Work Package 4

Cost-Benefit Framework and Methodology for Teacher Training Policy Measure Evaluation

Deliverable D4.2

Updated Framework After Piloting

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Executive Summary

The EffecTive project, funded by the Horizon Europe framework, aims to enhance **teachers' Pedagogical Digital Competence (PDC)** by identifying key factors that support this competence effectively and efficiently. It focuses on evaluating various training programmes to understand their impact on teachers' PDC, their practices and student outcomes, ensuring PDC improvement is both effective and cost-efficient. This involves extensive data collection from students and teachers across several pilot studies and 12 intervention studies in five countries.

The primary goal of this Deliverable is to provide **an update of the initial framework based on the insights** gained from the pilot phase and preliminary policy engagements with educational policy makers and practitioners. In the refined version, we conceptualise the CBF as a boundary object (Akkerman & Bakker, 2011): it provides a structure for analyzing training elements, costs, benefits, and contextual factors, while remaining adaptable to diverse national settings. In this role, the CBF fosters a shared language across researchers, practitioners and policy makers, enabling participatory, evidence-informed decision-making on the efficiency, effectiveness and equity of teacher professional development.

In **Section 2** of this Deliverable, we provide a rationale for the importance of evidence-informed decision-making based on cost-benefit assessments in the context of teacher professional development programmes. **Section 3** outlines the methodological process through which the refined Cost-Benefit Framework (CBF) was developed from theory (e.g. D1.1 analysis of policy measures, D1.2 effective teacher training approaches) to practice (D.2.1 analysis of training interventions, early policy engagements). In **Section 4**, we define the target group of the framework who are namely **a) educational researchers, b) teacher training providers and c) educational policymakers** and explore its potential relevance for various stakeholders. **In Section 5,** the core components of the CBF - training design elements, background variables, costs and benefits - and their sub-categories are presented. Accordingly, **Section 6** introduces the step-by-step process of making evidence-informed decisions using the CBF. To illustrate its practical application, in **Section 7,** we present three pilot cases from Austria, Estonia and Israel mapped onto the framework, demonstrating how it can be implemented in real-world contexts. As a result of the case studies, we provide policy implications and long term objectives which might guide decision-making processes around effectiveness, efficiency, equity and scalability. This section also focuses on policy engagement with

educational policy makers and practitioners and reveals insights regarding stakeholder needs, priorities, the challenges and opportunities CBF might bring and how to address them. Finally, **Section 8** concludes the Deliverable by summarising key insights and suggesting future directions for enhancing evidence-based decision-making in teacher professional development balancing costs and benefits.

Overall, **the case studies and policy engagement with the related stakeholders demonstrate the practical value of the CBF** in linking programme outcomes to their costs and identifying trade-offs. It provides a structured approach to support decisions about programme design, continuation or scaling. During the pilot phase, the CBF also served as a common reference across diverse national contexts which demonstrates its potential to foster shared understanding and collaboration among education stakeholders.

1. Introduction

One of the main objectives of EffecTive is to propose **a cost-benefit framework for teacher training interventions** that allows to systematically analyse the costs and benefits of teacher training interventions and to systematically document the research evidence. As a toolset, the framework should inform future decisions to select between different policy interventions regarding training to support teachers' PDC ensuring efficient use of public resources for the desired outcome.

In this regard, within the scope of Deliverable 4.1, the initial cost-benefit framework (Wagner et al., 2024b) was presented as a **structured glossary** that defines various categories and specific variables tailored for teacher PDC training. The glossary categorises and defines each element involved in evaluating the cost-benefit aspects of such training programmes. It was then used to map existing training interventions and to derive hypotheses for the experiments.

The goal of Deliverable 4.2 is to **refine the initial cost-benefit framework based on insights gained from the pilot phase**. The updated framework is designed as a **guideline**, empowering stakeholders to make **evidence-informed decisions** within their specific contexts while ensuring the efficient allocation of public resources.

2. Why the Cost-Benefit Framework matters

In the context of increasing demands on education systems and limited resources, making informed, strategic decisions about teacher training has become more critical than ever. **Decision-making in education should be purposefully directed toward enhancing education and training systems** and achieving this requires the use of research and evidence (EC, 2017). Although both researchers and policy-makers recognize the importance of assessing and evaluating teacher professional development, there is frequently a lack of clear guidance on how such evaluation should be conducted (King, 2014). From an efficiency and effectiveness perspective, evaluations of these initiatives combining these two dimensions are still largely missing (EC, 2022).

Given the increasing emphasis on teachers' digital competence, the CBF is especially critical. Digital training formats often promise greater efficiency and scalability, yet their actual effectiveness for teacher practice and student outcomes is uneven, and they risk deepening inequities if access and contextual factors are overlooked. The framework helps decision makers navigate this tension, ensuring that investments in digital competence are not only cost-efficient but also effective and inclusive.

Although numerous investigations address teacher education focusing on outcomes such as enhanced skills, increased knowledge and positive attitudes, there remains **a shortage of comprehensive frameworks and broader, system-level analyses** (König et al., 2023), especially ones that consider outcomes in light of the associated costs. Existing methodological approaches often lack consistency in evaluating what constitutes effective teacher training (Penalva, 2019). These limitations point to the need for more coherent, scalable and evidence-informed approaches for evaluating professional development programmes.

As teacher training involves multiple communities of practice - researchers, policy makers and practitioners- tools for evaluation must be both methodologically robust and interpretable across contexts. The CBF's dual focus on costs and benefits offers a common reference point that is rigorous enough for researchers, actionable for policy makers and transparent for practitioners. This adaptability without loss of structure is the defining characteristic of an effective boundary object.

Although the literature on the effectiveness and efficiency of teacher training programmes is expanding, there remains a relative scarcity of research on the tools

or frameworks that enable the transfer of this knowledge into practice. In the tradition of Research-Practice Partnerships (Coburn & Penuel, 2016), frameworks, tools and concepts that enable such transfer have been conceptualized as boundary objects (Akkerman & Bakker, 2011). These can be designed to support the integration of research evidence into policy and practice (Boaz & Oliver, 2023). The research on boundary objects is grounded in social learning theory and communities of practice (Wenger, 1998) which argues that human behaviors are shaped by the interactions between cognitive, behavioral and environmental factors (Ersan, 2016). Social learning theory highlights engagement in shared social practices (Wenger et al., 2011). Within this theory, the concept of a boundary object refers to artifacts that operate at the intersections of different communities of practice, facilitating meaningful interaction between them (Wenger, 1998). These objects enable collaboration across community boundaries ranging from simple coordination to offering deeper insights into others' practices (Wenger-Trayner et al., 2019).

In social learning terms, the **CBF mediates the negotiation of meaning between communities of practice**. By providing a shared structure for interpreting both pedagogical impact and cost, it creates a space where stakeholders can align on priorities without erasing their perspectives. It supports collaboration and negotiation between diverse stakeholders, in our case predominantly between educational researchers and practitioners (e.g., heads of teacher training institutions) and policy makers by helping them align priorities and make informed, collaborative decisions across different institutions and professional groups. This role becomes particularly critical in the development of teachers' PDC, where the promise of scalable and effective training must constantly be weighed against risks of exacerbating inequalities.

3. How has this framework been developed?

One of the objectives of the EffecTive project is to propose a cost-benefit framework for teacher training interventions that allows to systematically analyse the costs and benefits and to systematically document the research evidence. The development of this framework is conceived as a **continuous, iterative process** that evolves over the entire project timeline, building on insights and results generated through other project tasks, deliverables and stakeholder engagements.

As illustrated in Figure 1, the development of the CBF follows a **dynamic, multi-phase approach** including stakeholders' needs analysis, its initial conceptualisation, pilot testing through intervention studies, engaging stakeholders, and continuous refinement based on empirical findings and feedback. Rather than being a static tool, the CBF is designed to progressively integrate practical experiences, stakeholder needs, and research outcomes ensuring its relevance, usability, and adaptability across diverse educational contexts.

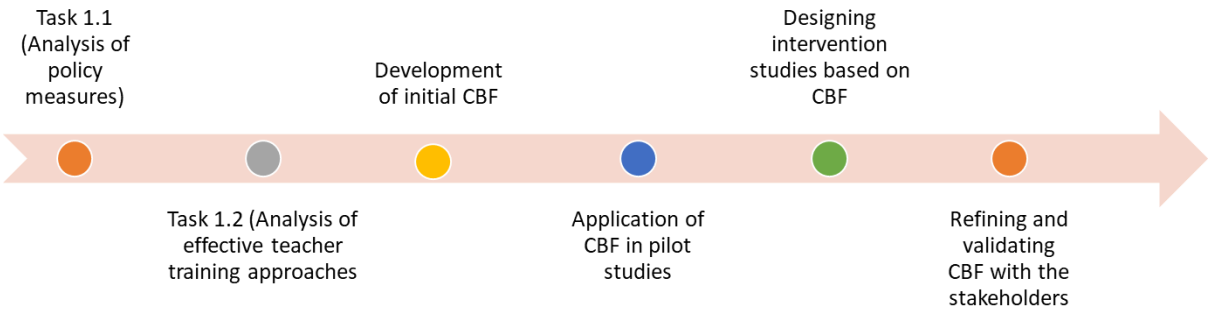

Figure 1. The CBF development process

The refinement and validation of the CBF will continue throughout the duration of the EffecTive project. To support this process, a series of stakeholder engagement activities will take place across partner countries, including Austria, Estonia, Israel, Germany, and Finland. These events are designed to bring together key actors involved in the development and delivery of teacher training programs including: **a) educational researchers, b) teacher training providers and c) educational policymakers.** Their ongoing contributions based on diverse perspectives is essential to ensure that the CBF reflects real-world needs, is evidence-informed and remains adaptable across different educational contexts. By functioning as a boundary object, the CBF also helps to bridge institutional and professional boundaries, enabling dialogue and collaboration across research, practice and policy domains.

3.1 Analysis of policy measures

At the very beginning of the project, in line with the aims of EffecTive, we prepared **a comprehensive report** (Zabolotna et al., 2024) **that provides the foundation for the work that is planned within EffecTive**. The report that provides (1) an overall view on the national and local policy frameworks and education system contexts with regard to PDC in Estonia, Finland, Austria, Germany and Israel; (2) the theoretical foundation of EffecTive where we explain our views on teacher and student competencies and skills; and (3) a preliminary analysis of the existing empirical

research where the project partners identified the main elements of effective teacher training interventions. This report directly informed the development of the initial Cost–Benefit Framework (CBF) by **highlighting policy priorities, contextual factors, and features of effective training in our case countries.** It offered essential insights into diverse institutional settings and stakeholder needs, supporting the design of **a flexible and adaptable framework.**

3.2 Analysis of effective teacher training approaches

An umbrella review was conducted to identify the core elements of effective teacher training for enhancing PDC. Drawing on prior research, five key themes were identified (Wagner et al., 2024a):

- **Training Characteristics:** PDC training programmes vary in structure, duration and delivery, with blended formats offering a strong balance between flexibility and in-person engagement. Pre-service teachers often showed greater gains, highlighting the importance of developmental context.
- **Training methods and key practices:** Commonly used strategies, such as reflection, hands-on learning, planning, and field experience, are most effective when combined. However, more comparative evidence is needed on the impact of individual methods.
- **Teachers' knowledge and motivation:** Interventions improved pedagogical and technological knowledge, particularly when long-term, collaborative and blended. Technological knowledge (TK), however, remains a challenge to develop.
- **Classroom Practices:** Teachers reported greater confidence and use of student-centered, tech-enhanced learning following practical, application-oriented training.
- **Student Outcomes:** Although limited, some studies showed gains in student engagement and academic skills, with results strongly shaped by contextual factors.

These findings informed and shaped the CBF by helping define categories—especially regarding benefits and training programme elements such as delivery modes, and short- and long-term impacts on teachers and learners. The review highlighted the need to account for contextual variation and the importance of sustained, quality practices in cost-effective programme design.

3.3 Initial cost-benefit framework

To develop the initial cost-benefit framework, the **EffecTive teacher training concept** was used (see Fig. 2) as a starting point. Figure 2 outlines relevant components of teacher training programmes considered in EffecTive: different training methods, delivery modes, teachers' PDC and student outcomes. As a next step, **collaborative brainstorming sessions** were conducted, in which researchers and experts on teacher PDC training came up with additional cost-benefit categories and descriptions. Based on the results analysis of policy measures (Zabolotna et al., 2024) and effective teacher professional training approaches (Wagner et al., 2024a), we extended the framework, particularly in terms of the key practices of each training method. To determine the different cost categories, we used a cost-effectiveness model previously developed by Tel Aviv University (Cohen & Nachmias, 2006) and adapted it for project purposes. As a result of these steps, the initial cost benefit framework was developed (Wagner et al., 2024b).

