effecTive

WORK PACKAGE 02

OVERVIEW OF THE PLANNED TRAINING INTERVENTIONS

DELIVERABLE D2.1

Work Package 2

Design of effective Teacher Training Interventions for PDC

Deliverable D2.1

Overview of the planned training interventions

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Executive summary

Deliverable D2.1 outlines our approach to designing and implementing training interventions aimed at developing teachers' **Pedagogical Digital Competence** (PDC), aligned with relevant policy measures. Our approach is grounded in the adapted ADDIE model, which ensures a structured process encompassing analysis, design, development, implementation and evaluation. This model guides the customization of training interventions to meet diverse needs across target groups and institutional contexts, fostering inclusivity and equity in professional learning.

In the second section, we provide **a theoretical background** that informs our training design. This includes key elements such as self-regulated learning, the ICAP (interactive, constructive, active, passive) framework for cognitive engagement, and the integration of technological, pedagogical, and content knowledge (TPACK) to foster teachers' digital competence effectively. These frameworks are tailored to empower teachers from varying backgrounds and experience levels, ensuring that all participants can build digital competence effectively and inclusively

The third section highlights **specific training cases**, categorised into two phases: the pilot phase, which focuses on refining training activities and content based on initial feedback, and the intervention phase, which operationalizes these activities in authentic teacher training environments. These cases directly support D3.1: Research Designs and Instruments, ensuring a coherent link between training practices and research designs. The iterative design ensures that equity considerations—such as access to resources, differentiated training approaches, and cultural relevance—are integrated throughout the training process.

Our training design approach emphasises active **engagement**, iterative **feedback loops**, and **contextual adaptation**. By focusing on the design principles that ensure alignment between theoretical foundations and practical applications, we offer training institutions a replicable design framework. While intervention studies are still under negotiation and elaboration, D2.1 provides actionable guidance for designing teacher training interventions leading to improved PDC and ultimately students' learning outcomes. This report offers a deeper understanding of how to structure and implement PDC-focused training, empowering teacher educators to develop sustainable, inclusive and adaptable professional learning practices.

The EffecTive project highlights critical design decisions, which are informed by theoretical frameworks, practical application and contextual relevance. The key design considerations include:

- **Contextual relevance:** Training interventions are adjusted to align with local educational policies, cultural contexts, and classroom realities. By incorporating domain-specific focus, training interventions make abstract concepts, like cognitive engagement, more accessible and actionable within subject-specific teaching practices, ensuring the training is applicable to diverse educational settings.
- **Integrated frameworks:** Combining theoretical foundations with hands-on practice creates meaningful connections between abstract ideas and practical implementation. Frameworks like ICAP guide training activities to progress from passive observation to interactive engagement, fostering teachers' ability to model and support student knowledge construction. Embedding Self-Regulated Learning strategies further equips teachers to encourage goal-setting, monitoring, and reflection in their own practices and for their students in technology-enhanced learning environments. This approach is expected to lead to improved student outcomes as well as greater equity and inclusion.
- **Collaboration**: Social learning is integral to fostering shared understanding and enhancing training outcomes. Engaging with experts provides valuable insights, while collaborative activities, such as co-designing teaching materials, promote joint knowledge construction. Feedback from mentors and trainers strengthens this process, offering reflective opportunities and guidance that help teachers refine their strategies and sustain professional growth.
- **Technology integration:** Training emphasises the alignment of technology with pedagogical goals and subject content, guided by the TPACK framework. This approach ensures that teachers understand the dynamic interplay between technology, pedagogy, and content knowledge. Domain-specific training addresses subject needs, while cross-disciplinary strategies equip teachers with versatile techniques for technology-enhanced teaching across various contexts.

These design principles collectively create a knowledge base for effective teacher training, illustrating how thoughtful alignment of context, collaboration, frameworks, and technology integration can foster meaningful and sustainable professional learning.

1. Introduction

The purpose of this deliverable is to provide an outline of the training initiatives designed in alignment with key policy measures and the corresponding evaluation approach. This document offers an overview of the training content, target groups and the various formats in which these interventions will be delivered. It also highlights the realised variations in the training approaches to ensure that diverse needs and contexts are effectively addressed.

By mapping out the training interventions, this deliverable provides stakeholders with a detailed understanding of how these interventions are designed, implemented and adapted to different educational settings. It highlights the strategies, instructional methods and formats used to foster teachers' PDC, ensuring alignment with project objectives and educational policy measures. Each component has been designed with consideration of the evaluation framework (D3.1), ensuring that the effect of these interventions can be measured and continuously improved throughout the project lifecycle.

2 Frameworks for Pedagogical Digital Competence (PDC) in EffecTive

The EffecTive project proposes that the **quality of education and learning can be increased by improving teachers' Pedagogical Digital Competence** (PDC). PDC is defined in the EffecTive project (Figure 1) as a synergy of teachers' technological, pedagogical and content knowledge (and their intersections), affective-motivational dispositions regarding technology integration in the classroom, their situation-specific skills (perception, interpretation, decision-making, PID), their cultural awareness and abilities to promote equity and inclusion in a specific learning situation (Blömeke et al., 2015; Roth et al., 2023; Skantz-Åberg et al., 2022).

Figure 1: Key dimensions of Pedagogical Digital Competence in EffecTive

Based on Roth et al. (2023), we have adapted a competence framework, which is based upon previously developed and well-established models, such as the **PID** model (Blömeke et al., 2015) and the **TPACK** model (Mishra & Koehler, 2006). These different models enable us to specifically address different dimensions of PDC. To explore the knowledge

dimension, we draw on TPACK, while with PID we focus on the skills dimension. Lastly, to approach attitudes and beliefs various models that have been shown to influence successful integration of technology in teaching, such as self-efficacy, are considered. Situation-specific skills in this model refer to cognitive processes and outline how individuals perceive information, interpret its significance and make decisions based on that interpretation. The core of the complementation between TPACK and PID lies in their synergy: while TPACK provides a structured understanding of the intersection of technology, pedagogy, and content knowledge, PID enables teachers to apply this knowledge dynamically through real-time decision-making based on classroom contexts. In essence, TPACK equips teachers with the **what** - a robust framework for planning effective, technology-integrated lessons. PID focuses on the **how** - helping teachers perceive classroom interactions, interpret their significance, and make adaptive decisions to ensure the lesson's success.

The development of PDC within the framework of Blömeke et al. (2015) is conceptualised **as a progression from latent traits to observable behaviours** (See Figure 2). Initially, teachers' knowledge and attitudes serve as foundational latent traits. These traits, such as content and pedagogical knowledge, technology integration skills and beliefs about teaching with technology, form the basis for developing PDC.

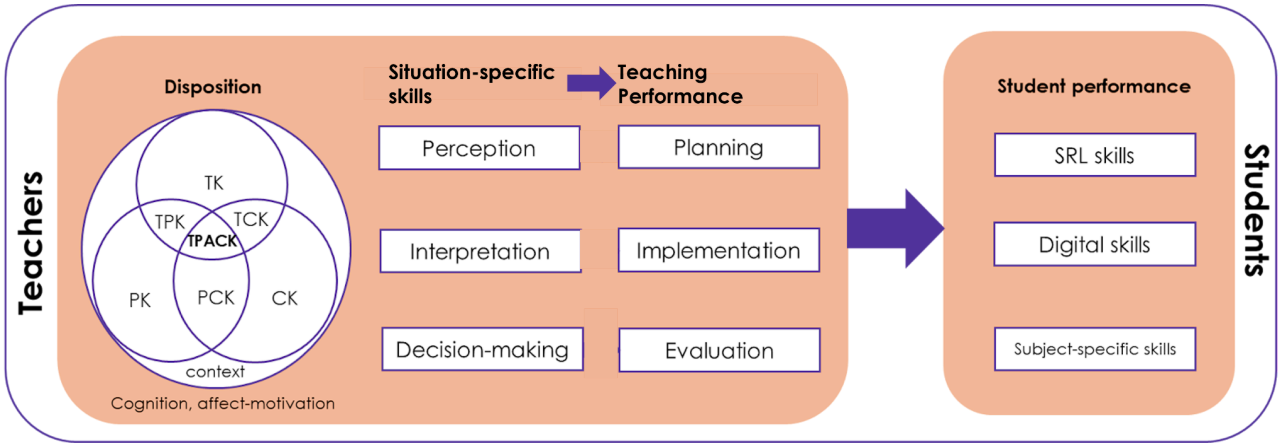

Figure 2: Teacher competence development and its impact on student learning

As teachers engage in professional learning experiences, **these traits evolve into situation-specific skills,** such as noticing classroom situations and making informed decisions in dynamic teaching environments (Figure 2). This process involves applying theoretical knowledge to practice, where teachers must adapt to different classroom contexts, student needs, and technological tools. Over time, these situation-specific skills

translate into observable behaviours, where teachers demonstrate their competence by integrating technology into their teaching, promoting self-regulated learning and fostering cognitive engagement in technology-enhanced learning environments.

3 Designing training interventions in the EffecTive project: applying the ADDIE model

WP2 is responsible for designing teacher training interventions, aligned with the theoretical foundations in WP1. In the next sections we will describe the design process of training interventions. One of the crucial tasks in the project is the design of effective training interventions which are aligned to the **policy programs** of each country, the **goals of our interventions**, and the **instructional design principles** for effective teacher training (Zabolotna et al., 2024).

To guide the design process, we adopt the **ADDIE model**, a well-established instructional design framework comprising five phases: Analysis, Design, Development, Implementation, and Evaluation. This model provides a systematic approach for creating effective training programs in diverse educational contexts. In addition, we extend our approach with Seufert's (2002) **Comprehensive Instructional Design model** (Figure 3), which introduces key elements relevant to planning, particularly within the Analysis and Design phases. The model clarifies how these foundational aspects (e.g., goals, content, conditions, and audience characteristics) inform the general approach, which is grounded in instructional theory, and the concrete design, which incorporates specific methods and didactics tailored to the training needs. The enhanced Analyze and Design phases provide a more structured and systematic methodology, ensuring that the planning process is both thorough and aligned with the specific needs of the target audience. These additional factors enhance the foundational ADDIE model by emphasising context-sensitive decisions.

As outlined in Seufert's (2002) model, our initial planning starts by defining the training's goals and content, informed by the D1.1 (Zabolotna et al., 2024). These elements establish the overall direction of the course and shape subsequent phases of analysis and design. Key contextual factors - such as target group characteristics and framework conditions - are clarified at this stage to ensure the training is relevant and tailored to participants' needs.

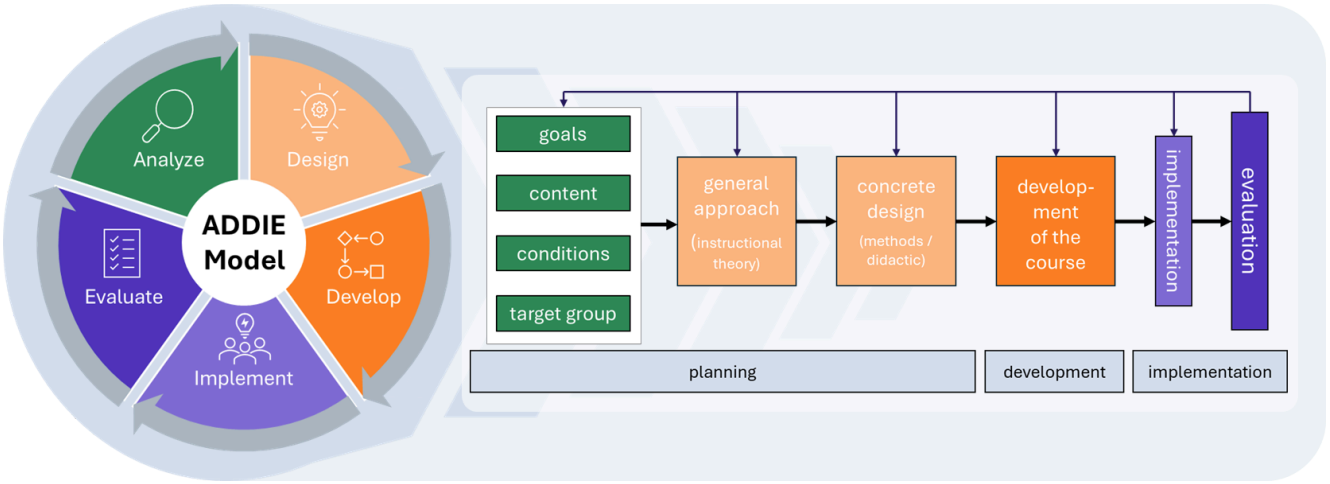

Figure 3: Integrating ADDIE with Comprehensive Instructional Design: A Framework for Teacher Training Development in EffecTive

Figure 3 shows the enhancement of the ADDIE framework, which provides a structured process for designing, developing, and evaluating teacher training interventions. It emphasizes the iterative nature of the process, progressing from Analysis and Design to Development, Implementation, and Evaluation. This framework serves as the overarching structure for creating effective and goal-oriented training programs.

Figure 4 builds on this by further outlining the essential training components - **conditions, target group, content, and instructional design** - that inform the Analyze and Design phases of the ADDIE framework. It describes key factors such as delivery modes, training duration, interaction modes, group sizes, target audiences, and instructional strategies. These elements ensure that the training is contextually relevant and effectively aligned with the needs of the teacher training institutions and other relevant participants. .

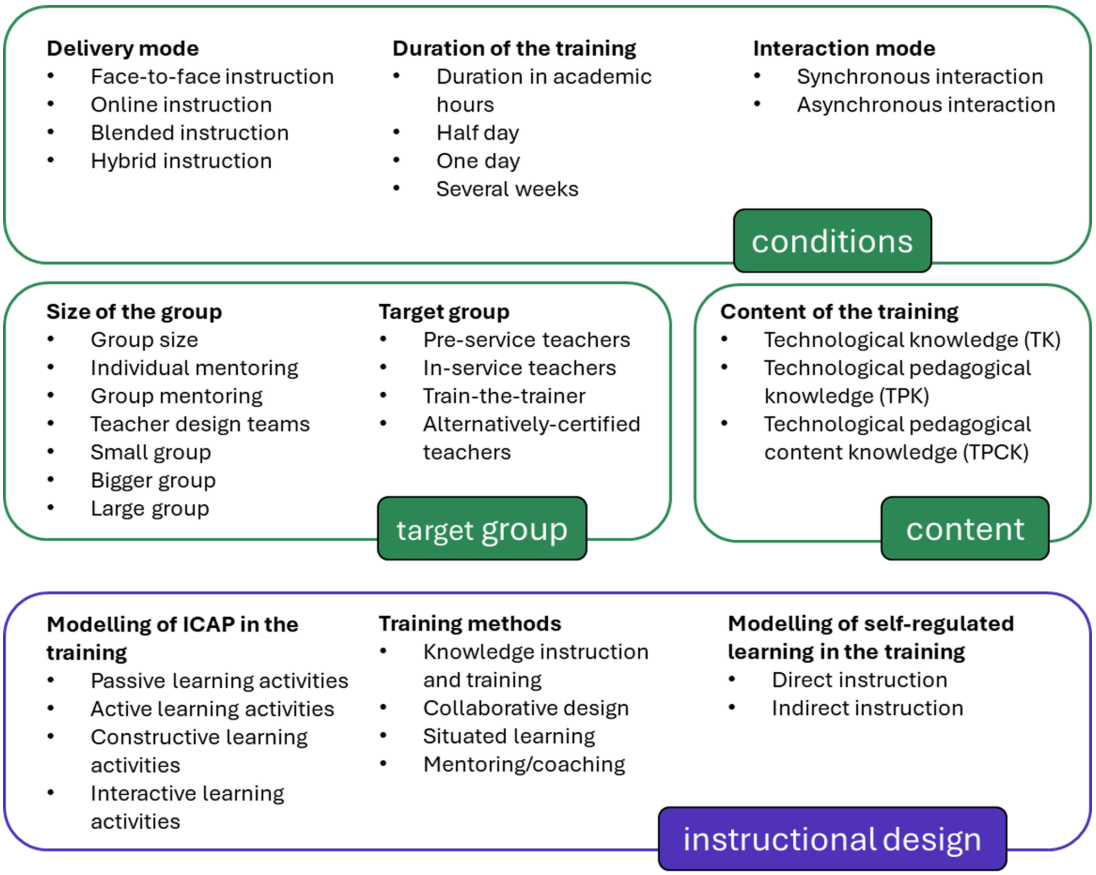

Figure 4: Core elements for structuring teacher training interventions in EffecTive

In designing teacher training interventions, we apply a set of instructional decision guidelines that integrate diverse training methods, pedagogical approaches, and digital competence frameworks. These guidelines are structured to ensure alignment with the project's overarching goals, the needs of each training context, and the theoretical foundations for effective teacher learning (Figure 5).

- **Teacher training methods:** we combine varying training methods, as outlined in D1.1 (Zabolotna et al., 2024) and D1.2 (Wagner et al., 2024), which are selected based on their primary effects on knowledge acquisition, skill development, and attitudinal change. The training interventions are designed to differentiate between the levels of different practices (knowledge instruction, collaborative design, situated learning and mentoring and coaching) to be integrated in the learning process. The higher the level of integration, the higher the benefits for teacher learning.
- **Pedagogical approaches:** The training integrates core pedagogical approaches that emphasise Self-Regulated Learning (SRL) and cognitive engagement, guided by the ICAP framework.
    - **SRL principles** are embedded throughout the training to encourage teachers to set goals, monitor their progress, and adapt their approaches.

