project intervention phase were implemented and experienced** across diverse contexts. By bringing together experience and evidence from pre-service, in-service, and whole-school cases, it contributes to an evaluation of participants' immediate reactions , but also a cross-case account of how the project's shared training principles were enacted in practice. Across the cases, the findings show that positive participant experiences can be achieved through a variety of training designs. Rather than identifying a single "best" approach, the analysis highlights that the quality of teacher professional development depends primarily on the alignment between instructional design, contextual conditions, and participants' opportunities to engage meaningfully with the training.

This deliverable provides an important empirical basis for later **cost-benefit discussions** in teacher professional development. This analysis helps clarify which training designs appear to combine strong participant experiences with relatively manageable implementation demands. The cross-case findings suggest that different instructional configurations vary not only in their perceived relevance and quality, but also in the degree of organisational support, scaffolding, time, and coordination they require. In this sense, the report helps identify feasibility-value trade-offs that are essential for later analyses of scalability, sustainability, and cost-benefit relations.

Beyond the immediate Level 1 findings, the EffecTive cases also provide broader design-oriented lessons about how professional development can support the development of teachers' pedagogical digital competence (PDC). Across the cases, the most meaningful training experiences emerged from training designs that treated digital competence as a broader professional competence involving pedagogical understanding, instructional design, context-sensitive judgement, and the connection to subject or domain-specific practice. The cases suggest that PDC development is best supported when conceptual input is closely connected to authentic teaching situations, when participants are given opportunities to analyse, design, adapt, and reflect on practices relevant to their own contexts, and when transfer into classroom practice is treated as an explicit design condition rather than a post-hoc expectation. At the same time, the findings indicate that more situated and complex formats require careful scaffolding and sufficient support in order to remain productive rather than burdensome. In this sense, the EffecTive project also contributes to practical insight into how teacher training for PDC can be designed as a coherent and context-sensitive learning process.

These insights form an important foundation for the next stages of the project. They support the interpretation of later analyses of learning outcomes and transfer (D3.2), inform the development of the project's cost-benefit framework (D4.4), and contribute to the formulation of policy-relevant lessons for the design and scaling of teacher professional development in technology-enhanced learning environments.

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Appendix 1

Level 1: Reactions

Training satisfaction: Training evaluation inventory (Ritzmann et al., 2014) to evaluate teachers' reactions towards the training (*subjective enjoyment, perceived usefulness, perceived difficulty, attitude towards training*) → 14 items, 5-point Likert scale ranging from "strongly disagree" to "strongly agree".

Subjective enjoyment:
1. Overall, I liked the training.
2. The learning atmosphere was agreeable.
3. The learning was fun.

Perceived usefulness:
1. I find the training useful for my job.
2. Investing time in this training was useful.
3. I can apply the content of this training in my job.
4. I derive personal use from this training.

Perceived difficulty:
1. The contents were comprehensible.
2. The language (foreign words and technical terms) was comprehensible.
3. I kept up thematically in the training.
4. The time was sufficient for the themes covered.

Attitude towards training:
1. I will apply what I learned to my day-to-day work.
2. I find it good that these topics were imparted and/or discussed.
3. I would recommend this training to my colleagues.

Subjective knowledge gain:
1. I have the impression that my knowledge has expanded on a long-term basis.
2. I will be able to remember the new themes well.
3. I think that I will still be able to report what I learned some time after the training.

Training quality: Richter & Richter (2024) (*clarity and structure, practical relevance, cognitive activation, collaboration*) → 18 items, 5-point Likert scale ranging from "strongly disagree" to "strongly agree"

Clarity and structure:
1. The goals of the course were clearly stated.
2. The course content was explained in a comprehensible manner.
3. In the event, the time was used efficiently.

4. The agenda of the course was clarified at the beginning.
5. The individual components of the course built on each other in a meaningful way.

Practical relevance:

1. The discussion of the contents was based on real examples from school practice.
2. The aspects covered in the course were related to my current professional practice.
3. The course addressed problems that I encounter in my everyday professional life.
4. What I learned in the course I can apply in my professional practice.

Cognitive activation:

1. My prior knowledge was incorporated into the course.
2. In the course, I was asked questions or given tasks that made me think.
3. I was able to reflect on my professional tasks in the course.
4. The feedback I received during the course provided me with concrete advice for my professional development.
5. The course offered the opportunity to question previous routines in my work.
6. In the course, I was able to think my way into the unknown.

Collaboration:

1. During the course, I had the opportunity to discuss the course content intensively with the other participants.
2. The course offered the opportunity to work on tasks with other participants.
3. The course allowed for work in small groups.

Cognitive Load: Klepsch, Schmitz, & Seufert (2017) (*intrinsic, extraneous and germane cognitive load*) and for a short version of passive and active load (Klepsch & Seufert, 2020). Passive load represents those factors that are driven from the learning environment and can be seen as load and burden and active load representing the effort a learner invests and are hence learner-driven. → 10 items, 7-point Likert scale ranging from “strongly disagree” to “strongly agree”

Intrinsic Cognitive load:

1. For this training, many things needed to be kept in mind simultaneously.
2. This training was very complex.

Extraneous Cognitive Load

1. During this training, it was exhausting to find the important information.
2. The design of this training was very inconvenient for learning.
3. During this training, it was difficult to recognize and link the crucial information.

Germane Cognitive Load:

1. I made an effort, not only to understand several details, but to understand the overall context of the training.
2. My point while dealing with the training was to understand everything correct.
3. The learning task consisted of elements supporting my comprehension of the task.

Passive / Active Cognitive Load:

1. Passive: The training was strenuous.
2. Active: I exert myself for the training.

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