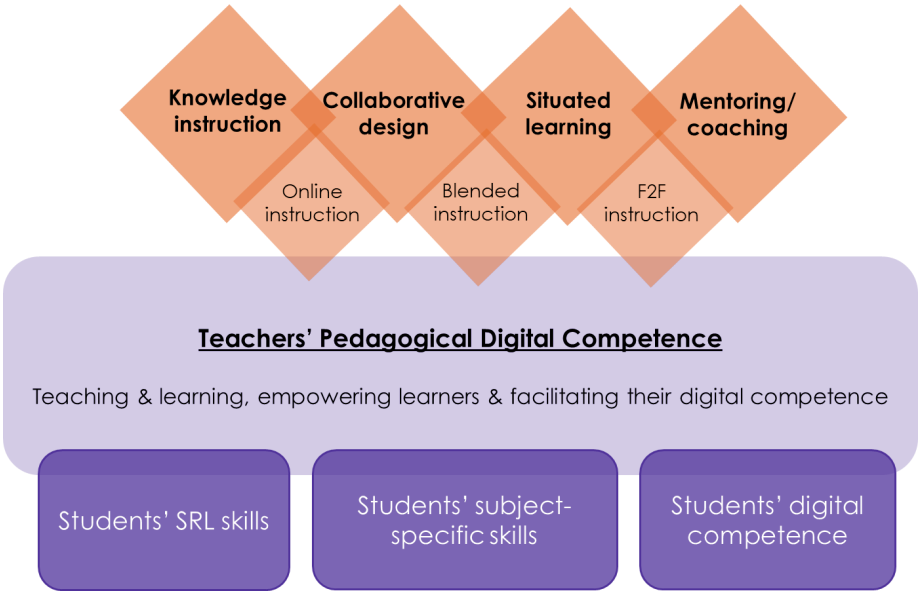

Figure 2. Components of teacher training programmes in EffecTive

3.4 Analysis of the training interventions

The initial Cost-Benefit Framework was applied iteratively throughout various phases of the project. During months 4–12, it was used to structure and inform the description of both the pre-pilot and pilot studies (Deliverable 2.1, Seufert et al., 2024). In this phase, the **CBF proved particularly valuable for establishing a shared terminology** among all case partners, facilitating coherent discussions around the

anticipated costs and benefits of the training programmes. In the course of these discussions, the framework was continuously updated as questions were discussed.

Following our pilot studies, **the results were mapped onto the CBF**, developing a series of case studies detailed in Section 6. By walking through each step of the evidence-informed decision-making process using the CBF, it was possible to explore how the framework functions in real-life contexts and identify areas for improvement. While the pre-defined categories in the CBF effectively supported the preparation and its use for the intervention studies during the pilot phase, it became clear that adapting the framework into a more user-friendly guideline format would be necessary to meet the practical needs of end users.

3.5 Preparation of the empirical intervention studies

Beyond its role in structuring initial discussions, the CBF also played a key role in guiding the design of intervention studies detailed in Deliverable 3.1 (Ley et al., 2024). It provided an overarching framework for aligning research designs with the broader goals of the project. In particular, it helped identify **the primary drivers of training-related costs and benefits**, as well as the **contextual conditions** necessary to interpret the outcomes meaningfully. Factors such as training methods, delivery modes, training duration, group size, and participant background were highlighted as critical variables that influence both the impact and cost-efficiency of interventions.

Furthermore, it helped to specify the main cost and benefit categories that will allow us to derive measures for operationalising costs and benefits as **dependent measures** in the intervention studies. For example, the benefits include more immediate reactions of trainees to the training, as well as more distal effects on their PDC development and even impact on student engagement and/or performance in the classroom. By doing so, the framework picks up important policy-related criteria for measuring the impact of policy measures for teacher training. Obviously, there are **immediate outcomes** of the training and **long term benefits** are difficult to measure in the short run. However, we assume immediate benefits will lead to long term benefits. These long term benefits will be discussed at Section 6 and 7.

3.6 Engaging Educational Practitioners with the CBF

In this first phase of development, the framework had an important role in driving the shared understanding of all those involved in the project. To ensure the CBF responds

to stakeholder needs and practical constraints, **a participatory process for refining and validating the framework with stakeholders** from educational policy making and teacher training institutions was conducted in Austria in May 2025. For this purpose, we developed materials and guidelines (see Appendix 1 for some examples) particularly targeted at practitioners to engage with the CBF (e.g. short descriptions and presentations of the CBF, templates to describe costs and benefits for a particular case, checklists to guide through the process, stakeholder journey mapping exercise to examine current decision-making practices and explore how CBF can be better aligned with them). The materials were made available to all partners and will be used to organize several engagement events. Based on their application across diverse contexts with relevant stakeholders, these materials will be further refined and ultimately turned into **a practical toolset** as part of Deliverable 4.4.

4. Who is this framework for?

This framework is designed to support a broad range of stakeholders, both **policy developers and implementing bodies**, involved in the design, implementation, and evaluation of teacher professional development. In our particular case, we focused on **stakeholders responsible for training related to teachers' pedagogical digital competence.** Drawing on Bronfenbrenner's Ecological Systems Theory (1992), we conceptualize teacher professional development as embedded in a multi-layered ecosystem (Figure 3).

At each level, the CBF functions as **a boundary object** (Star, 2010) - a shared tool that is adaptable to the perspectives and needs of various stakeholder groups while still providing a consistent and coherent structure for analysis and decision-making. It **supports collaboration and negotiation between diverse stakeholders** (e.g., educational policy makers, teacher trainer providers, teacher trainers) and educational researchers by helping them align priorities and interpret evidence. By accommodating these diverse perspectives without losing coherence, the CBF fosters mutual understanding and supports participatory, evidence-informed decision-making across professional boundaries.

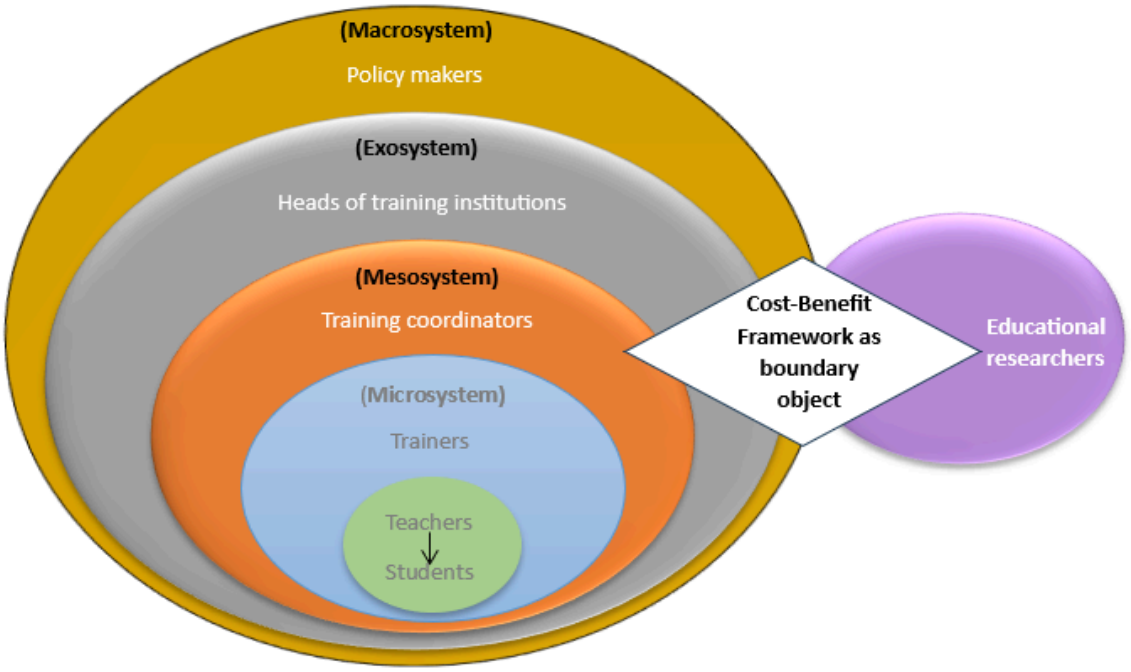

Figure 3. CBF as a boundary object in the educational policy ecosystem

To further contextualize the role of the CBF, Figure 3 illustrates how CBF operates as a boundary object within the broader educational policy ecosystem. This ecosystem can be broadly understood in terms of two main groups: **decision-makers** (policy makers) and **implementers** (heads of training institutions and training coordinators), each with distinct needs and priorities when it comes to evaluating and improving teacher training programmes.

Decision-makers are typically concerned with:

- Improving student outcomes, including goals related to inclusion and talent development
- Enhancing the quality of school performance for regional and national development
- Developing coherent and effective teacher policies, including sustainable CPD (continuous professional development) systems
- Ensuring value for money and efficient allocation of public resources
- Justifying current and future investments in digital infrastructure

Training implementers focus more on:

- Offering high-quality, relevant training opportunities
- Improving teacher competencies and classroom practices
- Securing sustainable financing mechanisms for programme delivery

To illustrate these different perspectives in practice, the following stakeholder personas in **Box 1** provide concrete examples when evaluating teacher training programmes. This framework supports users at different levels of the education system by offering **a shared reference tool for making evidence-informed decisions.** By fostering collaboration and aligning different perspectives, it promotes more balanced, efficient and effective teacher training initiatives.

Box 1. Stakeholder personas and their priorities

Context: As AI tools rapidly transform classroom teaching and learning, there is a need to **equip teachers with the knowledge and skills** to integrate these new technologies effectively into the classroom. In response, a **national initiative** is rolling out a large-scale **AI-focused teacher training programme** designed to build teachers' pedagogical digital competence. However, **funding is limited**, and decisions around the programme must carefully balance **cost-efficiency**, **effectiveness**, **scalability** and **regional equity**.

Mary – National Policy Maker (Macrosystem)	• Mary is responsible for the **fair and equitable allocation of funding** across the country. She needs to ensure that training reaches both urban and rural teachers **quickly** while also building **long-term regional capacity** to integrate AI effectively. The CBF helps Mary evaluate trade-offs between **speed, cost, and sustainability**—and identify strategies that balance these competing demands.
John – Head of Teacher Education Institution (Exosystem)	• John leads the development of the **national AI training curriculum**. He faces the challenge of designing **cost-efficient training that doesn't compromise quality**—ensuring teachers acquire real skills to integrate AI meaningfully in the classroom. The CBF supports John in mapping the **inputs, activities, and outcomes** of the training—helping him to **prioritize investments** that generate the most significant educational outcomes.
Emma – Training Coordinator (Mesosystem)	• Emma is responsible for the **day-to-day implementation** of the training at her school. She monitors teachers' progress and **tailors** the delivery to meet local needs. Working within a **tight budget**, Emma uses the CBF to ensure that resources are allocated to **activities that drive real learning outcomes**—and to continuously **improve and refine** the training based on data and feedback.

5. What are the key components of the CBF?

Teachers play a central role in education and in many countries, they represent the largest share of education-related expenditure (Crawfurd and Pugatch, 2020). As such, investing in teacher professional development **(TPD) is essential to ensure that teachers' skills remain current and effective** not only to support student learning but also to **justify this significant investment in terms of value for money** (Ndaruhutse, 2022). Existing research on TPD predominantly focuses on outcomes such as enhanced skills, increased knowledge and improved attitudes as highlighted by the recent systematic review by König et al. (2023). However, there is still limited work on structured evaluations that assess the costs relative to the benefits of different

training approaches considering contextual factors and long term impact (EC, 2007; EC, 2022; Cerna et al., 2021), especially in multi-stakeholder settings, where the priorities and terminologies are different.

The EffecTive project's CBF enables systematic analysis of teacher training interventions by **weighing costs against benefits and documenting supporting evidence.** Designed as a practical tool, it supports evidence-based decisions on training approaches to enhance teachers' PDC and ensure efficient use of public resources. Moreover, the framework serves as a shared reference for diverse stakeholders, offering a structured way to evaluate existing training programmes and identify opportunities for improving both learning outcomes and cost-efficiency. By fostering a common language and **shared understanding of trade-offs**, the CBF contributes to more coherent, transparent and evidence-based policy development.

As presented in Figure 4., the framework is structured around **four interrelated components** namely **training programme elements, background variables, costs, and benefits**. Each component includes specific categories and variables tailored to teacher PDC training. These elements are described in detail in the sub-sections that follow.

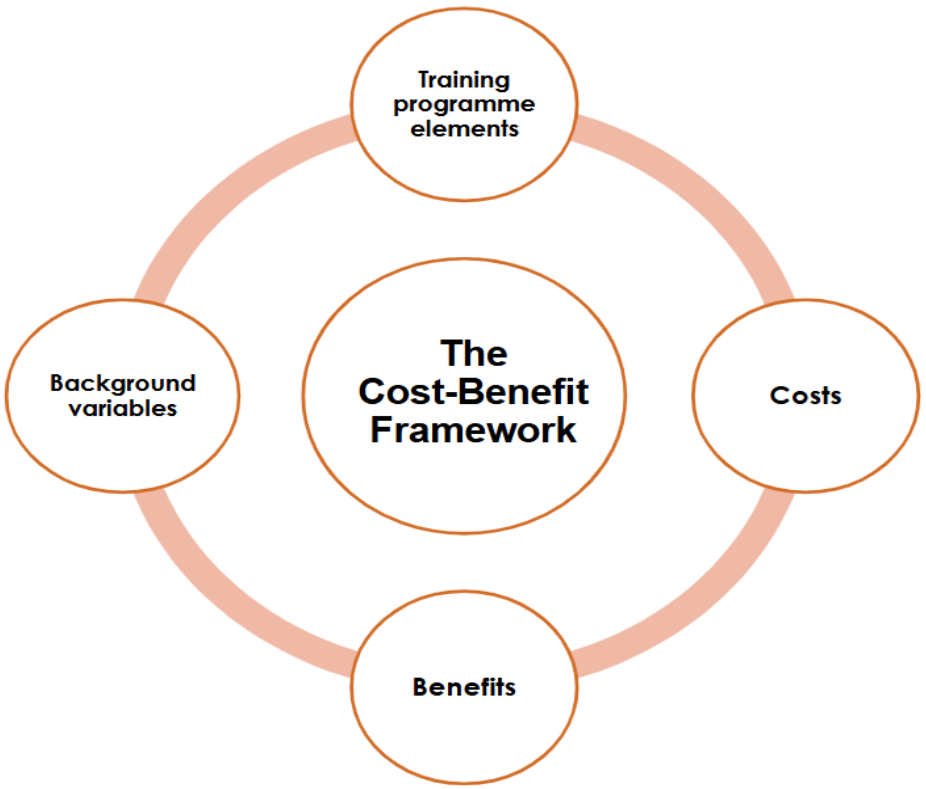

Figure 4. Key components of the CBF

5.1 Training programme elements

Training programme elements refer to the **specific characteristics of the teacher training** such as the delivery mode, interaction mode, duration of the training, group size, target group, content of the training as well as training methods as indicated in Figure 5. What each training element refers to and what sub-categories constitute these core elements are presented in detail in the Cost-Benefit Framework Glossary (see Appendix 2).