SRL is also modelled in training to support teachers in fostering SRL skills in their students to learn more effectively in a technology-enhanced learning environment and to increase the equity and inclusion in student learning outcomes.

- **The ICAP framework** is guiding instructional choices that align with desired cognitive engagement levels for students' learning in a technology-enhanced learning environment.
- **Digital competence models** for teachers and students are aligned with digital competence frameworks to support technology-enhanced teaching and learning. Digital competence are integrated as an extension of training methods, SRL, and the ICAP framework, emphasizing the transversal role of digital competence in fostering innovative approaches to teaching and learning.

The integration of these models, frameworks, and instructional design principles (Figure 5) provides a comprehensive framework for the design of teacher training programs within the EffecTive project. This framework supports a cohesive design process that aligns instructional strategies with policy framings, theoretical foundations, and contextual needs, ensuring that the training interventions are both effective and adaptable.

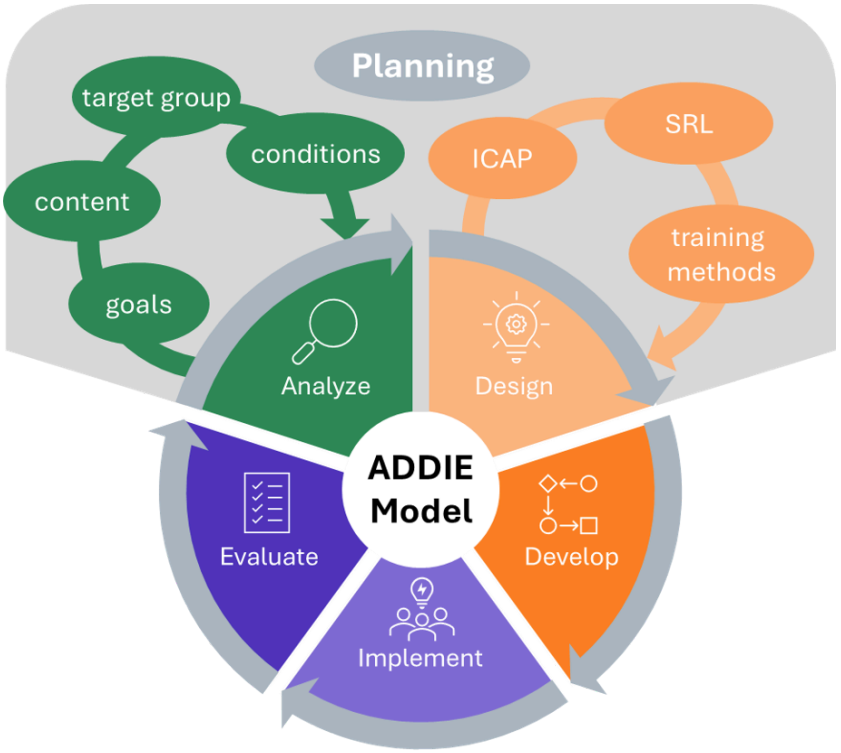

Figure 5: The Enhanced ADDIE Model

3.1 Single steps of the Instructional Design Process

In the following sections, the steps of the instructional design process are described, outlining how each phase contributes to the development of effective and goal-oriented training interventions.

3.1.1 Analysis

The Analysis phase begins with identifying key elements to shape the training intervention:

1. **Learning objectives**: Define what skills, knowledge and attitudes the training should develop.
2. **Content**: Determine the specific topics to be covered.
3. **Target group**: Conduct a thorough analysis of the participating teachers' professional needs, teaching contexts, technological proficiency levels, subject areas, and cultural or institutional backgrounds to tailor training interventions effectively.
4. **Framework conditions**: Account for the specific contexts, institutions, and resources available to ensure the training is practical and relevant.

In the EffecTive Project, the analysis begins with the theoretical frameworks that define the objectives of teacher training. The primary aim is to improve teaching and learning practices in technology-enhanced classrooms, guided by policy programs (Zabolotna et al., 2024). This objective is rooted in research-backed evidence, focusing on outcomes that directly benefit teachers by advancing their skills while also fostering improved learning experiences for students. To improve future training cycles, we utilize evaluation data from pre-pilot and pilot phases to refine our analysis. A key challenge in the EffecTive Project is coordinating multiple training interventions across different partners and countries, each with its own schedules, institutional rules, and logistical requirements, in a way which guarantees comparability of interventions.

3.1.2 Training Goals

The goals of our training are organised into four levels of expected benefits, progressing from immediate feedback to long-term impact (Figure 6). Exact constructs under each level are described in EffecTive D3.1.

- **Level 1: Participants' reactions**. This level focuses on teachers' immediate feedback on the training, including their satisfaction, perceptions of quality, and attitude. It

evaluates how engaging and well-structured the training feels to teachers who participate in our trainings.

- **Level 2: Knowledge and Attitudes.** At this level, we assess what teachers have learned and any shifts in their post-training attitudes. Key areas include knowledge, skills, and attitudes related to PDC: knowledge according to TPACK, technology integration skills, attitudes regarding digital technologies. This level emphasises participants' understanding of and confidence in SRL, teachers' ability to integrate technology effectively with teaching strategies and subject content, and their appreciation for and respect toward diverse classrooms and related adaptations in learning practices in terms of equity and inclusion.
- **Level 3: Behavioural impact.** This level examines how training influences teachers' actual behaviour in practice. Indicators include technology adoption, improved performance, situation-specific skills, and technology integration in real-world teaching.
- **Level 4: Long-Term outcomes.** The final level focuses on lasting impacts that are reflected in changes in students' learning outcomes. These include improvements in students' SRL skills, subject-specific and digital competence, increased interest in their subjects, and the establishment of inclusive and equitable learning environments.

Each level builds upon the previous one, starting with immediate responses and advancing toward long-term effect on student outcomes, as illustrated in Figure 6. This progression emphasises the importance of initial feedback, knowledge transfer, behaviour change, and overall impact on teaching and learning practices.

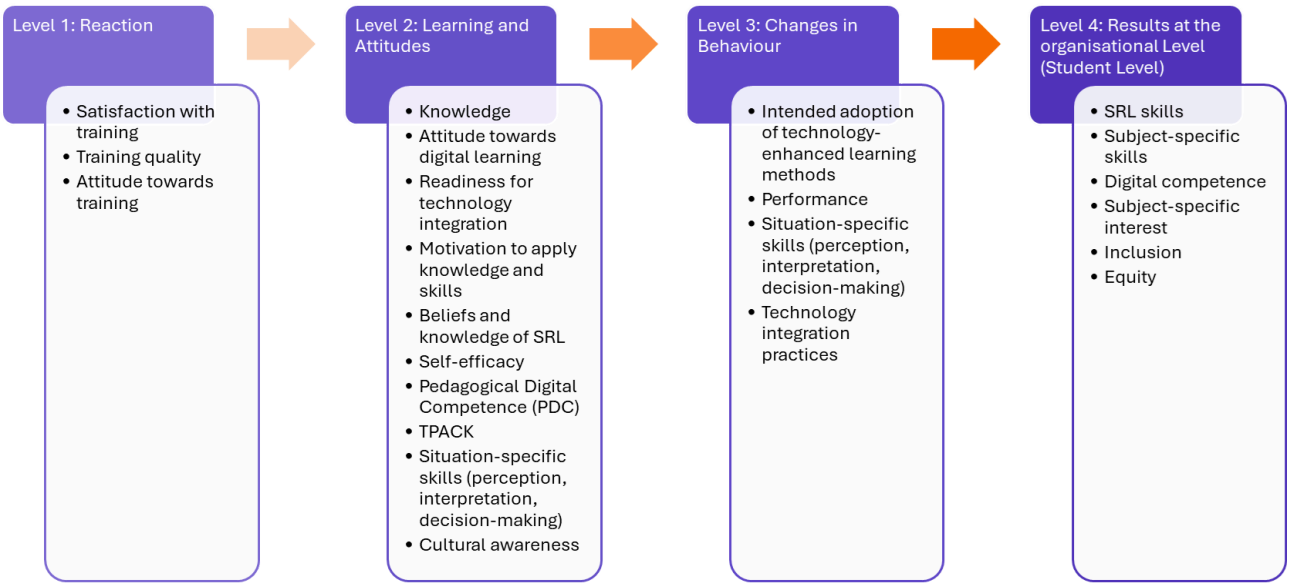

Figure 6: Overview of benefits on four different levels (Deliverable 4.1 – cost benefit framework)

3.1.3 Training Content

The training programs aim to provide teachers with main knowledge and skills across key domains that support technology-enhanced teaching practices fostering development of teachers SRL skills and promoting cognitive engagement. The content of the training focuses on the intersection of technology, pedagogy, and content, offering a framework for integrating technology into teaching. More specifically, while designing
A short initial description of the theoretical concepts is provided in the following.

TPACK

The EffecTive project adopts the TPACK model (Technological Pedagogical Content Knowledge) as one of the guiding frameworks to design teacher training courses. The TPACK model emphasises the interplay between three core types of knowledge - Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) - and their integration. In the design phase of teacher training courses, we will consider the specific dimensions of the TPACK model to ensure that the training comprehensively addresses:

- **Technological Knowledge (TK):** a teacher's ability to understand and use technology effectively in educational contexts. This includes knowing the

functionalities of digital tools, how to integrate them into lessons, and how to adapt them for different teaching needs. **Key elements** for training designers:

- Understanding the capabilities of tools like AI chatbots, interactive platforms (e.g., H5P, Kahoot), or collaborative tools (e.g., Padlet, Miro).
- Designing activities that involve hands-on practice with these tools to foster familiarity and confidence.
- Exploring how technology can enhance cognitive engagement and self-regulated learning (SRL).

- **Pedagogical Knowledge (PK):** involves understanding teaching methods, strategies, and practices that foster effective learning. It is independent of subject matter but essential for structuring learning experiences → (***how*** something is taught). **Key elements** for training designers:
  - Implementing frameworks like ICAP to foster deeper engagement.
  - Incorporating self-regulated learning techniques to promote learning.
  - Designing scaffolding strategies to guide student learning
  - Adapting teaching approaches based on learner needs, progress, and feedback from digital tools.
- **Content Knowledge (CK):** refers to expertise in the subject matter being taught: a) subject areas like mathematics, language learning, or history, focusing on the concepts, skills, and knowledge participants need to master in that discipline; b) theories and frameworks such as participants' digital competence, self-regulated learning, the 5E instructional model → (***what*** is taught). **Key elements** for training designers: ensuring the theoretical grounding matches the course objectives, whether it is domain-specific (e.g., grammar rules in language learning) or pedagogical (e.g., SRL strategies).
- **Integrated knowledge:** refers to the intersections of the core knowledge areas:
  - **Technological pedagogical knowledge (TPK):** Understanding how to use technology to support pedagogical goals, such as using AI chatbots to scaffold SRL.
  - **Technological content knowledge (TCK):** Understanding how technology can enhance or represent content, such as using simulations for scientific phenomena.
  - **Pedagogical content knowledge (PCK):** Knowing how to teach specific content effectively, such as designing SRL strategies for primary-level learners.
  - **TPACK (Full Integration):** The ability to combine TK, PK, and CK to create cohesive, effective, and engaging teaching practices. For example: Designing scenarios where teachers create a digital literacy lesson using

multimedia creation tools (technology) to teach students how to critically evaluate online information (content). Pedagogical strategies, such as organisation and elaboration techniques, are employed in the online environment to enhance participants' cognitive engagement and critical thinking skills (pedagogy).

The training also covers supplementary topics crucial for teaching in technology-enhanced learning environments:

Integration of SRL into CK (content knowledge), PCK (pedagogical content knowledge) and Technological Pedagogical Content Knowledge (TPACK) (Karlen et al., 2024): Integrating SRL into Content Knowledge, Pedagogical Content Knowledge, and TPACK enhances teachers' instructional practices as well as empowering students to become self-regulated learners, capable of managing and evaluating their own educational experiences. Here's how SRL integrates with each knowledge domain.

- **CK-SRL:** SRL integration into CK involves teachers modelling self-regulatory strategies related to the subject matter and makes knowledge about SRL itself the learning subject. This approach not only deepens teachers' subject mastery but also equips students with knowledge and tools to manage their own learning processes.
- **PCK-SRL:** Incorporating SRL into PCK requires teachers to design instructional methods that promote SRL. This includes creating learning activities that encourage students to set personal goals, monitor their progress, and reflect on outcomes. For example, teachers might implement peer assessments or self-evaluation techniques, enabling students to take an active role in their learning.
- **TPCK-SRL:** Integrating SRL into TPCK emphasises the teacher's skill in using technology to support self-regulated learning. Educators focus on continuously reflecting on and refining their use of technological tools and strategies to foster SRL, assessing the effectiveness of these methods and adapting them to suit diverse student needs.

Digital competence

We apply the DigCompEdu framework for designing interventions aimed at developing teachers' digital competence. This framework outlines key areas of competence for educators, providing an approach to align course design with specific goals. Depending on the objectives of the course, all or some subdimensions of DigCompEdu are applied to guide the development of teacher training. Key subdimensions:

- **Professional engagement** - Using digital technologies for professional interactions, collaboration, and continuous development. Example: Designing activities that foster teacher collaboration through platforms like Teams or Miro.
- **Digital resources** - Selecting, creating, and sharing digital content while ensuring accessibility and copyright compliance. Example: Training teachers to create digital resources aligned with their curriculum, pedagogical frameworks and adapt them for diverse learners.
- **Teaching and Learning** - Integrating digital tools into teaching strategies to enhance learning experiences. Example: Using platforms like H5P for interactive learning tasks or Padlet for collaborative projects.
- **Assessment** - Integrating digital tools to monitor, assess, and provide feedback on students' learning progress. Example: Introducing tools like Google Forms or Quizalize for formative and summative assessments.
- **Empowering learners** - Using technology to address learners' needs, fostering autonomy and engagement. Example: Training teachers to use AI tools (e.g., Grammarly) to design tasks where students receive real-time feedback on writing and independently revise their work. Alternatively, teachers can create flexible learning paths, offering students the tasks of varying complexity with hints and additional resources to support diverse learner needs
- **Facilitating learners' digital competence** - Enabling students to develop their digital competence. Designing lessons that engage students in creating multimedia projects to analyse and share information.

Courses grounded in DigCompEdu ensure teachers not only build their own digital competence but also **transfer these skills** to their students. Teacher training interventions based on DigCompEdu help teachers directly enhance their students' digital competence in the following areas:

- **Information and data literacy**: Teachers learn to design activities where students search, evaluate, and manage digital information critically.
- **Communication and collaboration**: Teachers are equipped to create collaborative learning tasks, such as group projects using shared tools like Google Docs or Teams.
- **Digital content creation**: Teachers are trained to guide students in producing digital artefacts, ensuring creativity and ethical use of resources.
- **Safety**: Teachers develop skills to teach students about online safety, data privacy, and cybersecurity.

- **Problem-solving:** Teachers design collaborative projects using tools like Miro, where students analyse complex problems, brainstorm solutions, and present their findings digitally.

Instructional design with technology: Teachers explore structuring activities that incorporate technology meaningfully, ensuring technology supports rather than overshadows learning objectives.

Equity and access in technology integration*:* The training highlights the importance of equitable access to technology, teaching strategies to overcome access barriers and create inclusive digital learning environments.

3.1.4 Target Group

The training programs are carefully designed to meet the unique needs, backgrounds, and goals of diverse educator groups. By tailoring the content to these specific groups, the trainings remains relevant, flexible, and effective across a broad spectrum of professionals in the field of education. The target groups include:

- **Pre-Service Teachers:** These individuals, often still in university, are preparing to start their teaching careers. Trainings for this group focus on essential pedagogical and technological skills, providing the confidence and competence needed to be an expert in today's dynamic classrooms.
- **In-Service Teachers** - Currently practising teachers seeking professional development to improve skills, stay updated on trends, or meet requirements. This group benefits from the authentic and collaborative training environment, where peer learning and experience-sharing are key components.
- **Train-the-Trainers** - Programs designed for individuals responsible for training others within their organisations, equipping them with effective techniques and tools.
- **Alternatively-Certified teachers** - Teachers who have entered the profession through non-traditional certification paths bring diverse professional backgrounds, and the trainings help align these experiences with effective teaching practices.
- **Student teachers** - Individuals completing teaching practicums as the final step toward certification. Trainings focus on applying theoretical knowledge in practical settings, preparing them for full-time teaching roles.
- **Administrators and educational leaders** - Though not traditionally included, administrators benefit from these trainings by understanding classroom technology integration, enabling them to make informed decisions on resources, professional development, and curriculum design to support student learning experiences.

- **Support staff and teaching assistants** - These contributors in the classroom benefit from training that enhances their ability to support technology-enhanced learning. Skills gained help them manage digital tools, assist in learning activities and provide support to both teachers and students.

The training programs are flexible and customizable for various group sizes, fostering engagement and learning in every setting. Formats include:

- **Small group:** Interactive, discussion-based sessions with a few participants encourage active participation, experience sharing, and feedback.
- **Bigger group:** In a group format, a larger number of participants are involved, which may require a shift in strategies to ensure everyone remains engaged and active. This could include using breakout sessions, digital collaboration tools, or group discussions to maintain interactivity.
- **Large group:** Large group trainings are suited for large audiences, typically in a lecture or presentation format, ideal for sharing broad knowledge at conferences or professional development events. Engagement is encouraged through interactive polls, Q&A sessions, or technology-based participation tools.
- **Individual mentoring:** One-on-one sessions with a mentor providing personalised, focused support tailored to individual needs and goals.
- **Group mentoring:** Small groups, typically colleagues or peers, work with a mentor, blending expert guidance with peer interaction for collaborative learning.
- **Teacher design teams:** Educators collaborate to develop instructional materials and strategies, promoting teamwork and innovative problem-solving.

When designing trainings, it is essential to consider whether participant groups are **heterogeneous** or **homogeneous**. Heterogeneous groups - with varied backgrounds or skill levels - benefit from differentiated instruction, flexible pacing, and collaborative activities to address diverse needs and promote individual growth. In contrast, homogeneous groups - with similar skill levels or experiences - enable a more focused, specialised approach, allowing for in-depth exploration of specific topics as participants move at a similar pace.

3.1.5 Framework conditions

Despite possible country specific conditions that vary across countries and need to be taken into account like terms, organizational structures which determine the institutions that provide, ensure and are funding teacher training, there are several key factors that need to be addressed when planning each individual intervention.

Duration of the training: The duration of trainings varies significantly to match the goals and depth of the material. Options include short, focused sessions lasting half a day or a full day, extended programs spanning several weeks or a semester, and comprehensive year-long formats. This flexibility allows trainings to be tailored to the complexity of the content and the participants' needs, whether for a quick skill refresher or an in-depth professional development experience.

Conditions for delivery mode: Trainings can be delivered through various instructional methods, each tailored to different learning preferences and logistical needs:

- **Face-to-face instruction**: Training is conducted in person, with both the trainer and participants present in the same physical location.
- **Online instruction**: Training is delivered entirely online, allowing participants to engage remotely.
- **Blended instruction**: Combines face-to-face and online methods, providing a mix of in-person and remote learning experiences.
- **Hybrid instruction**: Similar to blended learning, but with more flexibility in how and when face-to-face and online components are delivered.

Conditions for Interaction Mode

- **Synchronous interaction**: Participants engage in the training simultaneously, through live webinars or real-time discussions.
- **Asynchronous interaction**: Participants access the training content at their own pace, using pre-recorded videos, discussion boards, or self-paced activities.

3.2 Design

To design effective teacher training interventions that enhance teachers' PDC, it is essential to identify the design elements that contribute most significantly to positive outcomes for both in-service and pre-service teachers. Findings from our umbrella review in Deliverable 1.2 (Wagner et al., 2024) offer key insights. Effective PDC interventions vary widely in structure, duration, and delivery mode, often incorporating online, blended, and face-to-face formats. Among these, **blended modes** stand out for their effectiveness, balancing flexibility with opportunities for in-person interaction. Additionally, the **TPACK framework consistently emerged as a foundational model** across interventions, underscoring its importance in integrating content, pedagogy, and technology.

Key practices such as **reflection, rehearsal/field experience, and goal-setting** stood out as the most frequently applied practices in PDC training interventions (Wagner et al., 2024),

indicating the importance of combining SRL and practical learning for the teachers. These practices appear particularly effective for developing teachers' situation-specific skills, enhancing their readiness to adopt new practices. Additionally, **combining** multiple key practices (e.g., hands-on learning and reflection) from **different training methods** (e.g. knowledge instruction and situated learning) yielded better outcomes in equipping teachers to use technology in the classroom.

Our findings suggest that PDC training interventions positively impact knowledge and motivation essential for technology integration, particularly effective in **enhancing PK** and **CK**, although TK remains challenging (Wagner et al., 2024). This highlights a need for targeted support emphasising practical digital skills and continuous development, as TK requires ongoing adaptation to rapidly changing tools and is harder to integrate into standard training. **Longer interventions** designed with collaborative approaches in a blended mode tend to yield stronger PDC outcomes for teachers in general (Atmacasoy and Aksu, 2018; Ning et al., 2022). However, pre-service teachers typically benefit more from the training than in-service teachers, which might be related to their developmental phase, suggesting a need for tailored programs for in-service teachers.

Our review underscores that well-designed teacher training programs improve teachers' ability to integrate technology effectively into their teaching. This not only fosters more adaptable and student-centred instruction but also supports dynamic learning environments (Wagner et al., 2024). The effectiveness of these programs is closely linked to key factors, including the training methods used, the integration of the TPACK framework, and affective factors such as teachers' attitudes and confidence.

Although evidence on student outcomes remains limited in our review, existing findings suggest that the thoughtful integration of technology in the classroom can improve student learning outcomes, specifically in STEM subjects and reading competencies. However, results are inconsistent (Wagner et al., 2024). While some studies report significant improvements in subject-specific areas, such as reading comprehension and mathematics, others indicate no substantial changes or only minimal, statistically non-significant gains in subjects like mathematics and biology (Bragg et al., 2021). It also prompts important questions about how to design training interventions that **emphasise domain-specific focus** while seamlessly integrating the development of TPACK within teachers' respective subjects. By tailoring training to both the pedagogical variances of individual disciplines and the interconnected dimensions of technological, pedagogical, and content knowledge, interventions can better support effective teaching practices.

The design phase focuses on structuring the learning experience by selecting appropriate instructional methods, sequencing content effectively, and planning assessments to measure success. In the EffecTive project, this phase is guided by the training methods outlined in D1.1 (Zabolotna et al., 2024) and the instructional design principles for teacher training in PDC detailed in D1.2 (Wagner et al., 2024), ensuring that the learning objectives are aligned with both theoretical frameworks and practical application.

Modelling of ICAP in the Training

The ICAP framework (Chi et al., 2014) is integrated into training design to progressively enhance cognitive engagement and participant involvement across four levels: Passive, Active, Constructive, and Interactive.

- **Passive level cognitive engagement:** Represent the most basic engagement level, where learners receive information with minimal interaction, such as listening to a lecture or watching a presentation. This foundational stage is essential for basic knowledge transfer.
- **Active level cognitive engagement:** Require learners to engage directly with the material by, for example, answering questions or completing guided exercises. These activities promote retention and understanding by encouraging participants to think about and apply the content.
- **Constructive level cognitive engagement:** Require learners to generate new information or reinterpret existing knowledge, actively integrating it with their prior understanding. This means that new information is connected with existing knowledge and insights, learners interpret new experiences based on their previous knowledge and through assimilation.
- **Interactive level cognitive engagement:** Activities involve interaction and collaboration among learners, fostering deeper understanding and higher cognitive engagement.

By actively experiencing strategies that promote cognitive engagement, participants gain firsthand insight into how these methods impact learning. This involvement enables them to better understand the nuances of designing similar learning experiences, equipping them to create lessons that actively involve, challenge, and inspire their own students.

Modelling of Self-Regulated Learning in the Training

Self-regulated learning encourages individuals to set goals, monitor their progress, and reflect on their learning. In training, SRL can be developed through both direct and indirect instruction, each contributing to self-regulation skills in unique ways.

- **Direct Instruction:** This approach involves explicit teaching of SRL strategies, guiding participants through techniques like goal-setting, time management, and self-monitoring. Trainers provide structured lessons on organising tasks, breaking down complex activities, and using reflection to assess progress.
- **Indirect Instruction:** Here, self-regulation is implicitly integrated within training activities. Instead of direct instruction, tasks are designed to require planning, adapting based on feedback, and reflection, allowing participants to practise SRL naturally within real-world scenarios.

Together, these approaches form a model for fostering SRL. Direct methods offer clear strategies for immediate use, while indirect methods provide hands-on practice, embedding SRL as an enduring skill for professional and personal growth.

EffecTive Training methods

EffecTive training methods employ diverse approaches to support effective learning, tailored to participants' needs and contexts. These methods help learners acquire both theoretical knowledge and practical skills. In this section, we will present our own training cases, aligned with these categories, to illustrate how each approach is operationalized in practice. We will define specific criteria for each training method to ensure that our cases are accurately classified for evaluating their effectiveness.

1. **Knowledge instruction** - A foundational understanding of pedagogical principles and technology integration through theoretical knowledge and structured activities to build practical skills and foster a positive attitude toward adopting new methods. **Criteria**:
    a. **Duration**: Training should be long enough to cover theoretical concepts and practical applications comprehensively.
    b. **Intensity**:
        i. Information provided: content on technology integration and pedagogical theories.
        ii. Information processed: activities for processing and internalising information
    c. **Essential activity: Planning** - teachers create lesson plans that incorporate technology.
    d. **Depth of knowledge:**
        i. What to know: Cover specific content areas like self-regulated learning and its technological support.
        ii. How to support: Teach application of this knowledge in practice, including designing lessons that integrate technology effectively.

2. **Collaborative design** - teachers work together to create and refine instructional materials fostering collective insights and enhancing understanding.

   Criteria:

   a. **Number of design sessions**: Multiple sessions (at least 2-3) are required to ensure iterative development and refinement of the design outcomes.
   b. **Design outcome**: The result should be meaningful and applicable for teachers, addressing real classroom needs.
   c. **Innovation**: Produce new product / knowledge / artefact that could not be achieved individually, demonstrating collaborative effort.

3. **Situated learning** - Applying new practices directly within the classroom context. Emphasises learning through real-world application and iterative refinement.

   Criteria: The training should allow **sufficient time for at least one full cycle** of design, implementation, and reflection:

   a. **Design**: Teachers design **technology-integrated lessons** or instructional materials, applying their understanding of context-specific challenges.
   b. **Implementation**: Teachers **apply the designed materials** in their actual teaching contexts at least once.
   c. **Reflection**: structured approach for **teachers to reflect** on their experiences, discussing what worked, what didn't, and how to improve their practices.

4. **Mentoring** - personalised, expert guidance adapted to teachers' needs.

   Criteria:

   a. **Cycle**: Minimum is to complete at least one cycle of modelling, (self-)observation, and feedback.
   b. **Expert feedback**: sufficient one-on-one expert-novice feedback to support professional growth. Feedback can be Incorporate online feedback mechanisms if applicable for broader reach and flexibility.

In the design phase, EffecTive training is structured to meet learning objectives through carefully chosen instructional methods and content sequencing. The ICAP framework enhances cognitive engagement at four levels - Passive, Active, Constructive, and Interactive - allowing participants to experience and design engaging learning activities. Self-Regulated Learning is supported through both direct instruction and indirect methods that embed SRL within tasks for practical application. EffecTive Training methods are adapted to build both theoretical knowledge and practical skills, each approach is adaptable to diverse educational contexts, ensuring relevance in learning experiences.

3.3 Development

In the development phase, specific course programs, lesson plans, digital learning resources, and tasks are created to bring the training designs to life. This includes producing interactive modules, hands-on activity guides, video tutorials, and assessment tools that align closely with the learning objectives for PDC. Each learning activity, task, and material is tailored to equip teachers with practical skills and knowledge needed for effective technology integration. As the pilot studies launch in fall 2024, these materials will be refined based on real-time feedback from teachers, ensuring they are immediately applicable and relevant to classroom contexts.

3.4 Implementation

During implementation, the training programme is delivered to teachers (see section 3 for EffecTive training cases). Learning resources are provided via online platforms, and training sessions are conducted through a mix of seminars, workshops, webinars, and self-paced modules. Trainers monitor participants' progress and gather feedback on session content, pacing, tasks, and resources to refine the course design. Based on this feedback, adjustments are made to the course design to refine the integration of frameworks like TPACK and DigCompEdu, as well as to enhance the modelling of SRL and cognitive engagement. Feedback also addresses technical and logistical challenges to ensure teachers can fully engage with the training and effectively apply their newly developed skills in their teaching practice.

3.5 Evaluation

The evaluation phase measures the efficiency and effectiveness of the training programme on teacher performance and student outcomes. Our evaluation is divided into two parts. While we assess the effects of training on both teachers and students, as outlined in D3.1, we also focus on the evaluation of the training interventions themselves. Both approaches are detailed in D3.1, with the evaluation of training interventions designed based on the Kirkpatrick model (1998). Specifically, we evaluate participants' training satisfaction using the Training Evaluation Inventory (Ritzmann et al., 2014), which examines teachers' reactions to the training in terms of subjective enjoyment, perceived usefulness, perceived difficulty, and attitude towards training. Additionally, we assess training quality using Richter & Richter (2024), focusing on dimensions such as clarity and structure, practical relevance, cognitive activation, and collaboration.

Formative assessments are conducted throughout, including regular feedback surveys and progress checks to identify any areas for immediate improvement. Summative

evaluations at the end of the training collect data from teacher surveys, classroom observations, and student performance metrics, providing a comprehensive view of how well teachers have integrated the new technology into their lessons. Results are analysed to determine strengths and areas for improvement, guiding enhancements for future training phases. These findings will be used to make concrete recommendations for further professional development initiatives.

Following the ADDIE model, the EffecTive project ensures that each phase of teacher training interventions is thoroughly developed, implemented, and evaluated to meet the precise needs of educators. This iterative process, supported by theoretical frameworks and refined through pre-pilot and pilot phases, allows for detailed evaluation using a cost-benefit framework, continually improving and adapting to maximise educational impact.

4 Teacher training cases in EffecTive project

Teacher training interventions are targeted at both in-service and pre-service teachers across Estonia, Austria, Finland, Germany, and Israel to develop teachers' pedagogical digital competence.

The **pilot studies** and the **intervention phase** mark two distinct stages in teacher training development. Pilot studies focus on **testing and refining training methods** with smaller groups, primarily pre-service teachers, and emphasize experimentation with frameworks like **Knowledge Instruction (KI)** and **Situated Learning (SL)** in controlled settings. In contrast, the intervention phase shifts to **scaling and implementation**, targeting both pre-service and in-service teachers, often through whole-school programs.

The **scale and scope** differ significantly: pilot studies are **smaller** and exploratory, while the intervention phase involves **larger groups** and longer durations, aiming to evaluate real-world impact. Delivery modes in the pilot studies vary between online, face-to-face, and blended, whereas the intervention phase **prioritizes blended approaches**, integrating training into authentic teaching contexts.

The **focus on outcomes** evolves from formative feedback in the pilot studies to assessing **teacher practices and student outcomes** in the intervention phase, including cognitive engagement and SRL. Furthermore, while pilot studies test frameworks in structured environments, the intervention phase leverages **diverse conditions** to understand how interventions work across contexts, preparing for broader scalability.

4.1 Teacher training cases in the pilot phase

During the first phase (M6-14), we will pilot the developed training methods, instructional approaches, materials and research instruments. This phase serves as a period for refining and validating the effectiveness of these components.

The pilot will involve small-scale trials with selected groups of in-service and pre-service teachers from Estonia, Austria, Finland, Germany and Israel. These trials are designed to test the feasibility of the training methods and gather initial feedback on instructional approaches. Additionally, in WP3, we will assess the reliability and validity of the research instruments used to measure the effect of the training. The results from this phase will guide necessary revisions to optimise the interventions before they are implemented on a larger scale in the second phase.

All five partner countries will collectively conduct 13 cases in the pilot phase to test training methods, materials, resources, instruments, and data collection procedures. According to the pilot plan, approximately 400 teachers will participate in the training, with most cases conducted in pre-service settings.

In the pilot phase, EffecTive primarily **targets pre-service teachers**, aiming to build their skills in digital competence, self-regulated learning and cognitive engagement strategies. Key goals across the cases include designing digital learning experiences, integrating SRL, and using digital tools for formative and summative assessments. The **training content** extends over the technology use (e.g., H5P, AI tools, robotics), pedagogical frameworks like ICAP to foster engagement, and techniques to support SRL. Emphasis is placed on lesson planning, evaluating digital tools and applying strategies that embed cognitive and motivational SRL into teaching.

Delivery modes are flexible, with some cases conducted fully online, others self-paced, and others face-to-face, exploiting both synchronous and asynchronous interaction modes to suit each group's needs. Knowledge Instruction serves as the primary **training method**, providing a foundation of essential theoretical knowledge and direct instruction on integrating technology to teaching. In addition, Collaborative Design is also applied to encourage the collaborative design of new artefacts to synthesise knowledge into joint outcome. Situated Learning is also integrated to pilots, especially in contexts that require real-world applications, enabling teachers to practise and implement skills directly within classroom settings.

The aim of the pilot phase in EffecTive is to explore how to design teacher training interventions that enhance teachers' Pedagogical Digital Competence. This involves applying various frameworks in course design and equipping teachers to integrate digital tools into teaching and learning, either directly or indirectly, while exploring how different conditions influence the effectiveness and implementation of interventions, to gain insights into how and under what circumstances these interventions "behave," thereby better preparing for real-world application to support students' cognitive engagement and self-regulated learning.

All EffecTive partners are participating in the pilot phase.

The tables in the last section reveal the following: 4 cases from three universities (TLU, UOULU, TAU) focus on pre-service studies, while 2 cases (UWK, UULM) target in-service studies. 5 trainings (TAU, UWK, UOULU, UULM, TLU) will be conducted online, while 3 trainings will be face-to-face (UWK, UULM, TLU) and 2 trainings (UULM, TAU) will involve blended delivery.

7 trainings (UOULU, UULM, TAU, TLU, UWK) will apply the knowledge instruction method, 3 trainings (TLU, UWK, UULM) will integrate elements of situated learning, and 2 trainings (TAU, UWK) will emphasise collaborative design. 4 trainings (UWK, TLU) are domain-focused (e.g., math, language, pre-school), whereas six others (UOULU, TAU, UULM) are more general in scope.