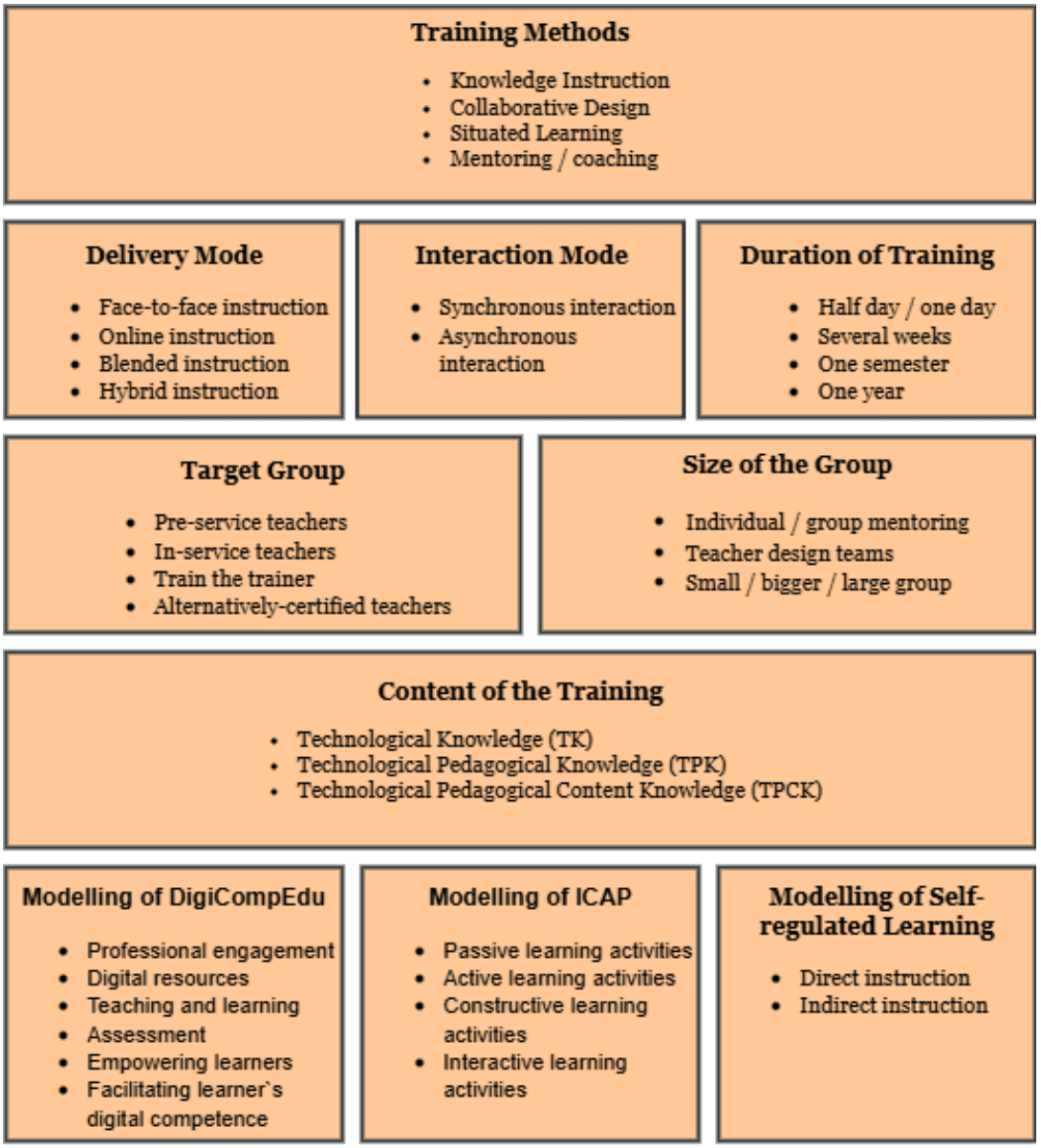

Figure 5: Training programme elements

Modelling of self-regulated learning (SRL) in the training, for example, refers to the incorporation and demonstration of self-regulated learning strategies within the

training programme. Self-regulation strategies can be either explicitly trained and discussed with their functions for learning (direct instruction) or the strategies can be implicitly embedded in the content to be learned (indirect instruction).

5.2 Background variables

In the EffecTive project, the **learning outcomes' dependence on the socio-economic background** is highly acknowledged. The CBF therefore includes several background variables both on the teacher and student level as well as the school and classroom context, so that PDC interventions can be developed in ways that reduce the dependence of educational outcomes on socio-economic background, mitigate digital divides, and explicitly promote equity and inclusion.. Figure 6 provides an overview of the included variables. The definition of each variable is detailed in the Cost Benefit Framework Glossary (see Appendix 2).

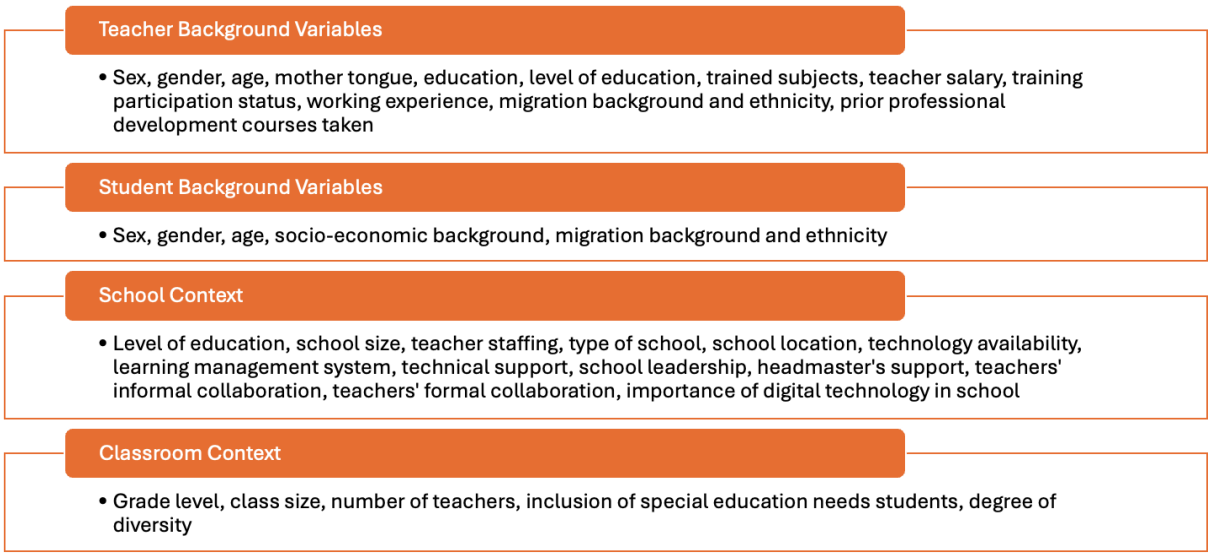

Figure 6. Overview of background variables

5.3 Costs

The costs for teacher training interventions can be divided into **infrastructure costs and pedagogical/instruction costs**. Infrastructure costs are related to the costs associated with establishing, maintaining and upgrading the physical, technological and administration infrastructure to support the operations and activities of a teacher training programme. On the other hand, pedagogical/instruction costs refer to the expenses directly related to the preparation and delivery of instructional activities within a teacher training programme.

In addition, we differentiate between **fixed costs and variable costs,** based on their sensitivity to scale. Fixed costs refer to expenditures that remain the same regardless of the number of courses or participants, for example, costs associated with technological and physical infrastructure, as well as costs related to course development and preparation. In contrast, variable costs change according to the number of courses/students, course length, learning material types etc. These include costs associated with training administration and course delivery. An overview of the main cost categories is presented in Figure 7, while detailed definitions for each category can be found in the Cost-Benefit Framework Glossary (see Appendix 1).

Another important economic consideration in the context of teacher training for PDC is the concept of **opportunity costs**. These refer to the value of the best alternative use of resources that must be foregone when a specific training initiative is pursued. For instance, when teachers allocate time to participate in PDC training, they may have to reduce time spent on other professional tasks such as lesson planning or mentoring. Similarly, financial and institutional resources directed toward PDC training may limit investments in other areas of school improvement. Recognising and assessing opportunity costs is essential for informed decision-making and for ensuring that investments in teacher training yield the greatest overall benefit.

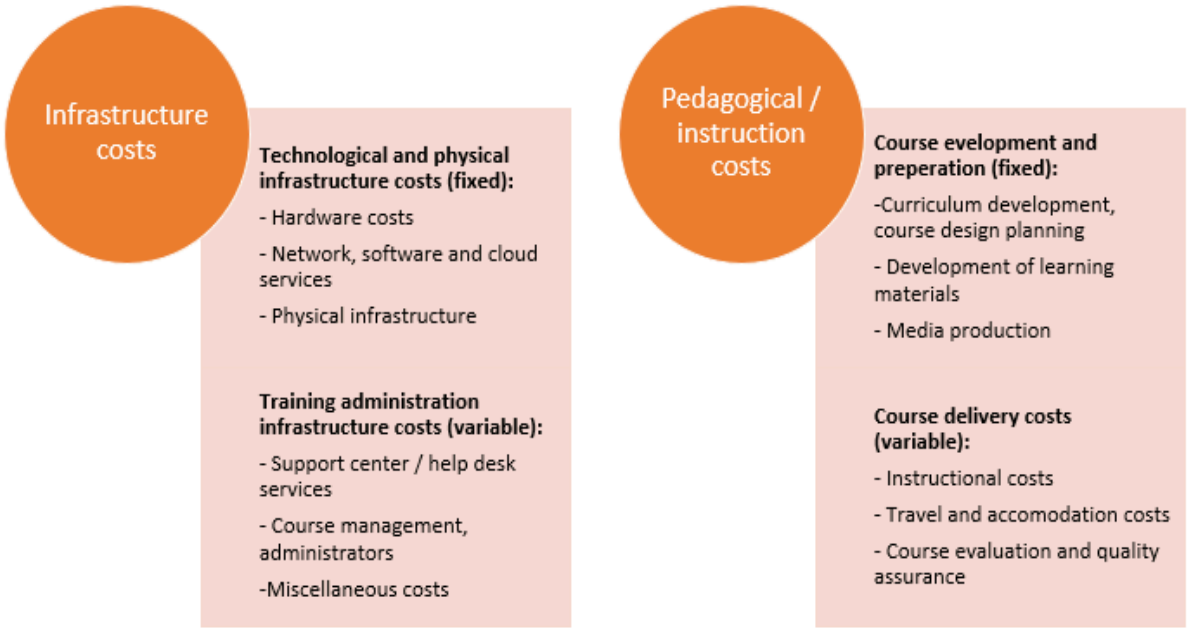

Figure 7. Overview of the different cost categories

5.4 Benefits

It is widely assumed that teacher training is effective if it results in changes in teachers' practices and improvements in student learning outcomes (e.g., Basma & Savage, 2018; Darling-Hammond et al., 2017). This assumption is based on a framework for evaluating training programmes developed by Kirkpatrick (1959). Grounding on this, to describe the benefit components of the present framework, we were **guided by Kirkpatrick's hierarchical model of training outcomes** (Kirkpatrick, 1959). The framework is frequently used in training evaluation research and also in the context of teacher professional development (see for example Desimone, 2009; Meyer et al., 2023). The framework defines increasing levels of training effectiveness, consisting of (1) participants' **reactions**, (2) **changes** in their **knowledge** and **beliefs**, (3) **changes** in their **practices**, and (4) **results** of their **changed professional behaviour** at the organisational level (e.g. student outcomes). While the original model does not address questions of heterogeneity in students outcomes, in EffecTive we extend it by explicitly considering equity and inclusion in student outcomes, asking not only whether learning improves overall but also whether achievement gaps are reduced and all learners benefit.As a result of stakeholder feedback, in the refined CBF, we introduced **an additional level, `Level 0`** which refers to participation in the training itself. This acknowledges that without sufficient reach, even the most well-designed training may not be efficient. Figure 8. provides an overview of the five different levels including the respective variables of our CBF. Detailed definitions of each level are covered in the Cost-Benefit Framework Glossary (see Appendix 2).

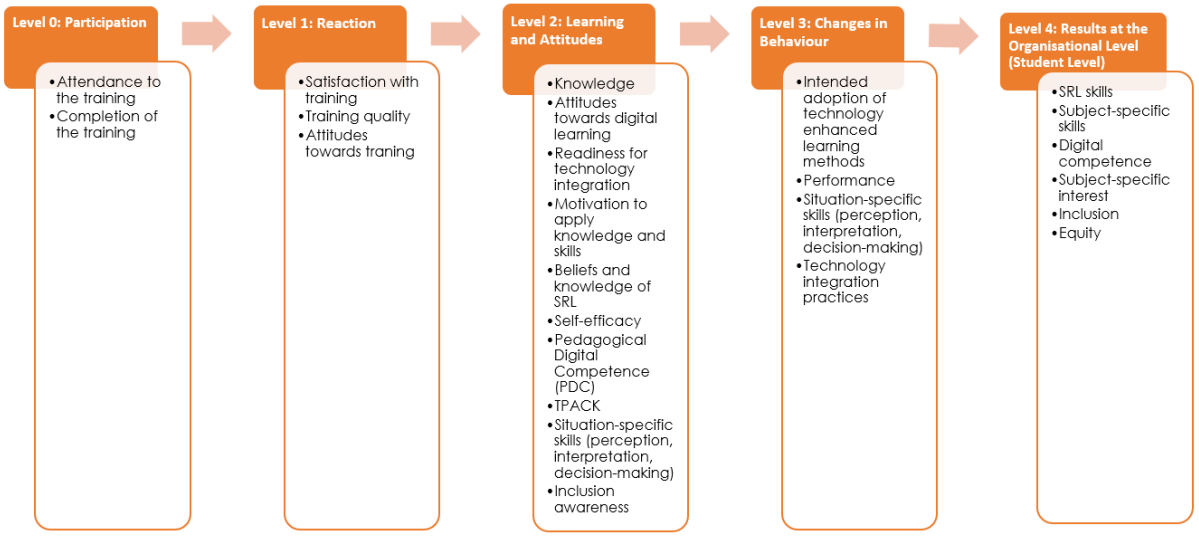

Figure 8. Overview of benefits on five different levels

6. How to make evidence-informed decisions based on the CBF

In the context of increasing demands on education systems and limited resources, making informed, strategic decisions about teacher training has become more critical than ever. Decision-making in education should be purposefully directed toward enhancing education and training systems and achieving this requires the use of research and evidence (European Commission, 2007). In this regard, the **CBF offers a structured approach to support evidence-informed decision-making** by helping stakeholders systematically weigh the benefits of a teacher training intervention against its associated costs.