All trainings model cognitive engagement, either directly or indirectly; however, 4 trainings (UOULU, UULM, TAU) explicitly integrate self-regulated learning (SRL) into the course design. Few trainings (3: UOULU, UULM, TLU) fully incorporate the DigCompEdu framework into their course design, while others focus on specific sub-dimensions, such as fostering student empowerment. Inclusion is not a primary focus of the current pilots and will be integrated into the intervention phase, given the complexity of the course designs and the need for additional preparation time.

Table 1: TLU Trainings in the pilot phase

Case: TLU	**Technology-enhanced learning & learning sciences**	**Basics of Digital competence**
Policy measure	**Policy**: 'Tark ja Tegus Eesti' strategy: training programs by teacher education institutions for teachers to enhance their digital competencies and pedagogical practices.	**Policy**: 'Tark ja Tegus Eesti' strategy: training programs by teacher education institutions for teachers to enhance their digital competencies and pedagogical practices.
Goals	After completing the course, the teacher is able to design digital materials and practices that integrate learning sciences, promote self-regulated learning and enhance students' cognitive engagement.	After completing the course, the teacher can integrate digital technologies into teaching, design engaging digital learning experiences, assess student progress with digital tool, and foster students' digital competence (Based on DigCompEdu)
Conditions		
Delivery mode	**Group 1 & 3:** Face-to-face **Group 2:** Online, self-paced	**Group 1 & Group 2:** Face-to-face
Interaction mode	**Group 1 & 3:** Synchronous **Group 2:** Asynchronous	**Group 1 & Group 2:** Synchronous
Training duration	**Group 1-3:** 1 semester (5 months): 5*4 hours seminars, the rest is independent learning	**Group 1 & Group 2:** 1 semester (5 months): 5*5 hours seminars, the rest is independent learning
Target group		
Target	**Group 1 & Group 3:** Pre-service: Informatics teachers and teachers who seek for extra qualification as educational technologist **Group 2:** Pre-service context: Mathematics teachers'	**Group 1:** Pre-service teachers (basic school, youth workers, special education teachers, educational technologist, language teachers) **Group 2:** Pre-service teachers
Size of the group	**Group 1:** n=25; **Group 2:** n=26; **Group 3:** n=25	**Group 1:** n=60; **Group 2:** n=30
Content		
Technology	Knowledge in using H5P and TeacherDesmos to creation of	**Group 1:** Focuses on using H5P for creating interactive content and

knowledge	interactive learning materials that include elements of SRL and cognitive engagement	the Learning Designer platform for lesson planning. **Group 2:** Engages with digital tools like Plickers, Kahoot, LearningApps, and Quizalize for assessments, and explores AR, robotics, GPS-art, and multimedia creation for interactive learning activities.
Pedagogical knowledge	**Cognitive engagement strategies** incorporating **SRL techniques** and applying **instructional design** principles	Knowledge of instructional design principles to design engaging digital activities to support students in acquiring and applying digital skills.
Content knowledge	**Group 2:** Mathematical thinking of primary school students	**Group 1: N/A** **Group 2:** Child development in the pre-school settings
Inclusion & Equity	The training provides knowledge and skills regarding SRL and hence acknowledges different learning prerequisites, enabling participants to identify and adapt strategies suitable for their unique needs. This experience for their own learning can also be transferred to their students	Not in the focus
Instructional design		
Training method	**Knowledge instruction** **Instruction**: direct instruction on key theoretical concepts, demonstration of the practical application of concepts, showcasing how to effectively integrate tools into teaching **Work samples analysis:** analysis of existing learning resources, evaluation of the effectiveness of designs and strategies, **Hands-on learning:** active engagement with tools by creating their own learning resources, applying the concepts **Lesson planning:** develop lesson plans that incorporate new methods and H5P resources,	**Group 1: Knowledge instruction** **Instruction**: direct instruction on key theoretical concepts, demonstration of the practical application of concepts, showcasing how to effectively integrate tools into teaching **Work samples analysis:** analysis of existing learning resources, evaluation of the effectiveness of designs and strategies, **Hands-on learning:** active engagement with tools by creating their own learning resources, applying the concepts **Lesson planning:** develop lesson plans that incorporate new methods and H5P resources **Group 2: Knowledge instruction (KI) + Situated learning (SL) +**

		Collaborative Design (CD) **KI:** direct instruction on key theoretical concepts, demonstration of the practical application of concepts, showcasing how to effectively integrate tools into teaching • **Hands-on learning:** active engagement with learning technologies • **Lesson planning:** in their own educational level **SL:** design practices based on methodological and theoretical principles, apply new practices first with their classmates and next in their own practice to understand their effect on students' learning, systematically reflect on their own teaching experiences and improve the design: • **Practice lesson planning** of technology-integrated lessons for their own context. • **Rehearsal/field experience**: implementing technology-integrated lessons in their own context with actual students. • **Reflection/self-evaluation** on technology integration practices. **CD**: learning process in which participants create a shared understanding of practices that results with a shared product.
Modelling SRL	**Group 2:** Teachers set learning goals, regular adjustment of their strategies based on feedback and self-assessment	N/A
Modelling of CK-/PCK-/TPCK-SRL	Through our training, we model the integration of CK, PCK, and TPCK with SRL by engaging teachers in technology-rich tasks that involve designing, implementing, and reflecting on instructional strategies. These strategies are aimed at fostering students' cognitive, metacognitive and motivational regulation while maintaining alignment with subject-specific pedagogical goals	N/A
Modelling ICAP	**Passive:** processing theoretical foundations by reading, listening, and observing digital tools in action. Through this, they identify features of	

	the tools and link them to potential classroom applications. **Active:** exploring and engaging with digital learning resources and web-based applications, analysing their practical use in authentic teaching scenarios **Constructive:** synthesising knowledge by designing learning activities, tasks, and lesson plans, integrating pedagogical concepts, digital tools, prior experiences, and subject-specific expertise to bridge theory and practice. **Interactive:** engagement in group discussions to collaboratively analyze and refine work examples, promoting co-construction of understanding. Group 2 extends this by collaboratively refining lesson plans, integrating diverse perspectives to produce a shared artifact.	
Digital competence	Competence to integrate digital tools into their **teaching and learning**, **empowering students** through engaging and SRL activities, employing digital tools for **formative and summative assessments** to enhance student progress.	The course is designed **based on DigCompEdu** and respective qualification standards - teacher' youth work organisers and special educators' qualification standard, which. all include a DigCompEdu

Table 2: UAU Trainings in the pilot phase

Case: UAU	**Promoting self-regulated and technology- enhanced learning in the classroom**	**Effective teaching and digital media**
Policy measure	**Policy**: training program by teacher education institution for pre-service teachers to enhance their digital competencies and pedagogical practices	
Goals	After completing the course, teachers understand learning as an (inter)active process, gain insight into self-regulated learning, acquire knowledge of tools and digital teaching formats (e.g., Flipped Classroom, Blended Learning), bridge theory and practice by designing media-enhanced learning activities, and apply new practices in their classrooms.	
Conditions		
Delivery mode	online face-to-face	face-to-face kick-off; online self-paced; face-to-face wrap-up
Interaction mode	synchronous and asynchronous parts	synchronous and asynchronous parts
Training duration	1 semester (5 months):	1 semester (5 months):

Target group		
Target	pre-service teachers	pre-service teachers
Size of the group	n = 17	n = 30
Content		
Technology knowledge	Knowledge in using digital tools to create interactive and technology-enhanced learning environments that include elements of SRL and cognitive engagement strategies.	
Pedagogical knowledge	Knowledge of how to teach and design effective instructional strategies for fostering self-regulated learning and engagement based on the ICAP framework, using principles of instructional design and adaptable methods for diverse contexts	
Content knowledge	Deep understanding of the theoretical and practical foundations of SRL and the ICAP framework, including their application to structure learning activities and support students' cognitive, metacognitive, and motivational regulation, especially within technology-enhanced environments, and outlining strategies to foster students' development of SRL skills	
Inclusion & Equity	The training provides knowledge and skills regarding SRL and hence acknowledges different learning prerequisites, enabling participants to identify and adapt strategies suitable for their unique needs. This experience for their own learning can also be transferred to their students	
Instructional design		
Training method	**Knowledge Instruction** • The training covers theoretical concepts such as the ICAP framework. • Content on technology integration in the classroom is provided. • Lesson planning: Development of lesson plans incorporating elements of the ICAP and SRL frameworks. **Situated learning** • Students apply new practices directly within the classroom context.	**Knowledge Instruction** • The training covers theoretical concepts such as the ICAP framework. • Content on technology integration in the classroom is provided. • Lesson planning: Participants develop lesson plans that incorporate elements of the ICAP framework and SRL strategies. **Collaborative design** • Participants work together to create and refine instructional materials.

Modelling SRL	The lectures will progress through direct and explicit instruction of SRL cognitive and motivational strategies.
Modelling CK-/PCK-/TPCKL-SRL	Teachers learn about the existing digital technologies (CK) and how they can model self-regulated learning strategies specific to their subject (CK-SRL), how to use them (TK and how to implement them in real classrooms across different subjects using instructional methods that promote self-regulated learning, such as goal-setting, progress monitoring, and reflection (PCK-SRL). Additionally, they explore how to leverage technology to foster self-regulated learning in their students, while reflecting on their own use of technology to support these processes (TPCK-SRL).
Modelling ICAP	**Passive**: processing information by attending lectures, reading materials, and exploring digital tools, building foundational understanding **Active**: engaging cognitively by interacting with digital tools, analyzing tasks and learning materials, and discussing practical examples to refine understanding. **Constructive**: synthesize and apply knowledge by developing a lesson plan, integrating learned concepts into cohesive teaching strategies and integrated sequence of the learning activities **Interactive**: co-construction of knowledge through collaborative discussions, analyzing tasks and lesson examples, sharing diverse perspectives, and fostering a shared understanding
Digital competence	Competence to integrate digital tools into their **teaching and learning**, **empowering students** through engaging technology-integrated teaching and learning activities

Table 3: UWK Trainings in the pilot phase

Case: UWK	**Self-paced Massive Open Online Courses (MOOC):** **1) MiniMOOC German Digital** **2) MiniMOOC EFL (English as a Foreign Language) Digital**	**Internal school training programmes "SCHILFplus":** **1) Digitally on the way through the school year at primary level** **2) Digital skills in practice at secondary level 1**
Policy measure	**Policy**: "Digital School – The 8-Point Plan for Digital Learning"	

Goals	1. After completing the course, teachers acquire teaching methods for using mobile devices in German and English as a Foreign Language classrooms, apply them meaningfully, and develop teaching sequences based on the 5E instructional model.	1. After completing the course, teachers develop skills to integrate digital media and educational technologies (e.g., Antolin for reading, Skooly for communication, Bee-Bots for logical thinking, Digi.case for computational thinking) for diverse classroom purposes. 2. After completing the course, teachers gain knowledge on cross-curricular integration of digital devices, handling AI in schools, data security, and safer internet practices, while enhancing their information, data, and media skills (e.g., copyright, image use, secure storage).
Conditions		
Delivery mode	**Group 1:** online; **Group 2:** online + face-to-face	Face-to-face
Interaction mode	**Group 1:** asynchronous; **Group 2:** asynchronous + synchronous	Synchronous
Training duration	Group 1: 14 training hours (usually completed within 2 weeks) Group 2: 14 training hours	1. 5 weeks (4 meetings) 2. 3 weeks (2 meetings)
Target group		
Target	In-service teachers	In-service teachers
Size of the group	Group 1: 15 teachers Group 2: 15 teachers	1. 18 teachers 2. 22 teachers
Content		
Technology knowledge	Knowledge about different educational technology tools (e.g., audience response tools, H5P, individual learning paths, quizzes, interactive videos, collaborative writing tools etc.)	1) Knowledge about different educational technology tools (e.g., digital reading platform, communication and organisational platform, programmable robots, problem-solving tools). 2) Knowledge about data security and safer internet, artificial

		intelligence; information, data and media skills (e.g., copyrights, image usage, secure storage, data protection)
Pedagogical knowledge	Knowledge about learning activities with mobile devices based on the 5E model of instruction (engage, explore, explain, elaborate, evaluate).	1) Knowledge about how to promote reading fluency, computational and logical thinking, differentiated instruction and hands-on and inquiry-based learning. 2) Knowledge about the cross-curricular integration of digital devices (laptops) and about the use of AI in the classroom
Content knowledge	Knowledge about how to use mobile devices in German and EFL classes	1) Teachers are introduced to educational technologies for various subjects in primary education (German, Maths, Science, EFL) 2) The training does not focus on particular school subjects.
Inclusion & Equity	The training provides knowledge and skills regarding SRL and hence acknowledges different learning prerequisites, enabling participants to identify and adapt strategies suitable for their unique needs. This experience for their own learning can also be transferred to their students	Not in the focus
Instructional design		
Training method	**Group 1: Knowledge instruction** **Instruction**: direct instruction on key theoretical concepts, demonstration of the practical application of concepts, showcasing how to effectively integrate tools into teaching (mostly through instructional videos) **Hands-on learning:** active engagement with tools by creating their own learning resources, applying the concepts **Practice lesson planning:** teachers individually develop lesson plans (teaching sequences) that incorporate new methods and mobile devices. **Group 2: Knowledge instruction + Collaborative design**	**Knowledge instruction + situated learning** **Goal setting:** teachers from one school set specific goals for the improvement of their technology integration practices. **Instruction:** direct instruction on key theoretical concepts, demonstration of the practical application of concepts, showcasing how to effectively integrate tools into teaching (mostly through a lecture by the trainer) **Rehearsal/field experience:** Teachers apply what they have learned in the training in their classroom. **Reflection/self-evaluation:** Teachers systematically reflect on and self-evaluate their technology integration practices.

	Instruction: direct instruction on key theoretical concepts, demonstration of the practical application of concepts, showcasing how to effectively integrate tools into teaching (mostly through instructional videos) **Hands-on learning:** active engagement with tools by creating their own learning resources, applying the concepts **Practice lesson planning:** teachers collaboratively develop lesson plans (teaching sequences) that incorporate new methods and mobile devices.	
Modelling SRL	Indirect: Teachers are encouraged to engage in SRL throughout the whole MOOC (self-paced, reflection questions etc.); "explore" unit includes some SRL aspects, e.g. flipped classroom)	N/A
Modelling CK-/PCK-/TPCK-SRL		N/A
Modelling ICAP	Cognitive engagement is modelled through the 5E Model of Instruction: **Engage** (active): design of activities that spark curiosity and activate prior knowledge, encouraging students to actively participate and connect with the learning topic. **Explore** (passive/active): investigation of concepts through guided discovery, balancing passive absorption of information with active experimentation. **Explain** (passive): facilitation of structured instruction to comprehend and process new concepts, focusing on understanding and clarity. **Elaborate** (constructive/interactive): application of knowledge in meaningful ways by creating, collaborating, and connecting new ideas to prior understanding **Evaluate** (reflective): assessment of progress, promoting reflective and metacognitive engagement.	**Passive:** processing information by observing and analyzing concepts and digital tools, developing foundational understanding **Active**: exploring and interacting with digital tools, practicing their use to deepen understanding of their applications and functionalities. **Constructive**: creation artifacts such as a letter to parents, lesson plans, or cloze texts for topic revision, incorporating AI tools **Interactive** participation in group discussions, exchanging ideas and collaboratively reflecting on practices and insights.
Digital competence	Competence to integrate digital tools into their **teaching and learning** (teaching, guidance, collaborative learning, self-regulated	Competence to integrate digital tools into their **teaching and learning** (teaching, guidance, collaborative learning, self-regulated

	learning) and to **empower students** (differentiation and personalisation, actively engaging learners).	learning) and to **facilitate students' digital competence** (information and media literacy, digital problem solving).

Table 4: UOULU Trainings in the pilot phase

Case: UOULU	**Case 1: Technology Enhanced Learning and Working**
Policy measure	**Strategy**: Finland's Digital Compass **Policy**: Policies for the Digitalisation of Education and Training
Goals	As a result of this training, teachers will integrate digital tools, understand key concepts in digital competence and literacy, apply digital frameworks to enhance teaching, and make informed decisions on technology implementation in the classroom.
Conditions	
Delivery mode	face-to-face
Interaction mode	synchronous & asynchronous
Interaction mode	10 h lectures, 20 h (5x4h) seminars, 70 h individual and collaborative work
Target group	
Target	pre-service teachers
Size of the group	n=117
Content	
Technology knowledge	knowledge about how to use different technological resources in real-life primary-level classroom
Pedagogical	knowledge and skills on how to notice, interpret and make informed decisions about technology implementation in classroom to foster the

knowledge	development of SRL skills and cognitive engagement
Content knowledge	knowledge of different existing digital competence frameworks used in teaching and learning; knowledge and understanding of the basic concepts and phenomena related to digital competence, media literacy, and programming competence.
Inclusion & Equity	The training provides knowledge and skills regarding SRL and hence acknowledges different learning prerequisites, enabling participants to identify and adapt strategies suitable for their unique needs to benefit their own learning and to be transferred to their students
Instructional design	
Training method	**Knowledge instruction** focused on the existing digital competence frameworks, media literacy, and programming competence and how these can be used in teaching and learning; **Collaborative design:** coursework contains the task of collaboratively designing and implementing a digital workshop for a primary level classroom **Situated learning:** Implementation of the digital workshop in a primary level classroom
Modelling SRL	Students have to reflect on their learning in a digital portfolio where they are indirectly prompted to engage in SRL.
Modelling CK-/PCK-/TPCK-SRL	Students engage in learning activities (digital portfolio) that indirectly encourage participants to set goals/monitor their progress/and reflect on outcomes (PCK-SRL).
Modelling ICAP	**Passive**: building foundational understanding through lectures on digital competence, programming competence, media literacy, and AI literacy. **Active:** interacting and engaging with digital tools to explore their application possibilities, using them to enhance their own learning and to design teaching strategies adjusted to practical tasks **Constructive**: synthesising and applying knowledge individually by creating specific components for a collaborative digital workshop, such as designing a module or activity **Interactive**: engaging in collaborative group discussions, exchanging ideas and evaluating peer contributions, to co-construct knowledge and shared outputs.
Digital competence	Developing pre-service teachers' knowledge of theoretical concepts related to digital competence and skills to integrate technology into their teaching and learning practices based on hands-on experiences

Table 5: TAU Trainings in the pilot phase

Case: TAU	**Pre-service teacher training "Digital Pedagogy 2.0: Promoting Independent Learners"**
Policy measure	**Strategy:** Using the possibilities inherent in modern technologies as a means of promoting teaching-learning and assessment, while being aware of the value and ethical dangers of misuse of knowledge and loss of privacy **Policy:** A training programme to enhance pre-service teachers' digital competencies and techno-pedagogical practices, promoting self-regulated learning and AI skills in their future teaching
Goals	After completing the course, the teacher understands the SRL process and strategies to effectively foster these skills in educational settings as well as GenAI skills. They will understand how Gen-AI can bolster these learning capabilities, combining theoretical insights with practical applications and will learn how to integrate a Gen-AI chatbot into their subject-specific teaching to enhance student autonomy and engagement
Conditions	
Delivery mode	**Group 1**: Fully Online; **Group 2**: Fully Online
Interaction mode	**Group 1:** Synchronous & Asynchronous **Group 2:** Synchronous & Asynchronous
Training duration	**Group 1:** 1 semester (3 months), **Group 2:** 1 semester (3 months)
Target group	
Target	Pre-service teachers
Size of the group	**Group 1**: n=37; **Group 2**: n=24
Content	
Technology knowledge	Understanding the functionalities, design principles, and integration of Gen-AI chatbots to support self-regulated learning in educational environments
Pedagogical knowledge	Teaching practices that effectively use AI chatbots to promote self-regulated learning, including scaffolding students' learning and adapting their teaching based on student personal progress.

Content knowledge	Foundational concepts and theories of self-regulated learning, including mechanisms, essential skills, and strategies for effective learning management.
Inclusion & Equity	The training provides knowledge and skills regarding SRL and hence acknowledges different learning prerequisites, enabling participants to identify and adapt strategies suitable for their unique needs. This experience for their own learning can also be transferred to their students.
Instructional design	
Training method	**Group 1:** Knowledge Instruction (KI) **Group 2:** KI + *Collaborative Design (CD)* **KI:** Cognitive and motivational self-regulated learning strategies within the context of problem-solving. **Work Samples Analysis:** Analysis of existing learning technologies, and evaluation of the effectiveness of various designs and strategies. • *Group 1: Each participant conducts the analysis individually.* • *Group 2: Participants work in groups to evaluate and analyze learning technologies collaboratively.* **Hands-On Learning:** Solving a learning task individually, utilizing a Gen-AI chatbot. • *Both groups: Each task is completed individually.* **Lesson Planning:** Develop a lesson plan that incorporates Gen-AI chatbots for promoting student independent learning. • *Group 1: Participants develop lesson plans individually.* • *Group 2: Participants collaborate in groups to develop lesson plans, incorporating peer feedback and joint decision-making.*
Modelling SRL	Direct/explicit instruction: Engaging with an Gen-AI chatbot that provides clear guidance and instruction on SRL strategies. ; The lectures will progress through direct and explicit instruction of SRL cognitive and motivational strategies.
Modelling CK-/PCK-/TPCK-SRL	Pre-service teachers explore the theory of SRL and learn various SRL strategies (CK-SRL), learn these strategies but also reflect on how to promote them among their future students and create lesson plans to promote SRL (PCK-SRL). Technology particularly through the use of AI chatbots that train pre-service teachers in SRL strategies helps them understand how to implement technology effectively to foster SRL in their future classrooms (TPCK-SRL)
Modelling ICAP	**Interactive**: Both groups engage in collaborative cognitive processes through online interaction with the Gen-AI chatbot. Group 2 (KI+CD) works together specifically on analyzing work samples and planning lessons, fostering shared understanding and co-construction of ideas. **Construction**: Deepening understanding by synthesizing knowledge to create a lesson plan that integrates the Gen-AI chatbot **Active**: Engaging with the material by solving tasks using the Gen-AI chatbot, applying concepts to specific context and refining

	understanding. **Passive**: processing information about SRL by observing and absorbing content through reading and watching videos, developing foundational understanding.
Digital competence	Competence to integrate digital Gen-AI tools into their **teaching and learning practices**, **empowering students** through engaging and self-regulated learning activities, and employing digital tools for **formative and summative assessments** to monitor and enhance student progress.

Table 6: UULM Trainings in the pilot phase

Case: UULM	**Digital Teaching and Learning (University module)**	**Self-regulated through the course of the study**
Policy measure	**Policy**: The State-funded university (Ulm) is subject to the education and science policies of Baden-Württemberg, which emphasize **research excellence**, innovation, and sustainability	**Policy**: The State-funded university (Ulm) is subject to the education and science policies of Baden-Württemberg, which emphasize **research excellence**, innovation, and sustainability
Goals	After completing the course teachers … • Have identified and distinguished between various concepts of digital teaching and learning • Have developed a comprehensive concept for an e-learning unit • Have provided support and guidance to participants in digital learning environments • Have enhanced e-learning offerings through the use of various digital tools • Have identified different types of e-assessments and explain their advantages and disadvantages • Have recognized and addressed challenges faced by both providers and participants in digital learning, responding to them in a professional manner	After completing the course teachers • Have developed a foundational understanding of self-regulated learning, its theoretical models (e.g., Zimmerman's model), and its relevance in academic and personal contexts • Have identified individual learning habits and motivational challenges • Have learned to assess and adapt strategies that improve learning efficiency and productivity • Have explored techniques to maintain motivation and overcome procrastination • Understood the role of intrinsic and extrinsic motivation in sustaining academic performance • Learned to monitor progress toward academic goals through self-assessment and feedback, as well as reflect on successes and challenges to improve future learning

		outcomes • Recognized the impact of emotions and stress on learning
Conditions		
Delivery mode	**Group 1:** Blended Learning with a Face-to-face online kick off and a face-to-face online wrap up, as well as online self-paced processing of the learning units with a recommended timeline	**Group 1:** Face-to-face
Interaction mode	**Group 1:** Synchronous and Asynchronous Elements	**Group 1:** Synchronous
Training duration	**Group 1:** 1 semester (6 months)	**Group 1:** 1 semester (6 months)
Target group		
Target	**Group 1:** Pre-service STEM teachers	**Group 1:** Psychologists during their Bachelor studies
Size of the group	**Group 1:** n=30	**Group 1:** n=30
Content		
Technology knowledge	Develop an understanding of tools that enhance digital learning, particularly in **Computer-Supported Collaborative Learning**, identifying and applying useful technologies to improve collaboration. The course covers various **e-learning concepts** and introduces different forms of **digital assessments**, including how to transition traditional assessments online. Participants will also learn to create **grading rubrics** for portfolio evaluations. The training further explores the use of **AI chatbots** as learning companions, guiding participants in creating prompts and understanding how AI tools can improve learner engagement.	Creating and maintaining an **e-portfolio** to encourage digital literacy and the use of technological tools for self-regulated learning (SRL). Visualizing articles and **using digital tools** (e.g., mind maps) foster creativity and technology integration. Incorporated online learning ensures flexibility and familiarity with **digital education platforms**. Preparing group presentations and uploading them to the e-portfolio promotes competency in using **presentation tools** and **digital collaboration platforms**.
Pedagogical	The course provides foundational **Digital Teaching and Learning** principles, explaining the **three areas of learning strategies** and the	The seminar employs gradual complexity, starting with **self-awareness tasks** (e.g., self-regulation questionnaires) and

knowledge	concept of **self-regulation**. Participants will apply time management techniques to improve their own learning and explore research on **time management** in education. They will learn methods for effective online course management, including **e-moderation** and interactive **e-tivities**. Teachers will also explore the **TPACK model**, understanding how technology, pedagogy, and content combine to create effective teaching practices.	building toward complex integrations like the INVO and ARCS models. Group presentations and shared assignments promote **peer learning** and teamwork. Regular reflexive assignments (e.g., reflecting on models of SRL, motivation, or stress) encourage **metacognition**, a core principle of effective pedagogy.
Content knowledge	Participants will gain a clear understanding of **digitalisation** across education and work contexts, including its historical development. They will explore **Klauer's six teaching functions** and learn how to apply them to evaluate e-learning courses. The legal aspects of digital education are covered, with a focus on **licensing** and the correct use of learning materials.	A core focus, exploring various **Self-regulated learning** models, strategies, and theoretical underpinnings like the INVO model. In-depth exploration of **motivation** theories (e.g., ARCS model) and practical application to personal learning projects. Emphasis on understanding and mitigating stressors and the role of emotions in learning. Connecting psychology, education, and technology to create a holistic understanding of learning processes.
Inclusion & Equity	Teachers will explore how **AI chatbots** and tools can support diverse learning needs, and how to legally and ethically create accessible educational content.	Tasks allow for flexibility (e.g., group vs. individual work) to accommodate diverse needs and circumstances. Providing asynchronous learning ensures accessibility for students with varied schedules or barriers to synchronous participation. Encouraging personalized projects ensures relevance to each participant's context, supporting diverse learning paths. The training emphasis on SRL acknowledges different learning prerequisites, enabling participants to identify and adapt strategies suitable for their unique needs.
Instructional design		
Training method	knowledge instruction, collaborative design	Knowledge instruction, collaborative design, mentoring and coaching

Modelling SRL	**Direct**: learning strategies, time management, learning goals **Indirect**: reflection, feedback and peer feedback, self assessment	**Direct**: SRL models, learning strategies, time managements, learning goals **Indirect**: reflection, feedback and peer-feedback
Modelling of CK-/PCK-/TPCK-SRL	**CK-SRL:** introducing learning strategies and knowledge about challenges in digital learning strategies from a learner perspective **No PCK-SRL or TPCK-SRL**	**CK-SRL**: explicit instructions on SRL models and phases **PCK-SRL**: progressively structured assignments, starting with self-awareness and advancing to application and integration (e.g. adapting SRL models to own learning projects). Collaborative learning assignments teaching SRL through engagement in discussions. **TPCK-SR**L: E-Portfolio to reflect on their learning using digital tools, helping them integrate SRL concepts with technology.
Modelling ICAP	**Passive**: absorbing information by reading texts and watching videos, processing content to build foundational understanding **Active**: engaging with material by completing chapter-end tasks and self assessments, applying concepts to strengthen understanding **Constructive**: deepening the understanding by participating in e-tivities, constructing new materials and AI chatbot, appling course concepts to real life scenarios **Interactive**: co-construction of knowledge through peer feedback, group work, various discussions to exchange perspectives and refine the understanding collaboratively	
Digital competence	Competence to integrate digital tools into their **teaching and learning**, **empowering students** through engaging and SRL activities, employing digital tools for **formative and summative assessments** to enhance student progress.	Competence to integrate digital tools into their **teaching and learning**, **empowering students** through engaging and SRL activities, employing digital tools for **formative and summative assessments** to enhance student progress.

4.2 Teacher training cases in the intervention phase

During the second phase (M13-24), the focus will shift to implementation of the refined training methods, instructional approaches, and materials across at least 13 intervention studies in Estonia, Austria, Finland, Germany and Israel.

This phase aims to investigate the effects of the training on both teachers and students. The interventions will be designed to assess how the training enhances teachers' knowledge, skills and attitudes. At the same time, we will examine the effect on students, including their learning outcomes and self-regulated learning abilities, according to the research designs presented in D3.1. The findings will contribute to refining best practices for teacher professional learning and instructional practices for technology-enhanced learning environments.

The tables in the upcoming section reveal the following: 5 interventions focus on pre-service studies, while 8 interventions target in-service studies. 6 trainings (TAU,UWK, UOULU) will be conducted online, while 4 trainings (TLU, UWK, UOULU) will be face-to-face and 3 training (UULM, TAU, UAU) will involve blended delivery.

8 trainings (UOULU, UULM, TAU) will apply the knowledge instruction method, 4 trainings (UWK, TLU, UAU) will integrate elements of situated learning, 3 trainings (TAU, UAU, UWK) will emphasise collaborative design and 3 trainings (TAU, UWK, UULM) will integrate mentoring and coaching. 5 trainings (TLU, UWK, UOULU) are domain-focused (e.g., math, language, pre-school), whereas 8 others (TAU, UULM, UAU) are more general in scope.

All trainings model cognitive engagement, either directly or indirectly; however, 7 trainings (UULM, UOULU, TAU, TLU) explicitly integrate self-regulated learning (SRL) into the course design. Few trainings (4: UOULU, TLU, UULM, UWK) fully incorporate the DigCompEdu framework into their course design, while others focus on specific sub-dimensions, such as fostering student empowerment. Inclusion is not a primary focus of the current pilots and will be integrated into the intervention phase, given the complexity of the course designs and the need for additional preparation time.

4.2.1: Intervention studies of TLU

Focus: In the intervention phase, the Tallinn University (TLU) case will evolve into two interventions with in-service teachers: **a subject-specific training** focused on maths and **a whole-school level intervention**. These interventions will focus on developing technology-enhanced learning strategies, aiming to develop teachers' pedagogical digital competence and pedagogical practices.

The first intervention will address subject-specific training in maths, guiding teachers to implement TEL-enhanced teaching strategies to improve student engagement and promote self-regulated learning. The second intervention will be a whole-school programme aimed at integrating effective TEL practices across subjects, fostering a unified approach to teaching and learning with technology. Both interventions are aligned with Estonia's "Tark ja Tegus Eesti" strategy, a national policy that promotes smart and active learning.

Target context: The intervention will be delivered face-to-face in a synchronous mode. The **subject-specific training will run for 9 months**, involving 40 in-service teachers, while the **whole-school programme will last 6 months**, engaging 60 in-service teachers.

Training approach: The instructional design involves **Knowledge Instruction + Situated Learning**, where teachers receive direct instruction and engage in hands-on tasks, including work sample analysis and lesson plan development, followed by at least five field experiences. For some of the teachers, an additional component of **mentoring will be provided,** where mentors guide them with personalised feedback and reflection sessions. The intervention will model SRL strategies, giving teachers firsthand experience in goal-setting, monitoring, and reflection processes that they can apply with their students. Through ICAP modelling, teachers will engage in activities that progress from passive observation to active task creation, lesson planning, and classroom implementation, promoting cognitive engagement in their own teaching.