In line with the goals of EffecTive, at the heart of this process lie three core principles: **efficiency**, **effectiveness and equity** as seen in Figure 9. These serve as guiding principles to ensure that teacher training programmes on PDC not only deliver positive outcomes but also do so in a way that is fair, inclusive and cost-efficient. The CBF provides a means to identify and assess trade-offs between these principles, such as balancing the need for high-quality training with the goal of reaching underserved regions or ensuring cost-effective delivery methods without compromising learning outcomes.

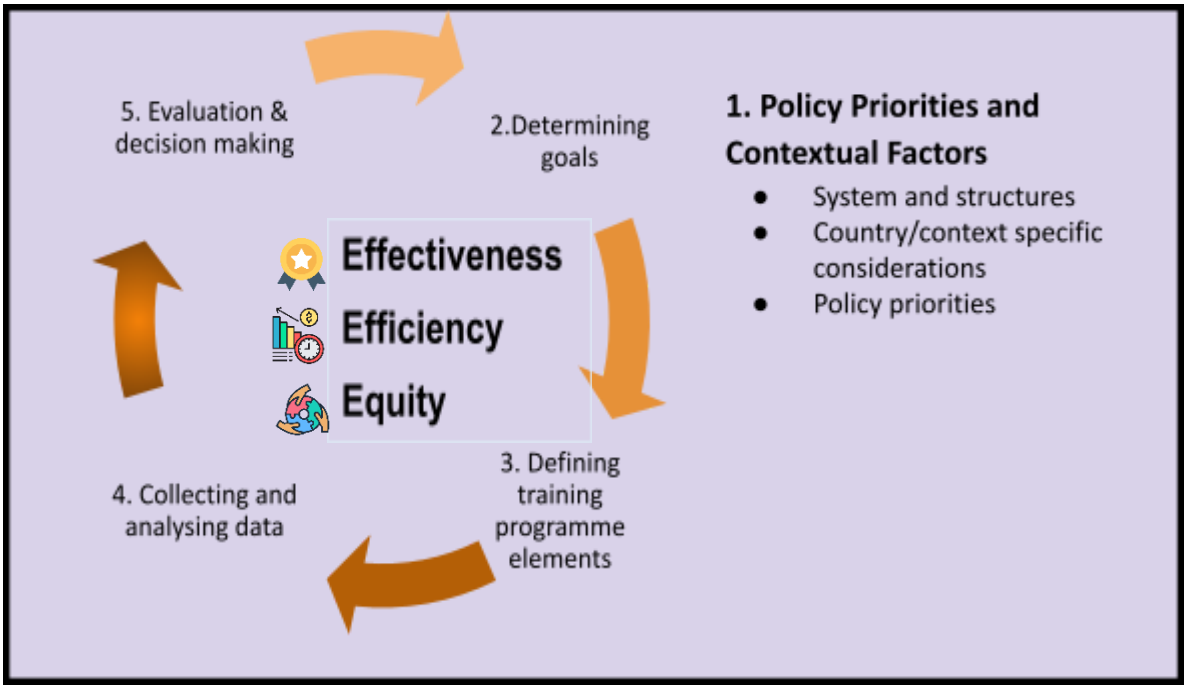

Figure 9. Evidence-informed decision making process based on CBF

The evidence-informed decision-making process guided by CBF consists of five key steps to ensure **the effectiveness, efficiency and equity** of teacher training interventions. This process-oriented approach has been developed drawing on insights and deliverables across the different workpackages of EffecTive project as summarized below:

Step 1. Identifying policy priorities & contextual factors: WP1. (Theoretical foundation & policies of effective teacher PDC training)

Step 2. Determining goals: WP1. (Theoretical foundation & policies of effective teacher PDC training) and WP2. (Design of effective teacher training interventions for PDC)

Step 3. Defining training programme elements: WP2. (Design of effective teacher training interventions for PDC)

Step 4. Collecting and analysing data: WP3. (Evaluating and analysing effectiveness of teacher training)

Step 5. Evaluation and decision making: WP4. (Cost-Benefit Framework for teacher training evaluation)

Together, these five steps represent a coherent, project-wide approach that integrates policy, theory and practice. The following sub-sections present a practical, step-by-step guide for applying the CBF to inform decision-making around teacher training for technology integration. Each step includes key considerations and examples to demonstrate how the framework can support evidence-informed, context-sensitive choices in programme planning and evaluation.

6.1 Identifying policy priorities and contextual factors

In education, the generalisability of findings is a complex and challenging issue. This is because each context has different characteristics, requiring differences in training programme, personnel, teaching methods, budgets, leadership and kinds of community support (Berliner, 2002). Therefore, it should be noted that **a training programme that yielded the expected outcomes may not be as effective in a different context.** At this point, Davies (2004) emphasizes that beyond research evidence, several other factors play a crucial role in decision-making. These include;

- **Professional experience and judgment**: The experience and judgement of policymakers provide practical insights drawn from years of working in

real-world settings. These often complement or balance research evidence that may not fully capture local or contextual realities.

- **Availability of resources**: Even the most effective policy cannot be implemented without sufficient funding, personnel, or infrastructure. Resource availability defines the boundaries of what is practically achievable.
- **Underlying values:** Personal, ideological, or institutional values influence what is considered important, ethical, or desirable. These values often shape decisions even when they contradict empirical evidence.
- **Established habits and traditions:** Institutions frequently operate according to long-standing routines and norms that resist change. Such traditions may impede the adoption of new approaches, regardless of the strength of supporting evidence.
- **The influence of lobbyists and interest groups**: Interest groups exert pressure to promote specific agendas, sometimes sidelining evidence-based considerations. Their influence is especially prominent in areas with significant political or economic stakes.
- **Practical constraints or unexpected circumstances**: Real-world limitations like tight deadlines, political instability, or sudden crises often disrupt planned decision-making processes. Policymakers must sometimes act without ideal evidence due to urgent or unpredictable conditions.

As illustrated in Figure 4, policy priorities and contextual factors influence every stage of the evidence-informed decision-making process with CBF. A deep understanding of the context in which teacher training occurs is essential for making well-informed decisions about what works, for whom and under what conditions. Therefore, it is crucial to integrate contextual considerations at each step of the process to ensure that training interventions are both relevant and effective.

6.2 Determining goals

Clearly defined goals are essential for evidence-informed decisions in designing, implementing, and evaluating teacher professional development. In this framework, goals should go beyond specific training aims or outcomes. Instead, they should clarify the **underlying decision-making situations that trigger the need for a cost-benefit evaluation**, such as:

- Whether to scale, redesign or drop an existing teacher training programme based on efficiency and/or effectiveness,

- How to allocate limited budgets across policy priorities,
- Which delivery formats (e.g., face-to-face, blended, online) are most effective in a specific context,
- Which training methods (e.g., knowledge instruction, collaborative design, situated learning and, mentoring/coaching) have the highest impact relative to cost,
- How to prioritize training needs across subjects, levels or regions.

In all of these scenarios, clearly defined goals help decision-makers to identify what outcomes matter most and how these align with the costs of delivering training. To support the formulation of these strategic goals, SMART criteria—Specific, Measurable, Achievable, Relevant, and Time-bound— have been widely used in educational planning and evaluation (Chen, 2015). Table 1 outlines how the SMART framework can support strategic goal-setting for the evaluation of teacher training programmes. It is important to take the respective context into consideration while applying these steps to address specific needs. Therefore, rather than applying SMART criteria simultaneously, proceeding with a stepwise approach based on the specific context may provide more meaningful outcomes (Bjerke & Renger, 2017).

Table 1. SMART criteria

✓	**S**pecific	What decision is being made? What outcomes or changes are being targeted?
✓	**M**easurable	How will success or impact be assessed? What indicators will be used?
✓	**A**chievable	Is the goal realistic? Do you have the necessary resources?
✓	**R**elevant	How does the goal align with broader policy objectives? Why is it important?
✓	**T**ime-bound	What is the time needed for accomplishing the goal?

As shown in Table 1, the process of setting SMART goals begins with clearly defining the **specific decision making process and expected outputs** that the teacher training programme aims to achieve. In the second step, it is essential to determine **measurable** indicators that will allow stakeholders to assess whether these outcomes have been reached. To ensure the goals are **attainable**, planners must reflect on whether the necessary resources such as materials, infrastructure and qualified personnel are available. Assessing **relevance** is also important since the training

programme should align with broader educational or policy priorities to ensure strategic value. Lastly, establishing a **time-bound** framework with realistic timelines is crucial for effective planning and monitoring of progress. Taking all five dimensions of SMART goals into account from the beginning will strengthen the overall design, implementation, and evaluation of teacher training programmes within the evaluation process.

6.3 Defining training programme elements

Defining the elements of a training programme during the planning phase or prior to its evaluation is crucial. **It allows for a structured design aligned with the objectives** set in the previous stage and supports a clearer understanding of the key cost–benefit trade-offs. This, in turn, enables more evidence-informed decision-making. For example, in a rural area with limited digital infrastructure, the format and delivery mode of a professional development programme may need to be very different from one designed for an urban area with more technological resources which in turn affects the costs and benefits associated with the training.

When defining these elements, it is also important to consider the specific **contextual factors at play.** As a result, the elements and their sub-categories may vary and should not be seen as fixed across different settings. For instance, national policy objectives such as promoting digital competence or inclusive education can shape the training objectives and influence which training elements are prioritized. Recognizing and adapting to these local needs ensures that the framework remains relevant and flexible in diverse educational contexts.

6.4 Collecting and analysing data

This step involves collecting and analysing data on background variables, costs and benefits of the training programme which are covered in below sections.

6.4.1 Costs

In this framework, the purpose of cost analysis goes beyond simply determining the total expenditure. Rather, it aims to offer a deeper understanding of the programme's goals and structure and the resources required to deliver it. Hence, a meaningful cost analysis begins with clearly defining the **intervention** and its **comparative baseline**. At this point, two common scenarios may apply (JPAL, 2018):

a) **New programme** which is implemented from scratch without prior intervention. In this case, all associated costs should be included and compared to a baseline of "zero intervention" (i.e., what would have happened without the programme).

b) **Modified or expanded programme** which builds on an existing initiative. The focus should be on identifying **additional costs** comparing two or more programme variations.

In the light of the related literature and our pilot studies within EffecTive, the following steps might be helpful to systematically collect and interpret costs depending on the starting situation for the cost analysis:

- **Identify and categorize costs.**

Begin by identifying all relevant cost components associated with the teacher training programme. Use the standardized cost categories provided in Appendix 1. CBF Glossary. If the programme shares resources with other interventions (e.g., IT infrastructure, personnel), ensure that only the **proportional use** of those shared inputs attributable to the training programme is included (JPAL, 2018).

- **Define cost units and types.**

Clarify who or what is bearing each cost and in what form. This includes **cost units** (e.g., training institution, school, trainer or participant) and **cost types** such as time (e.g., staff hours) or money (e.g., direct expenditures). Consult with relevant stakeholders such as training coordinators, instructors, financial officers or participants to gather reliable cost data and understand how resources are used in practice.

- **Classify costs as one-time or recurring** (JPAL, 2018).

Differentiate between **development costs** which refers to one-time expenditures like curriculum design, video production or platform setup and **recurring costs** which include ongoing expenditures such as trainer fees, participant stipends or hiring a room. This distinction helps assess the life cycle cost of a programme, meaning, how **cost-effectiveness changes over time**, especially when programmes are reused or extended across years or sites. For example, a programme with high development costs but minimal recurring costs (like an instructional video) becomes more cost-effective with repeated use throughout its life cycle.

➢ **Distinguish between fixed and variable costs** (Ndaruhutse, 2022).

Categorize costs as fixed and variable to understand cost dynamics over time. Programmes with predominantly fixed costs tend to become more cost-effective as they scale. To increase cost effectiveness, consider what aspects of the programme—such as in-person instruction—might be redesigned into **fixed-cost alternatives** (e.g., reusable digital content, automated feedback systems or chatbots) without compromising effectiveness.

Furthermore, in ICT-supported approaches to education, **various factors can significantly influence overall costs** either increasing or reducing them. In the light of the related literature, Ndaruhutse (2022) explains these factors as;

- The proportion of in-person instruction involved, whether the approach is blended or entirely online,
- The demand for physical infrastructure—such as buildings and travel or accommodation expenses—and how much of this can be replaced with virtual alternatives,
- Whether the programme is reusing existing educational materials or creating new content from the ground up,
- How the course development process is managed, including the activities involved, required inputs, and types of personnel employed,
- The level of public investment in digital infrastructure, such as telecommunications networks, cabling, and hardware,
- Teachers' access to digital tools and infrastructure, either through their institutions or personal resources, which affects the need to invest in new devices like computers, tablets, or smartphones for professional development,
- The potential of technology—such as online modules, self-paced formats, or automated grading systems—to reduce reliance on high-cost labor by automating certain tasks.

While making decisions on these factors, it is important to take the context, effectiveness of the training into consideration, as well. This means evaluating how well the chosen method aligns with the specific needs, capacities and goals of the target schools or regions. For example, a fully online format may reduce costs but could be less effective in settings with limited digital infrastructure or where face-to-face interaction is key to successful learning. Balancing cost-efficiency with training quality and contextual fit is essential for making evidence-informed decisions.

6.4.2 Benefits

The general assumption of EffecTive is that **the quality of education and learning can be increased by improving teachers' PDC through effective teacher training interventions.** Based on Roth et al. (2023), we have adapted a competence framework (see Fig. 10) that is grounded in previously developed and well-established models, such as the PID model (Blömeke et al., 2015) and the TPACK model (Mishra & Koehler, 2006). The PID (Perception, Interpretation, Decision-Making) model focuses on cognitive processes and outlines how individuals perceive information, interpret their significance, and make decisions based on that interpretation.

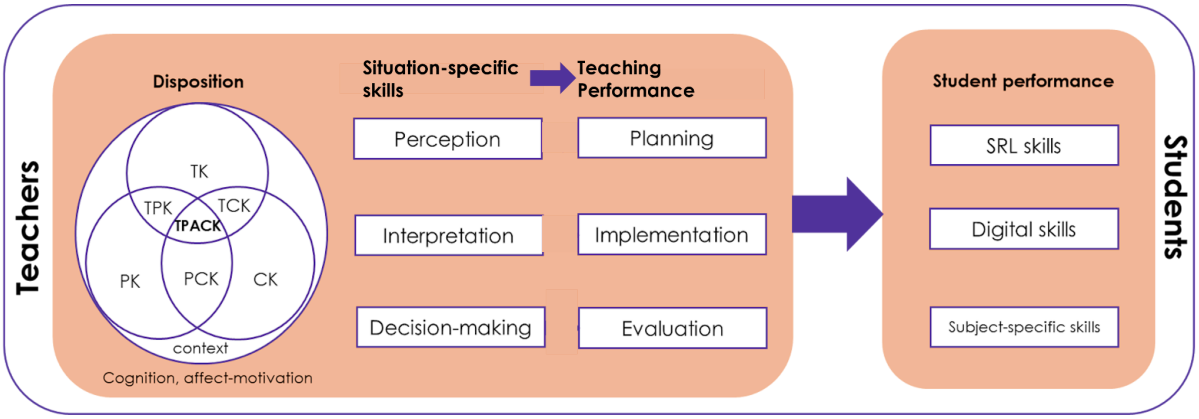

Figure 10. Competence Framework for Teachers' PDC (adapted from Roth et al., 2023)

In this framework, teachers' competencies are viewed as a continuum from **dispositions** or traits (cognitive, affective, and motivational) that underlie **situation-specific skills** (perception, interpretation, and decision-making) and, in turn, result in **observed behaviours** (performance) in a particular classroom situation leading to changes in students' learning (Blömeke et al., 2015). This framework outlined how we approach and measure the outcomes at teacher and student levels.

Based on our pilot studies within the EffecTive project, here are several key considerations that may be helpful for benefit data collection and analysis:

- ➢ **Align indicators with intended outcomes.**

Ensure that the benefit indicators collected reflect the core goals of the training. For instance, if the aim of a training is to improve teachers`s situation-specific skills, training satisfaction surveys are insufficient. Instead, it is important to consider using

scenario-based tasks, video analysis or other performance-based measures that capture the intended change more directly.

- **Minimize data collection burden.**

To reduce additional workload on participants, consider using streamlined, focused instruments. Where possible, make use of existing materials (e.g., instructional plans, reflection notes) as part of the data set.

- **Use multiple data sources.**

Avoid relying only on self-reported data. While surveys are useful, it is valuable to combine them with more concrete outputs like lesson plans or even-post changes in student assessments to show the impact more convincingly.

- **Plan for follow-up measurement.**

While immediate post-training feedback is informative, real benefits often emerge later when teachers have had a chance to apply what they have learned in the training. Where feasible, build in delayed post-measures to capture these longer-term effects.

- **Include comparison points.**

Even without a formal control group, it is possible to gain insight through pre-post comparisons or by examining outcomes across different levels of participant engagement. For example, comparing those who were more actively involved in the training with those less engaged may reveal meaningful patterns.

- **Capture background variable data.**

Collecting basic background information, such as school type, previous experience with technology, or available support systems, can be helpful to explain variations in outcomes. This information can also support the decision making process in a meaningful way.

- **Be realistic about training outcome levels.**

Keep in mind that positive participant feedback to the training (Level 1) does not always lead to changes in attitudes (Level 2) and practice (Level 3), and even when practices change, improvements in student outcomes (Level 4) may take time or not be observed. Recognizing these nuances helps to maintain a realistic interpretation of training effectiveness.

6.4.3 Background variables

Background variables are closely interrelated with the broader context in which the training programme is implemented. These **variables, at teacher, school, student and classroom level,** help define the characteristics of a setting in which training takes place. They can significantly influence both the outcomes of the training and how those outcomes are interpreted. For example, at the teacher level, a teacher's prior experience with digital tools can affect how much they benefit from a training on technology integration. At the school level, the availability of technology, supportive leadership or peer collaboration opportunities might promote or limit the translation of the knowledge acquired in the training into real classroom contexts. Understanding these variables allows us to interpret training outcomes in a way that reflects the real-world conditions.

Background variables are essential not in themselves, but as a way to understand **whether the impact of teacher training programmes** aligns with broader inclusion and equity **g**oals. Factors such as socioeconomic status, migration background and ethnicity or prior educational opportunities can significantly influence how different groups access and benefit from training. Recognising these variables allows programme designers and evaluators to identify disparities in participation and outcomes and to adjust the design to be more inclusive. In this light, it is also important to capture **how teachers' inclusion awareness shapes classroom practices and student outcomes,** including equity and inclusion, measured as students' sense of belonging. By taking background variables into consideration, the CBF can help ensure that training initiatives not only aim for effectiveness but also support equitable opportunities for all teachers and students.

6.5 Evaluation and decision making

This final step of the CBF supports **strategic, evidence-informed decision-making** enabling stakeholders to actively evaluate and reflect on results, prioritize resource use and identify where and how to improve, expand or adapt training programmes to local needs. Instead of viewing evaluation as the final step, this framework views it as a starting point for continuous learning, adaptation, and enhancement. The process is structured into three interconnected phases: Evaluate, reflect and act.

6.5.1 Evaluate

This phase focuses on systematically analyzing the data and outcomes gathered throughout the earlier stages of the CBF. At this point, the **logic model** serves as a structured tool that illustrates the connections between a programme's resources, activities, and expected outcomes, while also highlighting the underlying beliefs and assumptions that guide its design (Garret & Kaplan, 2005). Given the diverse nature of teacher education, the logic model also provides a conceptual framework for systematically evaluating teacher training programmes (Newton et al., 2012).

The adapted logic model presented in Figure 11 provides a structure for the evaluation process. It helps to identify **which elements of the programme deliver the strongest educational impact for the related costs and prioritize the resources.** Moving through, the model starts with the **goal or need** that the programme addresses. Then, **input** represents the costs associated with the training. The **outputs** address the training design elements and identifies participant characteristics and background variables which clarifies what is delivered, to whom, and how. The **outcomes** section maps the impacts of the training from immediate teacher outcomes (such as improved knowledge and positive attitudes) to student outcomes (like improved digital competence) and ultimately to long-term policy outcomes that reflect broader systemic change. Recognizing the role of **contextual factors**, the model also points out that these results are shaped by the policy, institutional and community environments in which the programme operates. These factors play a critical role in shaping what is effective and efficient since they determine whether the training intervention is feasible, scalable, or impactful in a specific setting. For instance, a blended training model might provide especially high benefits for schools in a rural area as it could reduce the amount of travelling required. At the same time it would require strong digital infrastructure which would make it less feasible in areas or for schools with limited access to technology.

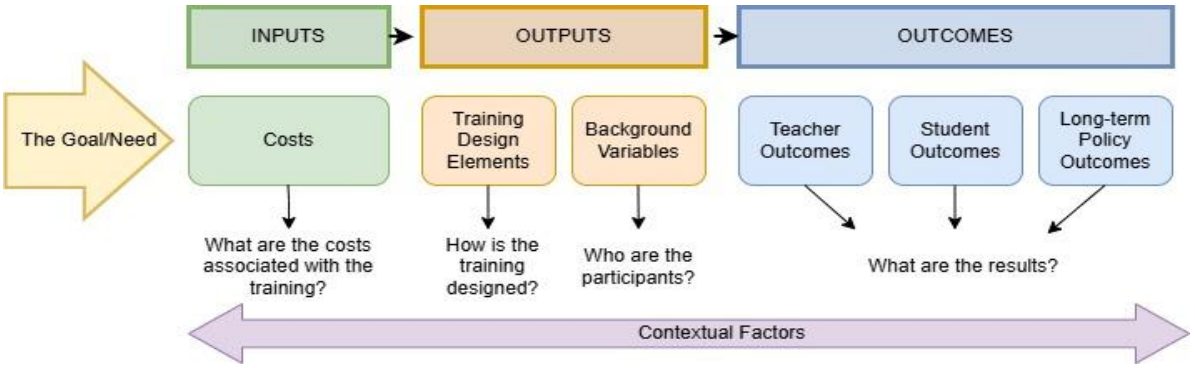

Figure 11. Logic model for CBF adapted from Taylor-Powell, & Henert, (2016)

The logic model helps stakeholders analyze performance, pinpoint bottlenecks and identify opportunities to achieve the expected outcomes. It enables comparisons between what was invested and what was achieved. Stakeholders can understand which aspects of the training are most effective and where adjustments may be necessary to maximize benefits.

6.5.2 Reflect

In this stage, stakeholders engage in **structured reflection** using a set of guiding questions linked to each part of the logic model to support the evaluations with an efficiency perspective. As presented in Table 2, these questions create a shared basis for interpretation and discussion across stakeholders, each of whom may prioritize different dimensions of success or feasibility. They help stakeholders not only to review the effectiveness of the programme but also to consider the trade-offs. For example, if the evaluation reveals that substantial resources were used but only modest improvements in teacher and student outcomes observed, stakeholders might consider alternative approaches to streamline costs or re-design the programme. By using these reflection questions alongside the logic model, stakeholders can think about resource allocation, programme adjustments, scaling-up and long-term strategies to make informed decisions.

Table 2. General reflection questions from cost-efficiency perspective

Logic Model	**Reflection Questions**
Goal/Need	Could the same goals be met with fewer resources (e.g. time, money)? Are there existing programmes we could use instead of creating something new?
Input	Were the existing resources used efficiently? Could we save time or money by working with other schools or organisations?

Outputs	Does the design of the training make best use of existing resources? Are there ways to streamline the delivery (e.g., blended, self-paced) without compromising quality? Are there training programme elements that might be re-designed into fixed cost alternatives? Are there training parts we can create once and reuse many times?
Outcomes	Are the outcomes significant enough to justify the costs? Did moderate investments lead to meaningful improvements in teacher knowledge, attitudes and practices? Did teacher changes translate to improved student outcomes?
Contextual Factors	Can we link the training to existing reforms (e.g. digitalisation, inclusion) to save costs? Does the training fit into our school development plan, so that we can build on other efforts?

In addition to the general reflection questions aligned with the logic model stages, there are further considerations depending on the specific purpose of using the CBF. Whether the goal is to design a new teacher training programme or to improve an existing one, the decision-making process may involve different reflection. Therefore, Table 3 presents additional guiding questions that can help stakeholders make evaluations based on their context **addressing the specific needs of new programme design and the improvement of ongoing interventions.**

Table 3. Specific reflection questions for new and existing programmes

New Programmes	Existing Programmes
Are there existing programmes we could use instead of creating something new?	Are there components of the programme that are worth sustaining?

Could existing tools, platforms, or materials be adapted to reduce development time and cost?	Are there components that no longer meet current needs or could be replaced?
Is the programme sustainable over the long term?	Are there opportunities to share the resources with similar programmes or institutions?

To help stakeholders interpret insights and guide informed decisions in line with the guiding questions above, the reflection matrix below (Figure 12) maps training programmes along two key dimensions: educational **impact** and associated **costs**. It provides a clear way to identify whether teacher training interventions are worth scaling, need adaptations or drop.

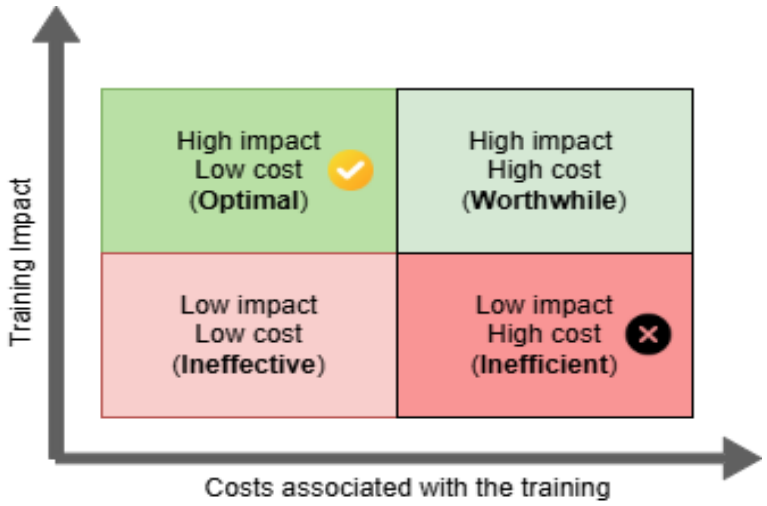

Figure 12. Reflection matrix

This matrix classifies teacher training programmes into four broad categories:

- **High Impact, Low Cost (Optimal):** These training interventions deliver strong results with modest use of resources which makes them ideal for scaling.
- **High Impact, High Cost (Worthwhile):** These training interventions may be valuable if the outcomes are strategic or long-term but funding should be considered to be sustainable.
- **Low Impact, Low Cost (Ineffective):** These interventions have minimal financial expenditures but may need to be re-designed to increase impact or dropped.