Table 6: TLU Trainings in the intervention phase

Case: TLU	**Teachers' in-service training on pedagogical digital competence in mathematics**	**Whole-school intervention to develop teachers PDC in culturally diverse settings**
Policy measure	**Policy**: 'Tark ja Tegus Eesti' strategy: training programs by teacher education institutions for teachers to enhance their digital competence and pedagogical practices.	**Policy**: 'Tark ja Tegus Eesti' strategy: training programs by teacher education institutions for teachers to enhance their digital competencies and pedagogical practices.
Goals	After completing the course, the teacher is able to design digital materials and practices that integrate learning sciences, promote self-regulated learning and enhance students' cognitive engagement.	After completing the course, the teacher is able to design digital materials and practices that integrate learning sciences, promote self-regulated learning and enhance students' cognitive engagement in culturally-diverse settings.
Conditions		
Delivery mode	Blended	Face-to-face
Interaction mode	Synchronous	Synchronous
Training duration	7 months: monthly seminars (6h) and independent activities between seminars	1 semester (5 months): monthly seminars (4h) and independent activities between seminars
Target group		
Target group	In-service teachers, primary school mathematics	Different teachers from one school, focus on culturally different teachers and
Size of the group	n=30	n=60 Group 1 (KI + SL): 30 Group 2 (KI + SL+MC): 30
Content		

Technology knowledge	Knowledge in using H5P and TeacherDesmos to creation of interactive learning materials that include elements of SRL and cognitive engagement	
Pedagogical knowledge	**Cognitive engagement strategies** incorporating **SRL techniques** and applying **instructional design** principles	
Content knowledge	**Group 2:** Mathematical thinking of primary school students	
Inclusion & equity	We address inclusion and equity by equipping teachers with strategies to design learning activities tailored to diverse needs (e.g., cultural backgrounds of Ukrainian students), adapt teaching practices with varied learning materials and levels of complexity, and ensure equitable access to resources and activities.	
Instructional design		
Training method	**Knowledge instruction + Situated Learning** **Instruction**: direct instruction on key theoretical concepts, demonstration of the practical application of concepts, showcasing how to effectively integrate tools into teaching **Work samples analysis:** analysis of existing learning resources, evaluation of the effectiveness of designs and strategies, **Hands-on learning:** active engagement with tools by creating their own learning resources, applying the concepts **Lesson planning:** develop lesson plans and set of tasks based on pedagogical concepts that incorporate elements of SRL and cognitive engagement and H5P resources,	Group 1: **Knowledge instruction + Situated Learning** **Instruction**: direct instruction on key theoretical concepts, demonstration of the practical application of concepts, showcasing how to effectively integrate tools into teaching **Work samples analysis:** analysis of existing learning resources, evaluation of the effectiveness of designs and strategies, **Hands-on learning:** active engagement with tools by creating their own learning resources, applying the concepts **Lesson planning:** develop lesson plans that incorporate new methods and H5P resources, **Practice lesson planning** of technology-integrated lessons for their own context. **Rehearsal/field experience**: implementing technology-integrated lessons in their own context with actual students. **Reflection/self-evaluation** on technology integration practices. **Group 2: Knowledge instruction + Situated Learning + Mentoring** Addition to above mentoring is added: **Modelling:** providing an observable example of the target teaching

		practice, which provides a visual guide for subsequent practice. **Observations:** Teachers can watch another teacher effectively integrate technology in the classroom.
Modelling SRL	Teachers set learning goals, regular adjustment of their strategies based on feedback and self-assessment	
Modelling of CK-/PCK-/TPCK-SRL	Through our training, we model the integration of Content Knowledge (CK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPCK) with Self-Regulated Learning by engaging teachers in technology-rich tasks that involve designing, implementing, and reflecting on instructional strategies. These strategies are aimed at fostering cognitive, metacognitive and motivational regulation while maintaining alignment with subject-specific pedagogical goals	
Modelling ICAP	**Passive:** reading and listening to theoretical foundations and observing digital tools in action, based on that participants identify features of a digital tool and relate them to potential classroom applications **Active:** engagement through tasks like exploring practical applications of tools in authentic teaching scenarios **Constructive:** participants design a lesson plan by connecting observations, personal teaching experiences and pedagogical theories to address specific classroom needs **Interactive:** group discussions to collaboratively analyse and refine work examples, fostering deeper understanding. In group 2: participants collaboratively refine lesson plans, integrating diverse ideas to produce a shared artefact	
Digital competence	Competence to integrate digital tools into their **teaching and learning**, **empowering students** through engaging and SRL activities, employing digital tools for **formative and summative assessments** to enhance student progress.	

4.2.2 Intervention studies of UULM

The DLL Module and DLL pre-service teacher course (6 ECTS) focus on digitised teaching and learning for both in-service and pre-service teachers. It equips participants with the knowledge and skills to integrate digital tools effectively in their teaching practices. Key goals include mastering digital teaching concepts, designing e-learning units, supporting participants in digital environments, and addressing challenges related to e-assessments. The course is delivered through a blend of synchronous and asynchronous methods, with both online and face-to-face components. It emphasises collaborative learning, e-moderation, and the use of innovative digital tools such as AI chatbots for enhancing learner engagement. Additionally, the course models self-regulated learning (SRL) by promoting learning

strategies, time management, and peer feedback, while also utilising the ICAP framework, encouraging passive, active, constructive, and interactive participation through various e-tivities and group work.

The second intervention, aimed at **in-service teachers** (n=33), is part of the "Digitalisation Focal Point" strategy by the Center for School Quality and Teacher Training. The goal is to equip teachers with essential digital teaching skills, covering concepts from designing digital learning modules to conducting digital assessments. By the end of the course, teachers will be able to guide participants effectively in digital environments, navigate common challenges, utilise tools like Blended Learning and the Flipped Classroom, and create engaging e-learning materials.

The course is **delivered through a blended format** that includes an initial online face-to-face kickoff, a self-paced online phase, and a concluding two-day face-to-face session. Interaction combines synchronous and asynchronous modes across the semester, providing flexibility while ensuring structured engagement.

The **content** covers **technology knowledge** (digital learning concepts, legal foundations for digital materials, and portfolio assessment rubrics), **pedagogical knowledge** (collaborative learning through the TPACK model, e-moderation techniques, and CSCL principles), and c**ontent knowledge** (self-regulation in digital learning and Klauer's teaching functions). The training methods focus on **Knowledge Instruction**, **Collaborative Design**, and **Situated Learning** to create a comprehensive learning experience.

Self-regulated learning is modelled directly through instruction in learning goals and time management, while reflection and peer feedback indirectly reinforce SRL skills. Cognitive engagement follows the ICAP framework, moving from passive information reception to interactive group discussions and peer feedback, fostering both individual learning and collaborative engagement.

Table 7: UULM Trainings in the intervention phase

Case: UULM	**Digitalisiertes Lehren und Lernen (digitalised teaching and learning) - in-service teacher module**	**Digitalisiertes Lehren und Lernen (digitalised teaching and learning) - pre-service teacher module**

Policy measure	**Policy**: focal point digitalisation at the centre for school quality and teacher training	
Goals	After completing the course teachers … • understand the fundamental concepts of digital teaching, from planning an e-learning concept to conducting digital assessments • explored effective strategies for supporting guiding participants in e-learning courses, addressing common challenges and difficulties in the digital learning environments • have learned about useful tools, apps, and various digital teaching formats, including Blended Learning and the Flipped Classroom • gained inspiration for designing engaging e-learning materials through the exploration of innovative digital learning formats	After completing the course students … • identified and distinguished between various concepts of digital teaching and learning • developed a comprehensive concept for an e-learning unit • provided support and guidance to participants in digital learning environments • enhanced e-learning offerings through the use of various digital tools • identified different types of e-assessments and explain their advantages and disadvantages • recognized and addressed challenges faced by both providers and participants in digital learning, responding to them in a professional manner
Conditions		
Delivery mode	Group 1: • online face-to-face kick off • online self-paced processing of the learning units with a recommended timeline • two day face-to-face wrap up in person Group 2: • online face-to-face kick off • online self-paced processing of the learning units with a recommended timeline • two day face-to-face wrap up in person	Group 1: • online face-to-face kick off • online self-paced processing of the learning units with a recommended timeline • online face-to-face wrap up Group 2: • weekly face-to-face lecture
Interaction mode	Group 1: synchronous and asynchronous parts Group 2: synchronous and asynchronous parts	Group 1: synchronous and asynchronous parts Group 2: synchronous

Training duration	Group 1: 1 semester (6 months) Group 2: 1 semester (6 months)	Group 1: 1 semester (6 months) Group 2: 1 semester (6 months)
Target group		
Target	In-service teachers	pre-service teachers
Size of the group	Group 1: n=23 Group 2: n=29	Group 1: n=24 Group 2: n=120
Content		
Technology knowledge	An overview of **digitalization in education and work** can be summarized, along with its historical progression. Various **e-learning concepts**, including their pros and cons, can be analyzed. The importance of legal foundations in creating **e-learning materials** is understood, and teaching materials can be evaluated based on licensing. Knowledge of **digital examination forms**, their advantages, and implementation strategies is also covered. Additionally, **grading rubrics** for portfolios can be created, and apps can be evaluated based on specific criteria.	Develop an understanding of tools that enhance digital learning, particularly in **Computer-Supported Collaborative Learning**, identifying and applying useful technologies to improve collaboration. The course covers various **e-learning concepts** and introduces different forms of **digital assessments**, including how to transition traditional assessments online. Participants will also learn to create **grading rubrics** for portfolio evaluations. The training further explores the use of **AI chatbots** as learning companions, guiding participants in creating prompts and understanding how AI tools can improve learner engagement.
Pedagogical knowledge	The benefits of collaboration among learners can be articulated, and research on **Computer-Supported Collaborative Learning** can be summarised and applied to develop learning environments. **Klauer's six teaching functions** can be understood, applied in examples, and used to evaluate e-learning courses. Necessary competencies for **e-learning instructors** can be identified, along with reflections on strengths. The **TPACK model** can be understood, outlining how its three competencies interrelate. Effective methods for online initiation and conclusion can be outlined, **e-moderation** stages can be applied, and peer feedback can be conducted.	The course provides foundational **Digital Teaching and Learning** principles, explaining the **three areas of learning strategies** and the concept of **self-regulation**. Participants will apply time management techniques to improve their own learning and explore research on **time management** in education. They will learn methods for effective online course management, including **e-moderation** and interactive **e-tivities**. Participants will also explore the **TPACK model**, understanding how technology, pedagogy, and content combine to create effective teaching practices.

Content Knowledge	**Digital teaching and learning fields** can be described, and **Schnotz and Bannert's model** (1999) can be explained. The construction of mental models, including why they take longer when learning from texts rather than images, can be discussed. Three areas of **learning strategies** can be outlined and applied. The concepts of **self-regulation** and **time management** in online learning can be explained, along with methods to enhance time management and relevant studies.	Participants will gain a clear understanding of **digitalisation** across education and work contexts, including its historical development. They will explore **Klauer's six teaching functions** and learn how to apply them to evaluate e-learning courses. The legal aspects of digital education are covered, with a focus on **licensing** and the correct use of learning materials.
Inclusion & Equity	Various **e-tivities** that enhance interactivity in teaching can be identified, and different tools available for classroom use can be recognized.	Participants will explore how **AI chatbots** and tools can support diverse learning needs, and how to legally and ethically create accessible educational content.
Instructional design		
Training method	**Group 1:** knowledge instruction, collaborative design, situated learning **Group 2:** knowledge instruction, collaborative design	**Group 1:** knowledge instruction, collaborative design, situated learning **Group 2:** knowledge instruction
Modelling SRL	**Direct**: Learning strategies, time management, learning goals **Indirect**: reflection, feedback and peer feedback, self-assessment	**Direct**: learning strategies, time management, learning goals **Indirect**: reflection, feedback and peer feedback, self assessment
Modelling CK-/PCK-/TPCK-SRL	**CK-SRL:** introducing learning strategies and knowledge about challenges in digital learning strategies from a learner perspective **No PCK-SRL or TPCK-SRL**	**CK-SRL:** introducing learning strategies and knowledge about challenges in digital learning strategies from a learner perspective **No PCK-SRL or TPCK-SRL**
Modelling ICAP	**Passive**: acquiring information by reading, watching videos and processing knowledge to develop basic knowledge **Active**: engaging with the learning material to complete tasks and self assessments, applying concepts to strengthen understanding **Constructive**: deepening understanding by participating in e-tivities, creating new materials, apply course concepts to real life scenarios **Interactive**: co-construction of knowledge through peer feedback,	**Passive**: passively receiving information (reading texts, watching videos) **Active**: completing tasks at the end of each chapter, self assessment tasks **Constructive**: participating in e-tivities, constructing new materials, apply course concepts to real life scenarios, creation of a AI chatbot **Interactive**: peer feedback, group work, various discussions

	group work, various discussions to exchange perspectives and refining understanding collaboratively	
Digital competence	Developing pre-service teachers' digital competence in **Digital Resources** by enhancing their ability to select and utilize digital tools aligned with learning objectives and contexts; in **Facilitating Students' Digital Skills** by equipping them to foster problem-solving in students; and in **Teaching and Learning** by integrating digital technologies to promote general competences, learner autonomy.	

Masternugget Digital 2 and SRL nugget

The **Masternugget Digital 2** and the **Self-Regulated Learning Nugget** (each 1 ECTS) are part of the UULM initiative, designed to enhance **in-service teachers**' skills in teaching and learning with digital tools. These programs align with the "Digitalisation Focal Point" policy by the Center for School Quality and Teacher Training and aim to empower teachers to integrate digital tools effectively into their teaching practices, foster self-regulated learning (SRL), and develop critical pedagogical and technological knowledge. While the structure and goals of the Masternugget Digital 2 are well-defined, much of the content for the SRL Nugget is still under development.

The Masternugget Digital 2 focuses on enabling teachers to identify and differentiate between various **e-learning concepts**, evaluate the advantages and disadvantages of these approaches, and make informed decisions when selecting suitable concepts for their courses. Teachers will also learn to understand key **cognitive and motivational processes** involved in **digital learning**, design strategies to support these processes, and evaluate and apply **digital tools** effectively. The SRL Nugget, on the other hand, will emphasise self-regulated learning strategies in a direct approach, taking self-regulated learning strategies into technology-enhanced learning environments.

Both courses are delivered through a **six-week blended learning format**, consisting of an initial online face-to-face kickoff, a self-paced online learning phase with a recommended timeline, and an online face-to-face wrap-up session. Interaction combines **synchronous** and **asynchronous** methods to provide flexibility while maintaining structured engagement. Each course targets in-service teachers, with groups limited to 25 participants.

The content of the Masternugget Digital 2 covers three knowledge domains. **Technology knowledge (TK)** focuses on familiarity with e-learning tools and the ability to select digital solutions that best support specific learning processes. **Pedagogical knowledge (PK)** emphasises understanding cognitive and motivational processes in digital learning and designing strategies to support these. **Content knowledge (CK)** involves evaluating and applying e-learning concepts effectively. Inclusion is not explicitly addressed but is implied in the focus on accommodating diverse learner needs. For the SRL Nugget, the content in all knowledge domains is still to be determined.

In terms of instructional design, the courses incorporate **knowledge instruction**, **collaborative design**, and **situated learning**. The SRL Nugget will additionally provide the participants with **mentoring/coaching** elements. **Self-regulated learning** is modelled **directly** through instruction on learning goals, strategies, and time management, and **indirectly** through reflection, feedback, peer assessment, and self-assessment activities. The **ICAP framework** is applied to ensure cognitive engagement, starting with passive information consumption (e.g., reading texts and watching videos), progressing to active engagement through tasks and self-assessments, constructive application by creating new materials and applying concepts to real-life scenarios, and culminating in interactive peer feedback and group discussions.

Table 8: UULM Trainings in the intervention phase

Case: UULM	Masternugget Digital 2 - Lehre ich anders mit digitalen Medien? (Masternugget Digital 2 - do I teach differently with digital media)	Selbstreguliertes Lernen und Lehren (self-regulated teaching and learning)
Policy measure	**Policy**: focal point digitalisation at the center for school quality and teacher training	**Policy**: focal point digitalisation at the center for school quality and teacher training
Goals	**After completing the course, teachers will be able to…** • Identify and differentiate between various e-learning concepts. • Assess the advantages and disadvantages of different	After completing the course, teachers will be able to… • Understand and distinguish between diverse e-learning methodologies and frameworks • Analyze the strengths and limitations of various technology-based learning strategies

	e-learning approaches. • Make informed decisions when selecting the most suitable e-learning concept for their courses. • Describe key cognitive and motivational processes involved in digital learning. • Design targeted strategies to support these learning processes through digital means. • Evaluate and select digital tools that effectively enhance specific learning processes.	• Apply critical thinking to choose the most appropriate e-learning methods tailored to course objectives and learner needs • Explain essential cognitive and motivational mechanisms that underpin successful digital learning experiences • Develop and implement customized approaches to foster self-regulation in learners through digital platforms • Critically assess and select digital tools that align with and enhance targeted cognitive and motivational learning outcomes
Conditions		
Delivery mode	Group 1: • online face-to-face kick off • online self-paced processing of the learning units with a recommended timeline • online face-to-face wrap up Group 2: • online face-to-face kick off • online self-paced processing of the learning units with a recommended timeline • online face-to-face wrap up	Group 1: • online face-to-face kick off • online self-paced processing of the learning units with a recommended timeline • online face-to-face wrap up Group 2: • online face-to-face kick off • online self-paced processing of the learning units with a recommended timeline • online face-to-face wrap up
Interaction mode	Group 1: synchronous and asynchronous parts Group 2: synchronous and asynchronous parts	Group 1: synchronous and asynchronous parts Group 2: synchronous and asynchronous
Training duration	Group 1: six weeks Group 2: six weeks	Group 1: six weeks Group 2: six weeks
Target group		
Target	In-service teachers	in-service teachers

Size of the group	Group 1: n=25 Group 2: n=25	Group 1: n=25 Group 2: n=25
Content		
Technology knowledge	Familiarity with various e-learning concepts and tools is developed. Additionally, the ability to assess which digital tools best support specific learning processes is cultivated.	not yet decided on
Pedagogical knowledge	An understanding of key cognitive and motivational processes in digital learning is provided. Concrete strategies to effectively support these learning processes in digital environments are also outlined.	To be decided
Content Knowledge	The ability to identify the advantages and disadvantages of different e-learning concepts is fostered. Participants are equipped to make informed decisions regarding the most appropriate concept for implementing an e-learning course.	To be decided
Inclusion and equity	While not explicitly addressed, the ability to assess and choose suitable digital learning concepts and tools suggests an underlying focus on accommodating diverse learner needs and promoting inclusivity in educational practices.	To be decided
Instructional design		
Training method	Group 1: knowledge instruction, collaborative design, situated learning Group 2: knowledge instruction, collaborative design In both groups teachers will learn how to plan and design effective digital learning environments. Based on theoretical models they can decide how learning processes are best supported via digital media (KI). They also train how to transfer digital media by designing lessons	Group 1: knowledge instruction, collaborative design, mentoring/coaching Group 2: knowledge instruction In both groups teachers will learn how to plan and design effective digital learning environments with a special focus on how to support self-regulated learning. Based on theoretical models they can decide how learning processes and cognitive as well as

	together with their colleagues (CD). Only in the experimental group do they also implement these lesson plans into their classroom, reflect on their experiences and the lessons outcomes, individually and in cooperation with other participants.	metacognitive learning strategies are best supported via digital media (KI). They also train how to transfer digital media and SRL by designing lessons together with their colleagues (CD). Only in the experimental group are they accompanied individually while they implement these lesson plans into their classroom, reflect on their experiences and the lessons outcomes, individually and in cooperation by the trainer or an individual tutor, providing feedback and advice.
Modelling SRL	**Indirect**: reflection, feedback and peer feedback, self-assessment	**Direct**: Learning strategies, time management, learning goals **Indirect**: reflection, feedback and peer feedback, self-assessment
Modelling CK-/PCK-/TPCK-SRL	**CK-SRL:** not directly trained but SRL experiences are prompted for reflection, only from a learner perspective	**CK-SRL, PCK-SRL and TPCK-SRL:** are explicitly and indirectly explained, trained, reflected an implemented, from a learner and teacher perspective
Modelling ICAP	**Passive**: acquiring information by reading, watching videos and processing knowledge to develop basic knowledge **Active**: engaging with the learning material to complete tasks and self assessments, applying concepts to strengthen understanding **Constructive**: deepening understanding by participating in e-tivities, creating new materials, apply course concepts to real life scenarios **Interactive**: co-construction of knowledge through peer feedback, group work, various discussions to exchange perspectives and refining understanding collaboratively	
Digital competence	Developing pre-service teachers' digital competence in **Digital Resources** by enhancing their ability to select and utilize digital tools aligned with learning objectives and contexts; in **Facilitating Students' Digital Skills** by equipping them to foster problem-solving in students; and in **Teaching and Learning** by integrating digital technologies to promote general competences, learner autonomy.	