- **Low Impact, High Cost (Inefficient):** This kind of programmes should go through critical evaluation and reallocation of resources.

By positioning the interventions on this matrix, stakeholders can have a clear understanding of where they stand and how they might proceed. This approach reinforces the strategic decision making process to achieve the expected outcomes.

6.5.3 Act

This final phase translates insights into concrete action. Evaluation should not be seen as the final point but another step for **iterative learning and adaptation.** Conclusions drawn from here should inform decisions on future teacher training programmes, resources and long-term strategy to achieve the expected outcomes. In this regard, stakeholders may use the results to:

- Refine content, training methods and delivery modes based on efficiency and effectiveness insights,
- Reallocate resources from low-impact elements to those with demonstrated effectiveness,
- Develop scaling strategies for effective training programmes,
- Adapt programmes to better fit policy or institutional contexts.

For example, a programme found to have "high cost, high impact" may be re-designed with blended delivery mode to reduce costs while preserving outcomes. Or, if a certain group responds particularly well, it could be adapted for other regions. Overall, by embedding evaluation into a cycle of evaluation, reflection and action, the CBF ensures that decisions are **adaptive, evidence-informed and context-sensitive** which are essential for addressing the complex demands of teacher training on PDC.

7. Evaluating the Cost-Benefit Framework

This section evaluates the CBF after its initial development and application in the project. First, the framework was applied in pilot studies to assess teacher training programmes, producing **case studies** that revealed its relevance, usability, and key challenges. Second, **policy engagement** with educational policymakers and practitioners provided insights into their needs and feedback for improvement.

Combined, these findings informed policy implications for PDC training and directions for refining the CBF.

7.1 Applying CBF in real-life contexts: Case studies

To demonstrate how the CBF can be applied in real-world settings, we present case studies from three countries, namely Austria, Estonia and Israel. The cases were conducted by project partners as part of the piloting phase data collection of the EffecTive project. This involved the design and implementation of several training programs for teacher pedagogical competence. The implementations were evaluated in terms of their costs and benefits with a common methodology and the CBF was then applied to systematically evaluate costs and benefits of the training programmes.

While each case shares common elements—such as the focus on developing teachers' PDC with specific training methods and the structured approach to cost-benefit evaluation—they also reflect country-specific characteristics shaped by local education systems, policies etc. By examining key background variables, training elements, costs, benefits and trade-offs, these case studies illustrate both **the versatility of the CBF as a global model and the unique contextual factors** that influence training effectiveness and efficiency. These assessments provide valuable insights for stakeholders for the optimization of teacher professional development across different settings.

Methodology

The case studies included in this section employed a **quantitative approach** to illustrate the application of the CBF in evaluating a teacher professional development programme aimed at enhancing teachers' PDC. The training programmes covered in these cases studies are described in more detail in D2.1. The data collection on the effects of the programmes (including data collection methods and instruments used and data analysis strategy) are described in more detail D3.1. Based on the implementation of these programmes in the pilot phase of the project, the CBF was then applied to support evidence-informed decision-making by linking training outcomes with their associated costs.

Data collection involved two main stages. First, **pre- and post-tests** were conducted to measure changes in participant teachers' knowledge, skills, and attitudes by the end of the training. These results formed the basis for estimating the potential

benefits of the training. Second, a **cost calculation** was carried out using cost categories defined within the CBF. Relevant cost data were gathered in collaboration with the related stakeholders involved in the training intervention, such as training coordinators and teacher trainers to ensure contextual accuracy.

Based on the outcome and cost data, a **cost-benefit assessment** was conducted to identify the **key trade-offs.** The results were summarised to help stakeholders make evidence-informed decisions about continuing the programme, taking into account both impact and resource requirements.

These case studies have some **limitations**. The outcome evaluation was based only on pre- and post-test data, with no qualitative, long-term follow-up to measure impact, such as student outcomes. Even though the costing was detailed based on cost categories, certain estimates were based on assumptions that may vary in different contexts. Finally, while the study examined training programmes conducted in different countries, each was tailored to its local context. This contextual variability may limit the transferability of the findings to other settings.

7.1.1 Internal school training programmes "SCHILFplus", Austria

7.1.1.1 Introduction and policy context

In Austria**, the 8-Point Plan for Digital Learning** was launched in 2020 by the Federal Ministry of Education, Science, and Research (BMBWF). It is an important part of Austria's strategy to ensure digital competence across all educational levels. The initiative "eEducation Austria" aims to realise the objectives of the 8-point plan of digitalisation by preparing educators and students for digitally supported teaching and learning. Schools participating in "eEducation Austria" are supported to integrate digital skills into their teaching practices, benefiting from training, individualised development advice, and resources provided by eEducation Expert Schools and the National Competence Centre "eEducation Austria".

Internal school training programmes (SCHILF) have long been a key approach in Austria to connect professional development with the specific needs of schools. This training format enables joint learning in professional learning communities for the entire staff of a school, a specific team of a school or even teams from several schools (in the case of SCHÜLF). The duration of such training sessions ranges from half a day to a few days, and the content of the training is determined jointly by the individual schools and the responsible University College for Teacher Education (PH).

However, one-off training sessions often have a limited long-term impact on teaching practices. To address this challenge, some teacher training institutions (e.g. PH Carinthia and PH Tyrol) have developed SCHILFplus, an extended training initiative that provides more sustained, needs-based support for schools across various areas of professional development. The training events consist of several parts and follow the design of knowledge instruction, implementation in the classroom and reflection. SCHILF and SCHILFplus align with Austria's broader educational objectives as the Austrian Federal Ministry of Education (BMB) emphasises the importance of continuous professional development for educators to enhance teaching quality and student outcomes. In the following sections, a pilot intervention, an example of SchilfPLUS, implemented within the EffecTive project in the Austrian context, has been mapped into the CBF as an example of how to support discussion and decision-making on key trade-offs.

7.1.1.2 The goal of the case study

SCHILF is a format that embeds the training in a school involving teachers and leaders and is adjusted to their needs. SCHILFplus was composed with a special focus on situated learning methods to enhance the transfer of knowledge into classroom practices. The goal of this case study was therefore **to find out the costs and benefits associated with SCHILFplus that enhance a SCHILF training (KI only) with a phase of situated learning (SL).**

7.1.1.3 Training programme elements

In this case study, two different training programmes based on the SCHILFplus format were included. At the end of the training, teachers were expected to…

- **Training 1:** 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.
- **Training 2:** 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).

In line with these goals, training programme elements are presented in Table 4.

Table 4. Training programme elements of SCHILFplus

UWK Case	**Internal school training programmes "SCHILFplus":** **1.** Digitally on the way through the school year at the primary level **2.** Digital skills in practice at secondary level 1
Policy measure	Policy: "Digital School – The 8-Point Plan for Digital Learning"
Conditions	
Delivery mode	Face-to-face
Interaction mode	Synchronous
Training duration	1. 5 weeks (4 meetings) 2. 3 weeks (2 meetings)
Target group	
Target	In-service teachers
Size of the group	1. 18 teachers – small size 2. 22 teachers – small size
Content	
Technology knowledge	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	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 the use of AI in the classroom

Content knowledge	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.
Instructional design	
Training method	Knowledge Instruction + Situated Learning **Key practices**: 1) goal setting, 2) instruction, 3) rehearsal/field experience, 4) reflection/self-evaluation
Modelling ICAP	**Passive:** processing information by observing and analysing concepts and digital tools, developing foundational understanding **Active:** exploring and interacting with digital tools, practising their use to deepen understanding of their applications and functionalities. **Constructive:** creation artefacts 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 (DigCompEdu)	**Teaching and learning:** Integrating digital tools into their practice (e.g., Antolin for reading, Skooly for communication, Bee-Bots for logical thinking, Digi.case for computational thinking) **Empowering learners:** Using technology for differentiation & personalisation, actively engaging learners **Facilitating learners' digital competence:** Enabling students to develop information and media literacy, digital problem solving

7.1.1.4 Data collection and analysis

a) Background variables

The training participants were, on average, 47 years old with 20 years of teaching experience (see Table 5). The training took place in public primary and secondary schools. These background factors can provide insight into the participants' prior experience and teaching environments, which may influence their engagement with training on digital competence and the adoption of new technologies in their classrooms. Since this was a pilot study, no data was gathered from students.

Table 5. Background variables

Teacher Background Variables	Student Background Variables	School Context	Classroom Context
•Age: 47 years old on average •Average teaching experience: 20 years	•N/A	•Primary and secondary school •Public school	•N/A

b) Costs

In this case study, all costs associated with the SCHILFplus intervention were collected and analysed against a **baseline of zero intervention**, as presented in Table 3. Cost estimates are expressed in monetary terms or time equivalents, based on interviews conducted with the teacher trainer and training coordinator involved in the programme.

As shown in Table 6, the primary cost drivers for this training relate to the course **development and preparation** category. Although **course delivery** often represents a significant share of total costs, this was not the case here. No travel or accommodation expenses were incurred, as the trainer was already employed at the participating school.

The analysis also suggests that the majority of the training costs are fixed costs, which remain stable regardless of the number of participants. Additionally, most costs appear to be **recurring**—such as those related to technological infrastructure, administrative support, and ongoing course delivery. In contrast, **one-time expenditures** were mainly concentrated in the course development phase, including course design planning, development of learning materials.

Table 6. Costs associated with the training

Category	Sub-category	Description	Cost Unit (Training institution/ School/ Instructor /Participant)	Cost
1.1. Technological and Physical Infrastructure Costs (fixed)	Hardware costs	Personal computers, projectors, specific equipment servers, peripheral equipment etc.	-	Available at the school

Category	Sub-category	Description	Cost Unit (Training institution/ School/ Instructor /Participant)	Cost
	Network, software and cloud services	LMS Software licenses or subscription fees **(Antolin and Skooly)**	School	237 + 449= 686€ per year
		Dedicated software **(Worksheetcrafter license)**	School	449€ per year
	Physical infrastructure	Class(room), library etc.	-	-
1.2. Training Administration Infrastructure Costs (variable)	Support center, help desk services	Pedagogical support for trainers, didactic consulting etc. (PH-online helpdesk)	Training institution	30 minutes
	Course management, administrators	Certificates and supplements (automatised via PH online), management office, secretary office, study programme coordination **(no SCHILFplus office, but coordinated via the other departments: planning, advertising, bookings**)	Training institution	Difficult to estimate
	Miscellaneous costs	Miscellaneous expenses: printing costs for SCHILFplus folders **(advertising**)	Training institution	33,33€ (1000€ for all SCHILFplus offers, 30 offers per year)
2.1. Course development and preparation (fixed)	Curriculum development, course design planning	Curriculum development - course design planning (including the evaluation process)	Instructor	50 hours[1]
	Development of learning materials	Local development/ (digital) adaptation of learning materials	Instructor	14 hours
	Purchase of learning materials	Personal license for **Worksheetcrafter** and participation in a **conference**	Instructor	70€

[1] According to common practice at PHs, 8 hours of training typically correspond to 8 hours of preparation. In this particular case, however, the trainer invested considerable effort in the preparation phase, exceeding the standard expectations.

Category	Sub-category	Description	Cost Unit (Training institution/ School/ Instructor /Participant)	Cost
	Media production	Costs associated with creating audiovisual content (videos, presentations etc.)	Instructor	6 hours
2.2. Course delivery costs (variable)	Instructional costs	Instructor personnel costs **(only salary in this case)**	Instructor	608€
		Teaching/learning time	Instructor	6 hours
		Student interaction time (follow-up questions after the training)	Instructor	Difficult to estimate
		Learning evaluation tools	-	-
	Travel and accommodation costs	Transportation costs for trainer, hotel or lodging expenses etc.	-	-[2]
	Learning/ instruction management	Learning assessment process management time	Instructor	1 hour
	Course evaluation and quality assurance	Course evaluation tools (via Microsoft Forms)	Training institution	10 minutes
		Future planning	Training institution	10 minutes

c) *Benefits*

As seen in Figure 13, this intervention yielded multiple outcomes across different levels, with training quality emerging as a key strength of the training programme. While there were gains in digital competence and technological pedagogical knowledge (TPACK) among participant teachers, these were moderate. In contrast, expected outcomes such as the intended adoption of new methods and increased self-efficacy showed little to no significant change.

[2] In this case, the trainer taught at the same school where the training took place. In regular SCHILFplus trainings, however, travel costs typically account for approximately 10% of the trainer's remuneration and are paid separately as a reimbursement for expenses (*Spesen / Beförderungszuschuss*).

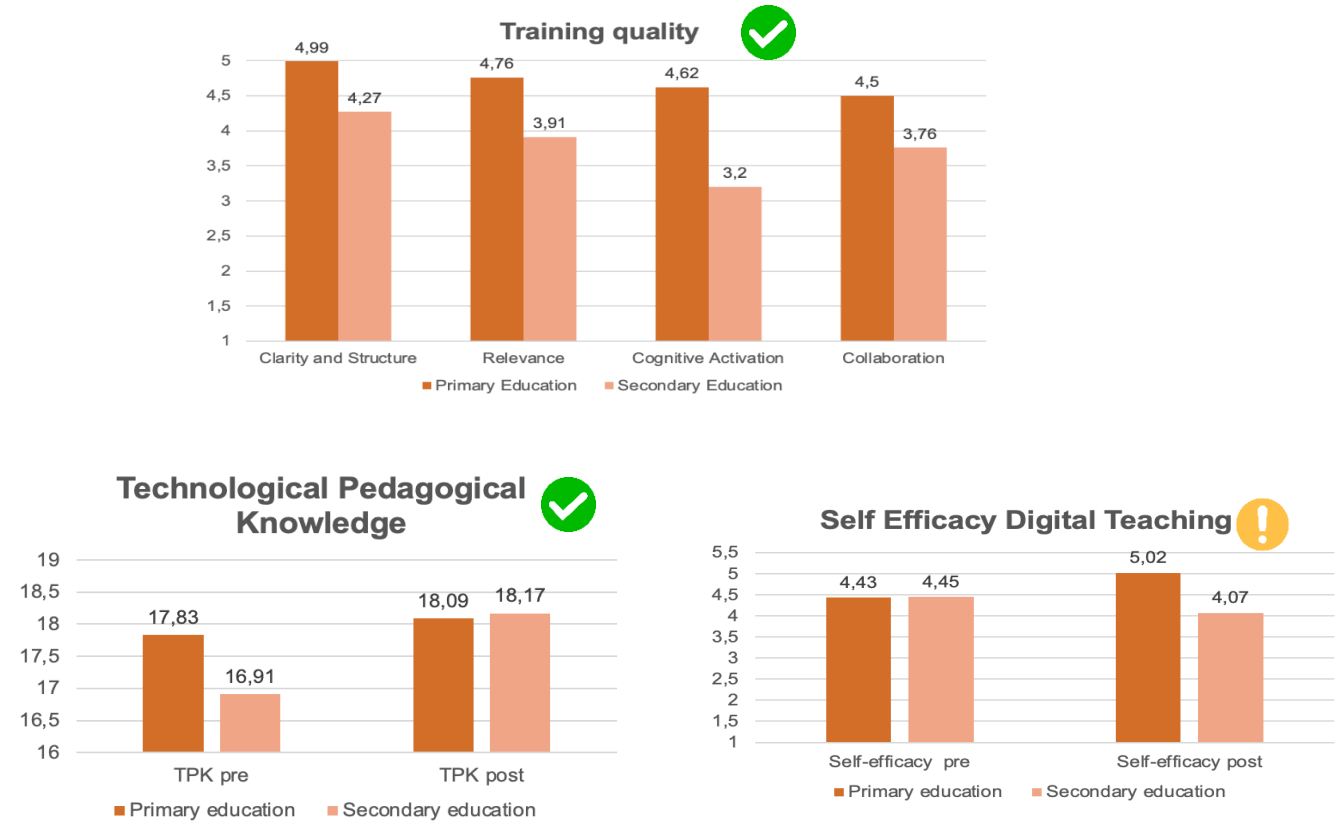

Figure 13. Core Benefits

Overall, the study demonstrated **positive outcomes**, particularly in eliciting highly positive reactions (level 1) and enhancing teachers' knowledge (level 2). However, the intention to translate this knowledge into practice (level 3) remains limited.

Table 7. Outcomes based on Kirkpatrick`s training evaluation model

Level 1. Reactions	**Level 2. Learning & Attitudes**	**Level 3. Changes in Behaviour**	**Level 4. Results at the Student Level**
Training quality (+++)	Self-efficacy (o) TPACK (+)	Intended adoption (o)	N/A

***** *based on Kirkpatrick's model and for an improvement based on the degree put (+), for decrease (–) and for no or little change(o).*

7.1.1.5 Evaluation and decision making

In this final evaluation phase, all data collected so far are synthesised and visualised in Figure 14. The SCHILFplus training programme, as depicted in the logic model,

demonstrates a theoretically grounded and contextually responsive approach to strengthening teachers' PDC. However, when assessed through a cost-benefit lens considering efficiency, effectiveness, and scalability, several strengths and limitations might emerge.

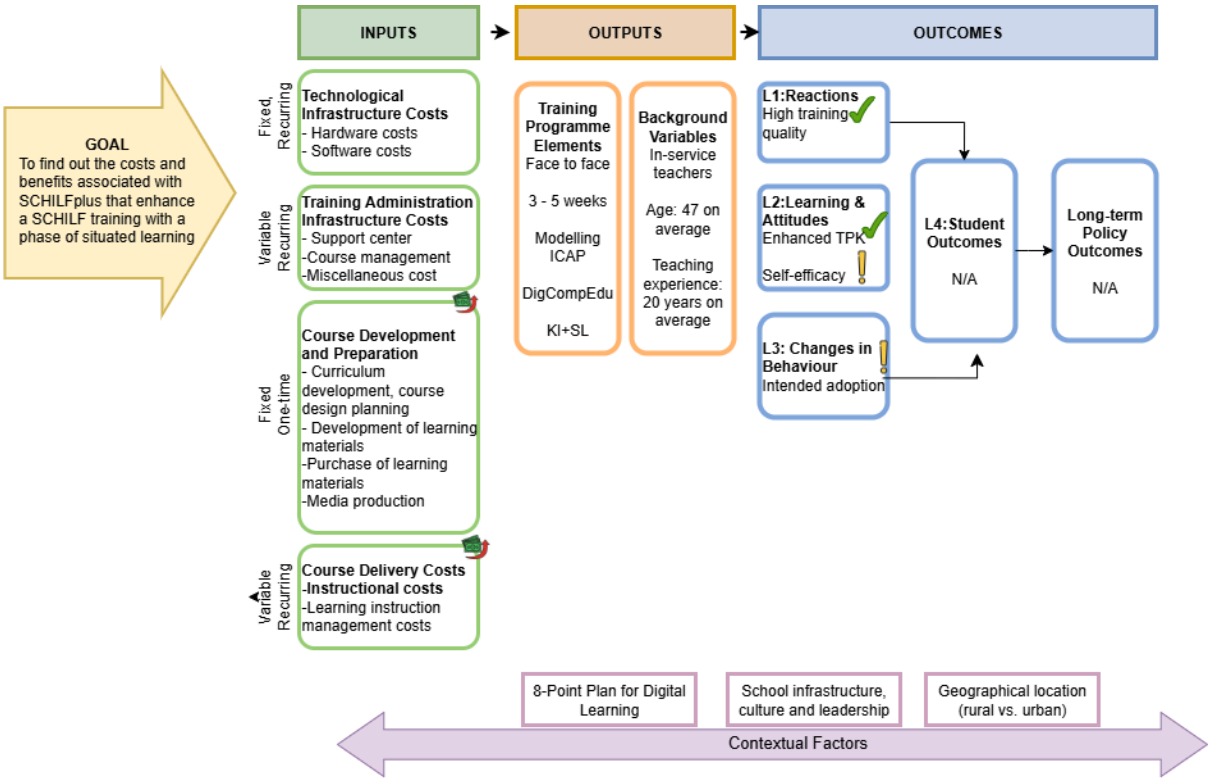

Figure 14. Adapted logic model for SCHILFplus case

The key trade-offs and insights for future implementation presented in this section are based on findings from a **stakeholder workshop** held in May 2025 in Austria. The workshop brought together representatives from educational policy and teacher training institutions. Working in groups, participants applied the CBF to the current case study, using available cost and benefit data to evaluate trade-offs. They also engaged in collaborative discussions to inform the strategic planning of future implementation of the SCHILFplus training.

Effectiveness:

The most significant benefit of SCHILFplus lies in its strong **potential for practical application** due to its **direct integration within the school context**. The success of the training closely depends on **its relevance and alignment with the actual needs of teachers**. When embedded within school development planning and complemented by individualised follow-up opportunities, SCHILFplus can be an

effective professional development approach. However, achieving this impact requires **careful coordination and integration** into the school's broader quality management processes.

Efficiency:

From an efficiency perspective, SCHILFplus could be considered a good use of resources when the training content matched with teachers' actual needs and incorporated opportunities for reflection. Some benefits, like **improved training quality**, justified their costs. Other expected outcomes, such as **self-efficacy and intended adoption**, had a weaker impact. There is a need for adjustments in training design or follow-up support.

The low delivery costs observed in this case were largely due to the trainer working in the same school, which represents a favourable but likely non-replicable condition. In settings where external trainers or travel are required, **delivery costs** may rise substantially, reducing the programme's overall cost-efficiency. To further enhance efficiency, narrowing down the range of topics offered and focusing on essential content could decrease the cancellation rate and make planning and coordination easier.

Scalability:

Cost analysis reveals that **the largest expenditures are mostly fixed and one-time costs.** This suggests the potential for improved cost-efficiency if the programme is reused or scaled. One possible scaling model could be SCHÜLF, where teachers from several schools participate in joint training sessions. However, SCHILFplus is particularly valued for its strong alignment with individual school contexts, which enhances both its relevance and effectiveness. As such, national-level scaling should not be pursued as a goal unless there is clear evidence of added value and feasibility.

Moreover, a nationwide rollout may pose challenges, particularly in terms of the coordination required between regional education directorates and pedagogical universities (PHs). Additionally, **teachers' limited availability**, due to **existing workload**, represents a barrier to broader implementation.

Insights for Future Implementation:

Based on the evaluation findings, several **practical recommendations** have emerged to guide the future implementation of SCHILFplus. These insights aim to enhance both the effectiveness and efficiency of the programme while preserving its core strengths and adapting it to varying school contexts:

- Consider blended delivery formats to reduce instructional and logistical costs while maintaining engagement and quality.
- Limit the number of training topics to focus on essential content, improving planning efficiency and reducing cancellations.
- Align the programme with schools' planning and development cycles to increase relevance and ease of implementation.
- Combine inter-school training (e.g., SCHÜLF) for schools with fewer than 10 teachers to enhance cost-efficiency and peer learning.
- Maintain strong alignment with the school context to ensure the training remains tailored to the specific needs of the school environment.
- Support implementation with adequate coordination, follow-up and resource planning to maximize both effectiveness and sustainability.

7.1.2. Educational technology & digital competence training, Estonia

7.1.2.1 Introduction and policy context

Developing teachers' PDC requires not only content knowledge but also effective, well-designed training methods. In Estonia, current policy directions emphasize that digital competence should not be addressed through stand-alone courses, but meaningfully embedded into subject teaching and pedagogy. This calls for **more integrated and complex training approaches that go beyond technical skills,** aiming to support teachers in using digital technologies to foster students' cognitive engagement, self-regulated learning, and equitable participation.

While methods like collaborative design (CD) and situated learning (SL) are theoretically well-suited to promote deep learning and transfer of skills into classroom practice, they also demand more time, resources, and trainer expertise. However, there is still limited evidence on the cost-effectiveness of different training approaches. This raises a critical question: how can we ensure that investments in

teacher training lead to meaningful and sustainable pedagogical change without becoming prohibitively resource-intensive?

In Estonia, teacher education policy promotes the development of digital competence aligned with the **DigCompEdu framework.** However, teacher education programmes vary considerably in how this goal is achieved. There is currently no clear evidence on the relative effectiveness or efficiency of different training methods in pre-service contexts. This gap has become increasingly pressing in light of **recent political priorities to advance AI-powered educational technologies**, which place new demands on teachers to demonstrate not only technical skills but also pedagogical adaptability.

7.1.2.2 The goal of the case study

This case focuses on an introductory course in teacher training aimed at developing pedagogical digital competence and understanding of child development, designed specifically for kindergarten teachers. The course was implemented in two formats:

- One group engaged in **Knowledge instruction and Collaborative design** (KI+CD) activities, emphasizing shared planning and reflection.
- The other group extended the training by applying the learned methods in real classroom settings, **involving Situated Learning** (KI+CD+SL) through lesson plan design, implementation and post-implementation analysis.

Although both groups were enrolled in the bachelor-level pre-service level teacher education programme (BA level), they differed in their teaching status. The KI+CD group consisted mainly of teachers without teaching experience, coming directly from secondary education. The KI+CD+SL group included practicing teachers, those already working in kindergartens). By comparing these cases, we aim to answer: What are the advantages and disadvantages in terms of costs and benefits and what training designs are scalable and sustainable in pre-service teacher education?

The study is designed **to inform decision makers**, including schools, teacher education providers, and policymakers about the effectiveness and resource implications of different teacher training models. Specifically, we compare on-campus, face-to-face training formats (combining knowledge instruction and collaborative design, KI+CD) typically used with pre-service teachers, to more

flexible, self-directed formats where in-service teachers engage with the same content independently and apply it in their own work contexts (KI+CD+SL).

Understanding how these different groups benefit from varying training formats helps to inform decisions about the optimal structure and cost-efficiency of future teacher education. In particular, it supports reflection on h**ow to balance guided instruction with workplace-embedded learning**, so that diverse teacher profiles, whether studying full-time, remotely, or through micro-credential programmes, receive meaningful and pedagogically impactful training. This is especially relevant given the growing trend of integrating adult learners into university-led online programmes originally designed for pre-service students.

7.1.2.3 Training programme elements

The training was offered as a **mandatory course** within an elective module on digital competence in teacher education. Participation was free of charge for all students. Participants took the course as part of their full-time university studies. No systematic data were collected on participants' socioeconomic background, but given the structure of the training, access was equal in terms of cost (free for all participants), and motivation was primarily driven by curriculum requirements rather than external incentives.

Both training formats were led by the same instructor, ensuring consistency in content and guidance. The trainer has professional expertise in both child development and educational technology, with practical experience in pre-school education as well as a strong academic background in teacher training and digital pedagogy. This combination of domain knowledge and technological competence enabled the trainer to address the needs of participants with diverse teaching experience and support their integration of digital platforms and environments into pedagogical practice. The training programme elements are presented in Table 8.