4.2.3 Intervention studies of TAU

Focus: During the intervention phase, the Tel Aviv University (TAU) initiative will evolve into **two distinct interventions: one for in-service teachers and another for pre-service teachers.** These interventions will focus on Self-Regulated Learning (SRL) and Generative Artificial Intelligence (GenAI) as tools to enhance learning. The goal is to develop teachers' pedagogical digital competence and techno-pedagogical practices. Upon completing the trainings, teachers will gain a thorough understanding of the SRL process and strategies to foster these skills effectively in educational settings. They will also acquire GenAI skills, learning how generative AI can enhance SRL capabilities by integrating theoretical knowledge with practical applications. Teachers will explore how to incorporate a GenAI chatbot into their subject-specific teaching to promote student autonomy and engagement.

Both interventions are tailored for pre-service and in-service teachers across various disciplines. The in-service teacher training is designed as a whole-school intervention. These initiatives align with Israel's "Learning Perception - Skills for the Education System 2021–2031" policy document, which emphasizes digital competence and techno-pedagogical practices to advance SRL and AI skills in future teaching.

Target Context: The **pre-service teacher intervention will be conducted fully online**, combining synchronous and asynchronous modes. This **semester-long (3-month)** training program will include 50 pre-service teachers.

The in-service teacher intervention will follow a blended approach, combining face-to-face sessions with synchronous and asynchronous online components. Delivered as a whole-school program, this training will span **6 months** and engage 40 in-service teachers.

Training Approach: For pre-service teacher training, the instructional design includes **Knowledge Instruction (KI)** to introduce cognitive and motivational SRL strategies within the context of problem-solving and GenAI in education. Participants will analyze existing GenAI technologies, evaluate the effectiveness of various designs, and develop lesson plans integrating GenAI chatbots to promote SRL skills. The course will be divided into two groups who will study in parallel. In Group 1, participants will complete activities individually, including work sample analysis, solving learning tasks, and lesson planning. In Group 2, participants will engage in **Collaborative Design (CD)**, working in teams to evaluate learning technologies, develop lesson plans, incorporate peer feedback, and make joint decisions.

For in-service teacher training, the instructional design also incorporates KI and CD across two groups. Group 2 will include an additional **Situated Learning (SL) component,** where participants use a GenAI chatbot with their students during classroom sessions as part of a situated learning experience.

Across all trainings, both in-service and pre-service teachers will interact with a GenAI chatbot specifically designed to support SRL strategies such as goal-setting, monitoring, and reflection within problem-solving contexts. Participants will critically reflect on their experiences as both students and teachers. They will develop lesson plans, with some implementing these plans in classrooms to advance their students' skills. For teachers implementing lesson plans in classrooms, this iterative, spiral training model ensures they first experience the chatbot as learners, then plan and apply it as educators. Participants return to the course to share insights from their classroom implementation, promoting continuous refinement of their practices. Additionally, all training programs address critical thinking in the context of generative AI, peer help-seeking facilitation, and effective time management with digital tools.

Table 9: TAU Trainings in the intervention phase

Case: TAU	**Pre-service teacher training "Digital Pedagogy 2.0: Promoting Independent Learners"**	**In-service teacher training "Engaging with AI: Leveraging a GenAI Chatbot to Enhance Self-Regulated Learning"**
Policy measure	**Strategy:** Using the possibilities inherent in modern technologies as a means of promoting teaching-learning and assessment, while being aware of the value and ethical dangers of misuse of knowledge and loss of privacy **Policy:** A training programme to enhance pre-service teachers' digital competencies and techno-pedagogical practices, promoting self-regulated learning and AI skills in their future teaching	**Strategy:** The Learning Perception - Skills for the Education System 2021-2031 **Policy:** A training programme to enhance pre-service teachers' digital competence and techno-pedagogical practices for promoting Self-regulated learning and AI skills throughout their future teaching.
Goals	After completing the course, the teacher understands the SRL process and strategies to effectively foster these skills in educational settings as well as GenAI skills. They will understand how Gen-AI can bolster these learning capabilities, combining theoretical insights with practical applications and will learn how to integrate a Gen-AI chatbot into their subject-specific teaching to enhance student autonomy and engagement	

Conditions		
Delivery mode	**Group 1**: Fully Online; **Group 2**: Fully Online	**Group 1:** Blended**; Group 2:** Blended
Interaction mode	**Group 1:** Synchronous & Asynchronous **Group 2:** Synchronous & Asynchronous	**Group 1:** Face-to-face, Synchronous & Asynchronous **Group 2:** Face-to-face, Synchronous & Asynchronous **Group 3:** Control - does not participate in training
Training duration	**Group 1:** 1 semester (3 months)**, Group 2:** 1 semester (3 months)	**Group 1**: 6 months; **Group 2**: 6 months
Target group		
Target	Pre-service teachers	In-service teachers
Size of the group	**Group 1**: n=28; **Group 2**: n=22	**Group 1**: 20; **Group 2**: 20; **Group 3:** 10
Content		
Technology knowledge	Designing and integrating Gen-AI chatbots into educational practices for enhancing self-regulated learning (Indirect, learning by doing)	
Pedagogical knowledge	Teaching practices that effectively use AI chatbots to promote self-regulated learning, including scaffolding students' learning and adapting their teaching based on student personal progress.	
Content knowledge	Foundational concepts and theories of self-regulated learning, including mechanisms, essential skills, and strategies for effective learning management.	
Inclusion & Equity	Will be decided	
Instructional design		
Training method	**Group 1:** Knowledge Instruction (KI) **Group 2:** KI + *Collaborative Design (CD)*	**Group 1:** Knowledge Instruction (KI) + Collaborative Design (CD) **Group 2:** KI + CD + *Situated Learning (SL)*

	KI: Cognitive and motivational self-regulated learning strategies within the context of problem-solving. **Work Samples Analysis:** Analysis of existing learning technologies, and evaluation of the effectiveness of various designs and strategies. • *Group 1: Each participant conducts the analysis individually.* • *Group 2: Participants work in groups to evaluate and analyze learning technologies collaboratively.* **Hands-On Learning:** Solving a learning task individually, utilizing a Gen-AI chatbot. • *Both groups: Each task is completed individually.* **Lesson Planning:** Develop a lesson plan that incorporates Gen-AI chatbots for promoting student independent learning. • *Group 1: Participants develop lesson plans individually.* • *Group 2: Participants collaborate in groups to develop lesson plans, incorporating peer feedback and joint decision-making.*	**Knowledge Instruction:** Cognitive and motivational self-regulated learning strategies within the context of problem-solving. **Work Samples Analysis:** Analysis of existing learning technologies, and evaluation of the effectiveness of various designs and strategies. • *Both groups:* Participants work in groups to evaluate and analyze learning technologies collaboratively. **Hands-On Learning:** Solving a learning task individually, utilizing a Gen-AI chatbot. • *Group 1: Each task is completed individually.* • *Group 2: Each task is completed individually; participants also practice using the chatbot with their students during situated learning, in groups of teachers in class.* **Lesson Planning**: Develop a lesson plan that incorporates Gen-AI chatbots for promoting student independent learning. • *Group 1: Participants collaborate in groups to develop a lesson plan design* • *Group 2: Participants collaborate in groups to develop lesson plans and implement them in class.* **Reflection and feedback:** Reflect on the successes and challenges encountered while integrating the chatbot into classroom instruction. • *Group 1: This activity does not apply as there is no implementation of the chatbot in the classroom.* • *Group 2: Teachers participants collaborate in groups to reflect on their experiences of implementing the chatbot in their teaching practice, discussing what worked and what could be improved.*
Modelling SRL	Direct/explicit instruction: Engaging with an Gen-AI chatbot that provides clear guidance and instruction on SRL strategies. ; The lectures will progress through direct and explicit instruction of SRL cognitive and motivational strategies.	

Modelling CK-/PCK-/TPCK-SRL	**CK-SRL:** Pre-service teachers explore SRL theories and strategies **PCK-SRL:** Pre-service teachers learn and reflect on how to promote these strategies with their future students and develop lesson plans that incorporate SRL practices to understand how to promote SRL strategies effectively within the subjects they plan to teach. **(AI) TPCK-SRL:** The course includes using Generative AI, such as a chatbot, to train pre-service teachers in SRL strategies during problem-solving, fostering reflection on their learning and future classroom implementation	**CK-SRL:** Pre-service teachers explore SRL theories and strategies **PCK-SRL:** Teachers reflect on their SRL activities, based on their current teaching contexts. They share how they promote these strategies with their students and further develop or refine lesson plans that integrate SRL practices based on real classroom experiences. **(AI) TPCK-SRL:** The course features a GENAI chatbot for training teachers in SRL strategies during problem-solving. Teachers share their classroom implementation experiences, discussing challenges and solutions in training sessions.
Modelling ICAP	**Interactive**: Both groups engage in online interaction with the Gen-AI chatbot. Group 2 (KI+CD) collaborates on analyzing work samples and planning lessons, fostering shared understanding through discussion, reflection, and joint decision-making. **Construction**: Constructing new knowledge by applying SRL strategies, learners create a lesson plan that integrates the Gen-AI chatbot to address complex, real-world problems. **Active**: engaging with the Gen-AI chatbot to complete tasks, applying concepts and refining their understanding through practical use. **Passive**: building foundational knowledge by reading and watching videos on SRL and Gen-AI	**Interactive:** Both groups engage in online interaction with the Gen-AI chatbot; Both groups collaborate on work samples analysis and lesson planning; *Group 2* (KI + CD + SL) interacts with their students during the implementation of the chatbot in class and build shared knowledge through discussion, reflection, and joint decision-making. **Construction**: Constructing new knowledge by applying SRL strategies, learners create a lesson plan that integrates the Gen-AI chatbot to address complex, real-world problems. **Active**: engaging with the Gen-AI chatbot to complete tasks, applying concepts and refining their understanding through practical use. **Passive**: building foundational knowledge by reading and watching videos on SRL and Gen-AI
Digital competence	Competence to integrate digital Gen-AI tools into their **teaching and learning practices**, **empowering students** through engaging and self-regulated learning activities, and employing digital tools for **formative and summative assessments** to monitor and enhance student progress.	

4.2.4: Intervention studies of UWK

In the intervention phase, the University for Continuing Education Krems (UWK) case will evolve into two interventions with in-service teachers: a **Massive Open Online Course (MOOC)** in combination with face-to-face training and a **whole-school level intervention**. These interventions will focus on fostering teachers' pedagogical digital competence, their classroom practices, and student outcomes.

The first intervention aims to promote the didactically meaningful use of digital media by teachers in primary school and to subsequently strengthen students' computational thinking and creative problem solving. The second intervention will be a whole-school programme in the area of digital education aimed at integrating effective technology-enhanced learning practices across subjects. Both interventions are aligned with Austria's "Digital School—8-Point Plan for Digital Learning".

Target context: The interventions are provided by Austrian teacher education colleges. The first intervention will be conducted in two stages, consisting of an asynchronous online phase and synchronous face-to-face meetings involving in-service teachers working in primary schools. The specific setting of the second intervention is not yet decided but will engage lower secondary school teachers.

Training approach: In the first intervention, the instructional design combines Knowledge Instruction and Collaborative Design. The first stage involves direct instruction and hands-on activities, while the second stage focuses on developing a shared understanding of the design context and elements, along with conducting design sessions and implementation planning. In the second intervention, the instructional design involves different combinations of **Knowledge Instruction + Situated Learning + Mentoring**. In the first group (knowledge instruction only), teachers from one school participate in an internal school training programme. In the second group (knowledge instruction + situated learning), teachers from another school participate in an internal school training programme, apply what they have learned in the training in their classrooms, and reflect on their experiences. In the third group (knowledge instruction + situated learning + mentoring), teachers from another school additionally receive guidance from a mentor throughout the whole process.

Table 10: UWK Trainings in the intervention phase

Case: UWK	Learn to think, solve problems (digi.case): Massive Open Online Course (MOOC) + face-to-face training	Internal school training programme: Digital education/media education
Policy measure	**Policy**: "Digital School – The 8-Point Plan for Digital Learning"	
Goals	After completing the course, teachers will be able to… • use digital media in a didactically meaningful way in their teaching contexts • design activities with digital tools to promote analytical and structured thinking for students • strengthen students' computational thinking and creative problem solving	Not yet decided on, but in general after completing the course, teachers will be able to use digital media in a didactically meaningful way in their teaching contexts to promote self-regulated learning and cognitive engagement.
Conditions		
Delivery mode	**Group 1:** online; **Group 2:** online + face-to-face	Face-to-face
Interaction mode	**Group 1:** asynchronous; **Group 2:** asynchronous + synchronous	Synchronous
Training duration	Not yet decided on	To be decided
Target group		
Target	In-service teachers	In-service teachers
Size of the group	Group 1: 20 Group 2: 20	Group 1 -3: not known yet
Content		
Technology knowledge	Understanding how to use digital tools (digi.case media case in the form of games and tasks) to scaffold problem solving and computational thinking	To be decided

Pedagogical knowledge	Knowledge about teaching computational thinking effectively to enable students acquire problem-solving skills	To be decided
Content knowledge	Understanding how to teach learning outcomes envisaged in the curriculum, such as problem-solving skills, by integrating digital tools	To be decided
Inclusion & Equity	To be decided	To be decided
Instructional design		
Training method	**Group 1: Knowledge instruction** • **Instruction:** direct instruction on key theoretical concepts, demonstration of the practical application of concepts, showcasing how to effectively integrate tools into teaching (mostly through instructional videos) • **Hands-on learning:** active engagement with tools by creating their own learning resources, applying the concepts • **Practice lesson planning:** individually developing lesson plans (teaching sequences) that incorporate new methods and digital tools. **Group 2: Knowledge Instruction + Collaborative design** In addition to the practices above, these key practices from collaborative design are added: • Practice lesson planning: collaboratively planning technology-integrated lessons in groups.	**Group 1: Knowledge instruction** • direct instruction on key theoretical concepts, demonstration of the practical application of concepts **Group 2: Knowledge instruction + situated learning** • Teachers participate in an internal school training programme (instruction). • Teachers apply what they have learned in the training in their classroom (implementation). • Teachers reflect on their experiences (reflect). **Group 3: Knowledge instruction + situated learning + mentoring/coaching** • Teachers participate in an internal school training programme (instruction). • Teachers apply what they have learned in the training in their classroom (implementation). • Teachers reflect on their experiences (reflect). • Teachers regularly meet a mentor/coach who provides individualised feedback.
Modelling SRL	**Indirect:** Teachers are encouraged to engage in SRL throughout the whole MOOC (self-paced, reflection questions, etc.) Additionally, in Group 2, during face-to-face trainings, feedback and peer feedback will be provided.	To be decided

Modelling CK-/PCK-/TPCK-SRL	Not yet decided on	To be decided
Modelling ICAP	**Passive:** Engaging in activities such as reading and listening to theoretical foundations, while observing demonstrations of digital tools and their potential applications in teaching. **Active:** Completing hands-on tasks with digital tools to explore their functionality in different teaching approaches **Constructive:** designing teaching sequences (e.g. lesson plan) by connecting observations, personal teaching experiences and pedagogical theories to address specific classroom needs **Interactive:** (In group 2 only) Participating in group discussions to build a shared understanding of learning technologies and collaboratively plan and develop technology-integrated lessons.	To be decided
Digital Competence (Based on DigiComEdu)	• Digital resources: Selecting digital resources considering learning objective, context, etc. • Facilitating students' digital skills: especially information and media literacy and problem solving • Teaching and learning: using digital technologies to foster and enhance learner collaboration	To be decided

4.2.5: Intervention studies of UOULU

The intervention phase at the University Oulu (UOulu) will be carried out for (1) teacher education students enrolled in the Technology Enhanced Learning and Working course and (2) in-service teachers for whom the training is currently under planning. Teacher education students participating in the mentioned course will receive through it the knowledge and skills related to digital competence, digital competence frameworks, digital tools used for teaching and learning, and will be trained how to pedagogically implement them in real

classrooms. For in-service teachers we preliminarily plan to design a Massive Open Online Course (MOOC) that would be applied to the control group; MOOC would be combined with face-to-face training and collaborative activities for teachers in the experiment group. The content of the training will focus on teachers' PDC, self-regulated learning as part of teaching and learning, learning support for students in technology-enhanced learning environments, teachers' classroom practices and student outcomes.

Target context: The interventions are provided by the Faculty of Education and Psychology at the University of Oulu. For teacher education students, the course is implemented face-to-face and in Microsoft Teams. Students receive knowledge instruction through lectures and develop and practise their knowledge and skills during seminars which include collaborative design and situated learning. The specific settings for the in-service teachers' group are still under planning in collaboration with our faculty partners.

Training approach: In the teacher education student case, the training includes knowledge instruction, collaborative design, and situated learning. Students acquire new theoretical knowledge related to digital competence and its implementation in the classroom during lectures; in seminars students apply their knowledge in practical settings through collaborative group work. By the end of the course, students have to design a lesson plan ("digital workshop") for preliminary school pupils in different schools in the Oulu area. After each workshop, students will reflect with their teacher on the implementation of the lesson plan. The intervention for the in-service teachers will focus on knowledge instruction through the MOOC. Teachers will be provided with short video-recorded lectures, reading materials, self-reflection tools and tools for lesson design. The intervention for the in-service teachers' experiment group will utilise MOOC as the basis for knowledge instruction, however it will be complemented with face-to-face training sessions with a teacher trainer/university researchers, collaborative lesson design, and situated learning. Teachers will be asked to implement their lesson designs in their classrooms and reflect on how the implementation went.

Table 11: UOULU Trainings in the intervention phase

Case: UOULU	Pre-service students teacher training: Technology Enhanced Learning and Working	in-service teachers continuous training: SRL and PDC

Policy measure	**Strategy:** Finland's Digital Compass **Policy:** Policies for the Digitalisation of Education and Training	
Goals	As a result of this training, teachers will be able to: • Integrate digital tools and practices in their field, adapting to a digitalized society and committing to lifelong learning. • Recognize and comprehend key concepts in digital competence, media literacy, and programming, fostering new literacy skills. • Understand the significance of various digital competence frameworks and apply this understanding to enhance teaching and learning. • Make informed decisions on technology implementation in the classroom by noticing, interpreting, and evaluating its impact on the learning process.	Not yet decided on, but in general as a result of the training, teachers will be able to integrate digital tools and practices in their field, adapting to a digitalized society and committing to lifelong learning.
Conditions		
Delivery mode	Face-to-face	Online / blended
Interaction mode	Synchronous & asynchronous	Asynchronous & synchronous
Training duration	10 h lectures, 20 h (5x4h) seminars, 70 h individual and collaborative work	Not yet decided on
Target group		
Target	Pre-service teachers	in-service teacher
Size of the group	2x65	Estimated 2x25 teacher
Content		

Technology knowledge	Knowledge about how to use different technological resources in real-life primary-level classroom	To be decided
Pedagogical knowledge	Knowledge and skills on how to notice, interpret and make informed decisions about technology implementation in classroom	To be decided
Content knowledge	Knowledge of different existing digital competence frameworks used in teaching and learning; knowledge and understanding of the basic concepts and phenomena related to digital competence, media literacy, and programming competence.	To be decided
Inclusion & Equity	To be decided	To be decided
Instructional design		
Training method	**Knowledge Instruction** • **Direct instruction**: key digital competence frameworks, media literacy concepts, and programming skills, emphasizing their application in teaching and learning contexts. • **Hands-on learning:** active engagement with digital tools and practice applying these frameworks to real-world scenarios to reinforce their understanding. **Situated learning:** Pre-service teachers design and implement a digital workshop collaboratively, applying their knowledge in a primary-level classroom context to connect theory with authentic teaching experiences. **Collaborative design:** Pre-service teachers work together to plan and execute a digital workshop for a primary-level classroom, fostering teamwork, shared decision-making, and practical application of pedagogical and technological knowledge.	**Group 1:** **Knowledge instruction:** teachers engage in a MOOC designed to develop their PDC through structured content delivery, including theoretical foundations, examples, and guided activities. **Group 2:** **Knowledge instruction + Situated learning + Collaborative design:** **Knowledge instruction:** Teachers participate in the same MOOC as Group 1 to build a foundation in PDC. **Situated Llarning:** • **Planning**: Teachers attend in-person training sessions exploring practical applications of PDC in authentic classroom contexts and plan classroom practices. • **Classroom implementation:** Teachers implement their collaboratively designed lesson plans in their classrooms, applying their learning in a real-world setting. • **Reflection:** Teachers reflect on the effectiveness of their lesson implementation, discussing outcomes and identifying areas for improvement with peers and facilitators.

		Collaborative design: Teachers work in teams to co-create lesson plans that integrate digital tools and pedagogical strategies.
Modelling SRL	Pre-service teachers will reflect on their learning in a digital portfolio where they are indirectly prompted to engage in SRL.	To be decided
Modelling CK-/PCK-/TPCK-SRL	Pre-service teachers learn through KI about the existing digital technologies (CK), how to use them (TK), and how to implement them in real classrooms in different subjects (TPCK). Additionally, students engage in learning activities (digital portfolio) that encourage participants to set goals/monitor their progress/and reflect on outcomes (PCK-SRL).	To be decided
Modelling ICAP	**Passive**: Participating in lectures to build foundational knowledge on digital competence, programming competence, media literacy, and AI literacy, which informs individual contributions to group tasks. **Active**: Independent exploration and application of digital tools for personal learning and teaching preparation, contributing insights to the group. **Constructive**: Individual creation of specific components for a collaborative digital workshop, such as designing a module or activity, which are later integrated into the group's final product. **Interactive**: Collaborative group discussions where individuals contribute unique ideas and provide peer feedback to refine shared outputs.	To be decided
Digital competence	Building teachers' knowledge of theoretical concepts and enhancing their skills to integrate technology into teaching, fostering their ability to select, create, and apply digital tools effectively through hands-on, practice-based experiences.	To be decided

4.2.6: Intervention studies of UAU

In the intervention phase, the UAU case will focus on two training programs for in-service teachers, aimed at enhancing their Pedagogical Digital Competence (PDC), improving classroom practices, and fostering student outcomes. These programs will combine Knowledge Instruction with Situated Learning and Collaborative Design, integrating theoretical knowledge with practical classroom application. The first program (KI+SL) will emphasize the application of new practices directly within classroom contexts, allowing teachers to connect theory with authentic teaching experiences. The second program (KI+CD+MC) will extend this approach by incorporating collaborative design activities, enabling teachers to co-create instructional materials, and providing ongoing mentoring support to facilitate reflection and adaptation throughout the process.

Target context: These interventions are designed for in-service teachers across various subject areas, with a focus on integrating technology-enhanced learning practices. Each program will involve approximately 30 teachers and be delivered through a blended learning format, combining online and in-person sessions. The instructional design includes both asynchronous and synchronous components to ensure flexibility and engagement.

Training approach: The training program for in-service teachers is structured to include a combination of Knowledge Instruction, Collaborative Design, and Situated Learning, ensuring a comprehensive and hands-on learning experience. Through **Knowledge instruction**, teachers are introduced to foundational concepts, such as PDC, SRL, and effective technology integration. This phase focuses on equipping teachers with theoretical knowledge and practical insights into the use of digital tools and methodologies like the Flipped Classroom and Blended Learning. The **Situated learning** component involves applying developed lesson plans directly in real-world classroom settings. Teachers gain experience in adapting their knowledge to authentic teaching scenarios, which helps in developing their situation-specific skills—the ability to notice, interpret, and respond to complex classroom dynamics effectively. In the **collaborative design** settings, teachers work in groups to co-create lesson plans and instructional materials, incorporating diverse methodological approaches. These collaborative activities foster shared expertise and encourage reflection on the practical application of their learning to classroom contexts. This training approach empowers teachers to experiment with and refine various

teaching methodologies (e.g., Flipped Classroom) and enhances their capacity to use digital tools in ways that foster deeper learning and engagement among students.

Table 12: UAU Trainings in the intervention phase

Case: UAU	**In-service teacher training:** KI+SL	**In-service teacher training:** KI+CD+MC
Policy measure	**Policy:** Training program for in-service teachers to enhance their digital competencies and pedagogical practices.	
Goals	As a result of this training, teachers will be able to… • develop situation-specific skills, knowledge, self-efficacy and digital competence to integrate digital tools to teaching and learning and apply new practices directly within the classroom context. • use technology in the classroom in a didactically meaningful way and have knowledge of useful tools, apps and various digital teaching formats (Flipped Classroom, Blended Learning), including common challenges and difficulties in the digital learning environments. • fostering students' SRL skills	
Conditions		
Delivery mode	online/blended	
Interaction mode	synchronous & asynchronous	
Training duration	To be decided	
Target group		
Target group	In-service teachers	
Size of the group	n = 30	n = 30

Content		
Technology knowledge	Knowledge on how to use different technological resources in teaching contexts to enhance student learning outcomes.	
Pedagogical knowledge	Knowledge and skills on how to implement technology in the classroom to foster students' SRL skills and to reduce inequities in TEL environments.	
Content knowledge	Knowledge and understanding of the theoretical and practical foundations of SRL and the ICAP framework, including their application to structure learning activities and support students' cognitive, metacognitive, and motivational regulation, especially within technology-enhanced environments; outlining strategies to foster students' development of SRL skills.	
Inclusion & Equity	To be decided	
Instructional design		
Training method	**Knowledge Instruction** • The training covers theoretical concepts such as the ICAP framework. • Content on technology integration in the classroom is provided. • Lesson planning: Development of lesson plans incorporating elements of the ICAP and SRL frameworks. **Situated learning** • Teachers apply new practices directly within the classroom context.	**Knowledge Instruction** • The training covers theoretical concepts such as the ICAP framework. • Content on technology integration in the classroom is provided. • Lesson planning: Development of lesson plans incorporating elements of the ICAP and SRL frameworks. **Situated learning** • Teachers apply new practices directly within the classroom context. **Collaborative design** • Participants work together to create and refine instructional materials.
Modelling SRL	The lectures will progress through direct and explicit instruction of SRL cognitive and motivational strategies.	
Modelling of CP-/PCK/TPCK-SRL	Teachers learn about the existing digital technologies (TK) and how they can model self-regulated learning strategies specific to their subject (CK-SRL), how to use them and how to implement them in real classrooms across different subjects using instructional methods that promote	

	self-regulated learning, such as goal-setting, progress monitoring, and reflection (PCK-SRL). Additionally, they explore how to leverage technology to foster self-regulated learning in their students, while reflecting on their own use of technology to support these processes (TPCK-SRL).
Modelling ICAP	**Passive**: Observing concepts and digital tools to build foundational understanding of SRL and ICAP framework **Active:** Engaging with digital tools to explore their functionality and applications to foster the development of students' SRL skills and cognitive engagement **Constructive:** Developing a lesson plan that synthesises learned knowledge, allowing participants to actively apply concepts and transfer knowledge into a cohesive teaching strategy. **Interactive:** Participating in group discussions that involve deep analysis of lesson examples, encouraging the sharing of diverse perspectives and fostering a joint understanding.
Digital competence	Deepening teachers' understanding of theoretical concepts related to technology integration and fostering their ability to select, create, and apply digital tools effectively in classroom contexts, thereby enhancing their proficiency in the areas of **Digital Resources** and **Teaching and Learning**

Teacher training faces the dual challenge of integrating technology meaningfully into classrooms and fostering skills aligned with pedagogical approaches supporting students' development and learning. This chapter outlined the EffecTive project's intervention phase, illustrating practical designs that help teachers develop PDC. Through training methods, such as KI, SL, CD, MC, and self-regulated learning strategies, these training programs serve as a guide for designing teacher professional learning.

EffecTive's intervention studies (n=14), conducted across Estonia, Austria, Finland, Germany, and Israel, demonstrate the interplay of design elements, contextual factors (country, school and classroom level), and teacher outcomes, creating a knowledge base for effective teacher training. The EffecTive intervention studies highlight several key factors that should influence the success of teacher training programs:

- **Contextual relevance:** Trainings are aligned with local educational policies, cultural contexts, and specific classroom realities to ensure both applicability and scalability. Incorporating a domain-related focus, when possible, is particularly valuable, as concepts like cognitive engagement can often be more tangible and easier to understand within the context of a specific subject area.
- **Integrated frameworks:** Combining theoretical foundations with hands-on practice strengthens teacher confidence and competence by creating connections between abstract concepts and real-world application. For instance, applying the ICAP framework ensures that training activities progress from passive to interactive engagement, allowing teachers themselves, but also to understand how students can be fostered to construct knowledge. Or embedding Self-Regulated Learning strategies into the training equips teachers with the skills to model and foster goal-setting, monitoring, and reflective practices in their classrooms.
- **Collaboration:** Social learning plays an important role in fostering shared understanding and enriching the training experience. By engaging with experts in training, teachers gain insights and practical knowledge that deepen their competence. Collaborative activities, such as designing joint artefacts, promote the co-construction of knowledge and help create a shared understanding of teaching practices. Feedback from mentors and trainers enhances this process, providing guidance and reflection opportunities that help teachers refine their skills and align their strategies with best practices. This multifaceted collaboration builds a strong foundation for sustained professional growth.
- **Technology integration:** Our trainings emphasise not only the technical use of digital tools but also their alignment with pedagogical goals and subject content, as outlined by the TPACK framework. This integrated approach ensures that teachers

understand the interplay between technology, pedagogy, and content. In domain-specific cases, training addresses the pedagogical needs of particular subjects, making abstract concepts like cognitive engagement more relatable and actionable. In other cases, the emphasis is on cross-disciplinary strategies, equipping teachers with adaptable techniques for technology-enhanced teaching and learning across diverse contexts.

5 Conclusion and future outlook

Deliverable 3.1 (Ley et al., 2024) provides an overview of the **general research design and specific designs** for each case within the EffecTive project. The training cases described here contribute to the evaluation by aligning with specific conditions and training methods, providing opportunities to examine dependent variables related to teacher and student outcomes. Each case targets groups such as pre-service and in-service teachers at both primary and secondary levels. These cases are structured to observe variables such as teachers' knowledge, skills, attitudes, and relevant background factors that may influence the training's effectiveness. Additionally, mediators like teachers' SRL skills are monitored, providing insights into how training affects both immediate outcomes and long-term impacts. Data collection follows a pre- and post-test design for teachers and students, supporting planned analyses on training outcomes. This process integrates assessments across various stages of the training phases, ensuring that both the pilot and intervention phases provide insights into the effectiveness of training methods for enhancing teacher knowledge, skills, attitudes, and student learning. These insights help us to refine and improve the training design based on evidence from implementation.

This **evidence is then mapped to the cost-benefit framework** (D4.1) in an iterative process that aligns intervention outcomes with measurable indicators of costs and benefits (Wagner et al, 2024b). We are collecting data that is gathered and categorised across cost and benefit dimensions, including general training program parameters (e.g., duration, delivery mode), training content, costs (instructional, administrative), and benefits at both teacher and student levels. This iterative approach ensures that the framework evolves alongside findings from the interventions, becoming increasingly aligned with real-world applications and insights. In the next phase, we will continue analyzing cost categories across training methods, further comparing knowledge instruction alone with its combinations with collaborative design and situated learning. Building on the identified key cost drivers - such as personnel costs for training coordinators, resources for managing group dynamics, fostering design interactions, and contextualizing learning - we will focus on optimizing these elements. Collaborative design's increased costs, driven by coordination needs, and situated learning's

contextualization investments will be examined for efficiency improvements. This work will refine our understanding of cost-intensive elements in blended methods, enabling more targeted and sustainable applications in future interventions.

The training interventions presented in this chapter **highlight and map diverse approaches aimed at developing teachers' PDC**. Each case was designed to align with country-specific policy measures and adapt to the needs of different target groups, ranging from pre-service teachers to experienced in-service educators. The cases span across various formats, including blended learning, online modules, and hands-on workshops, and incorporate frameworks like ICAP, TPACK, and SRL to ensure pedagogy-grounded teaching practice.

The training cases outlined in this deliverable demonstrate **a range of strategies adapted to specific target groups,** including pre-service and in-service teachers, and highlight the flexibility needed to adapt to technological and institutional constraints. Each case was designed to ensure that participants engage in meaningful learning activities, progressing from foundational knowledge-construction to reflective and practical application tasks.

While the interventions have yet to be implemented, this deliverable serves as a roadmap for their execution, **offering a structure for pilot and intervention phases** and laying the foundation to inform comparative and experimental research designs in D3.1. The descriptions emphasise the intended outcomes of each training approach, from fostering self-regulated learning to integrating technology into diverse teaching practices. These cases also reflect the project's commitment to evidence-based design, which will be further validated through systematic evaluation in subsequent phases.

As the next steps in the project, the focus will shift to:

- **Implementation** - initiating the training interventions in collaboration with teacher training institutions and schools.
- **Evaluation** - collecting data to assess the effectiveness of the interventions, aligned with the evaluation framework outlined in D3.1.
- **Refinement** - using feedback from the pilot and intervention phase to iteratively improve training content and training methods

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