Table 8. Training programme elements of PT1.5 case

Case	**Educational technology in learning processes**
Policy measure	• Lifelong Learning 2020 • Tark ja Tegus Eesti 2035
Conditions	
Delivery mode	Face-to-face, synchronous

Interaction mode	• Group 1: Knowledge instruction (KI)+ Collaborative Design (CD). • Group 2: Knowledge instruction (KI)+ Collaborative design (CD)+ Situated Learning (SL).
Training duration	1 semester: 20 academic hours of face-to-face sessions and 136 hours of independent study.
Target group	
Target	Initial teacher training 1: KI+CD - mainly pre-service teachers who do not teach yet in the school 2: KI+CD+SL - largely teachers who have started teaching in the school
Size of the group	1: KI+CD - 32 participants (large group) 2: KI+CD+SL: 44 participants (large group)
Content	
Technology knowledge	Use of various digital platforms and learning environments (e.g., Plickers, Kahoot, LearningApps, e-Koolikott, Quizalize), as well as educational technologies (e.g., augmented reality, robotics, GPS-art, multimedia creation tools).
Pedagogical knowledge	Child development and its connection with child age-appropriate digital competence
Content knowledge	Knowledge about educational technology and learning in technology-enhanced environments
Inclusion & Equity	Ability to notice and support individual differences in learning situation was implicitly addressed to improve the inclusion awareness of teachers
Instructional design	
Training method	KI+CD: • Knowledge instruction - student and teacher digital competence based on DigComp 2.2 and DigCompEdu models (localized) • Hands-on learning - GPS art, compact robots, augmented reality, online learning materials • Collaborative planning of learning activity supporting child development KI+CD+SL • Knowledge instruction - student and teacher digital competence based on DigComp 2.2 and DigCompEdu models (localized) • Hands-on learning - GPS art, compact robots, augmented reality,

	online learning materials • Hands-on learning - GPS art, compact robots, augmented reality, online learning materials • Collaborative planning of learning activity supporting child development • Planning learning activity for own settings, implementation, analysis and reflection
Modelling SRL	**Not in this case**
Modelling ICAP	**Passive:** Reading scientific articles to plan the learning process **Active:** Selecting and testing suitable digital environments and platforms for the relevant teaching and learning practices **Constructive:** Creation of digital content and lesson plans **Interactive:** Collaborative design of learning activities that foster child development and digital competence
Digital competence	The course is designed based on the DigCompEdu framework and the Estonian teacher qualification standard (level 7), supporting the development of teachers' digital competence across all areas: professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence

7.1.2.4 Data collection and analysis

a) Background variables

Across the full sample (N = 76) the average age was 27.5 years (SD = 9.77), with a wide range from 19 to 55 years. The median age was 22, indicating that the distribution was skewed toward younger participants. The two training groups differed notably in age: KI+CD training participants were significantly younger (M = 20.7) than those in KI+CD+SL (M = 32.2), reflecting a likely difference between pre-service and in-service teachers. 60% of participants had no or minimal work experience, 34% had 1–5 years of experience, 4% had 6–10 years of experience and 2% had 11–15 years of experience.

Table 9. Background variables

Teacher Background	Student Background	School Context	Classroom Context
Age: 27.5 years old on average. Language: Estonian speaking	Not applicable (training was for initial teacher training student teachers)	N/a	N/a

b) Costs

The costs associated with the two training approaches—one designed for session-based learners and the other for day-to-day learners— suggests that their cost structures are almost similar. Both methods required roughly the same number of training hours and relied on comparable resources meaning that neither model presents a clear financial advantage over the other. The primary distinction, therefore, does not lie in the training method but in the benefits of each training as well as common underlying cost drivers.

The costs linked to the two training formats are outlined in Table 10. Instructional costs emerge as the main cost driver with teaching, evaluation, and course management representing the recurring expenditures. Operational costs, such as administrative support and digital infrastructure (e.g., software subscriptions, cloud services), are also important although their financial weight is less significant than that of instructional time.

In contrast, physical infrastructure plays only a minimal role in the overall cost structure, since these resources are already covered by the institution. This suggests that the long-term sustainability of both training models depends less on physical and digital infrastructure and more on continuous investment in human capital for such categories as course management, course development, delivery and evaluation.

Table 10. Costs associated with the training

Category	Sub-category	Description	Cost Unit (Training institution/ School/ Instructor /Participant)	Cost
1.1. Technological and Physical Infrastructure Costs (fixed)	Hardware costs	Personal computers, projectors, sound systems, specific equipment servers, peripheral equipment (including robotics and augmented reality tools)	Training institution	**Available at the institution. Computer cost on average 1499€/per 4 years**

	Network, software and cloud services	Internet services, cloud computing services, learning management system (LMS) software licenses, server maintenance, video conferencing software (e.g. ZOOM), accessibility tools etc	Training institution	**~400€/per year**
	Physical infrastructure	Class (room), libraries	Training institution	**N/A**
1.2. Training Administration Infrastructure Costs (operational)	Support center, help desk services	Pedagogical support for trainers, didactic consulting (i.e. costs associated with providing advice, guidance and support to trainers involved in delivering the training programmes)	Training institution	**2 hours per course**
	Course management, administrators	Management office, including timetable, assessment support, room planning and student support	Training institution	**~ 10h per course**
	Miscellaneous costs	Miscellaneous expenses: printing costs (learning materials, hand outs)	Training institution	**0.05€x500=25€ per course**
2.1. Course development and preparation (fixed)	Curriculum development, course design planning	Curriculum development - course design planning (including the evaluation process)	Instructor	**100 hours/ Per year**
	Development of learning materials	Local development/ (digital) adaptation of learning materials, purchase of learning materials, self-developed educational resources such as handouts, textbooks and educational resources (physical and digital)	Instructor	**20 hours**
	Media production	Video guides, animations, presentations and other multimedia materials (animation examples)	Instructor	**10 hours**
2.2. Course delivery costs (operational)	Instructional costs	Trainer personal costs, teacher assistant personal costs, teaching/learning time, student interaction	Instructor	**120 hours (4x10x3groups) 1600€ per course**

		time, support staff, learning evaluation tools		**(excluding the evaluation and feedback costs)**
	Travel and accommodation costs	Transportation costs for trainers and, in some cases, for teachers	Instructor	**N/A**
	Learning/ instruction management	Learning assessment process management time, working time with external entities, management costs	Instructor	**80 hours =1066€**
	Course evaluation and quality assurance	Course evaluation tools: LMS feedback, course assessment time and student evaluation	Instructor	**80 hours =1066€**

c) *Benefits*

The main expected benefit of the training was to enhance future teachers' ability to meaningfully integrate technology into teaching, while keeping in mind the principles of child development and their age-appropriate digital competence. To evaluate the effectiveness of the training, we investigate its benefits on three levels:

- Satisfaction and perceived quality of the training experience
- Development of digital competence and self-efficacy
- Perceived adoption intentions and motivational beliefs regarding the new learnt methods

Participants perceptions about training programme quality and satisfaction

What we found: Practicing teachers who engaged in workplace-based situated learning rated the training especially positively in terms of clarity and structure, relevance to their daily work, and how well it supported deeper thinking and reflection (training quality). These elements resonated with their real-life teaching responsibilities and professional needs. Beginning teachers, who participated through regular on-campus sessions, also found the training valuable. Despite differences in training methods and professional background, both groups reported similar levels of subjective enjoyment, perceived usefulness, positive attitudes toward the training, and perceived knowledge gain (training satisfaction).

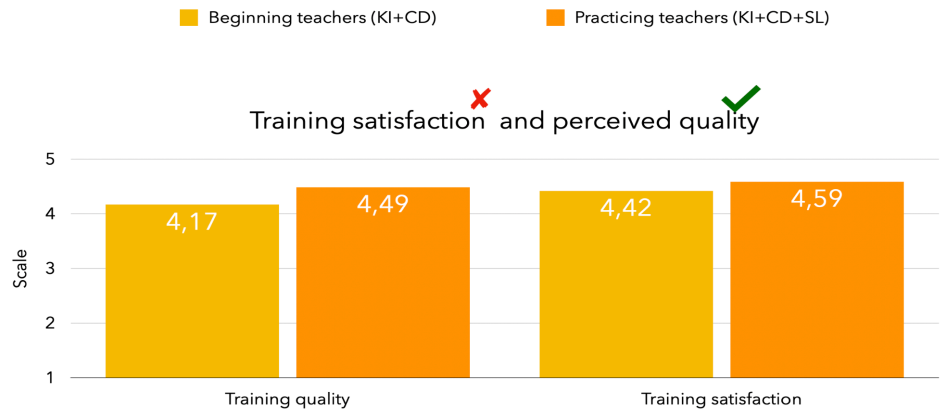

Figure 15. Effects on training satisfaction and perceived quality

Why it matters: Well-designed training can be effective for both beginning and practicing teachers, even when delivered through different methods. While practicing teachers may benefit more from workplace-embedded elements that connect directly to their teaching context, beginning teachers gain from structured guidance and foundational input. This highlights the importance of designing training formats to participants' professional profiles to ensure relevance and transfer while maintaining core instructional quality across methods.

Participants' knowledge gain

What we found: While the training may have contributed to some improvement in participants' conceptual understanding of technological knowledge in KI+CD+SL, these gains were modest, and no meaningful differences emerged between the two training formats (KI+CD vs KI+CD+SL). Instead, participants' prior knowledge at the start of the programme was the strongest predictor of learning gains.

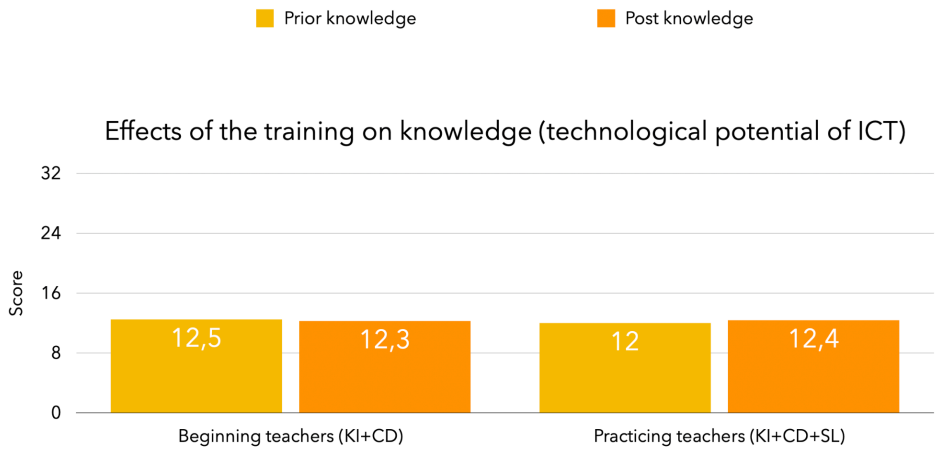

Figure 16. Effects of the training on knowledge

Why it matters: This finding highlights the importance of taking participants' entry-level knowledge into account when designing teacher training. Those with stronger prior knowledge, typically practicing teachers, were better positioned to benefit from the training content, while those with more limited starting points gained less, regardless of the method. This suggests that a one-size-fits-all approach is insufficient. To ensure meaningful learning outcomes, training should be differentiated to match participants' existing competence levels, and wherever possible, groups should be composed of learners with relatively similar prior knowledge to enable more targeted instruction and appropriate scaffolding.

Participants' perceived digital competence

What we found: One of the main outcomes of the training was participants' perceived digital competence, which improved in both groups from the beginning to the end of the training. Those who had to apply the content in their own teaching context (KI+CD+SL) reported higher end-level competence (although statistically not significant). At the same time, beginning teachers, who started with lower confidence, showed a steeper learning curve over the course of the training compared to practicing teachers.

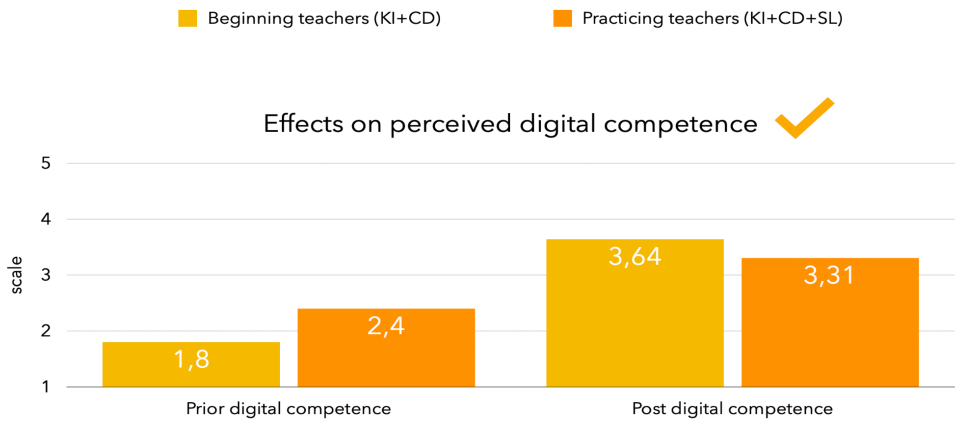

Figure 17. Effects on perceived digital competence

Why it matters: These findings highlight two important aspects: first, that context-based application enhances the impact of training; and second, that beginning teachers may benefit greatly from training when starting from a lower baseline. This reinforces the importance of aligning training formats with participants' starting points, ensuring that beginners receive strong foundational input, while experienced teachers benefit from opportunities to integrate new knowledge into their daily teaching practice. It also suggests that well-designed training can support

different learner profiles effectively, as long as their developmental needs are considered.

Participants' perceived self-efficacy on digital learning

What we found: The training aimed to strengthen teachers' confidence in their ability to support digital learning. Overall, participants reported a modest increase in self-efficacy by the end of the course. However, there was no clear difference between the two training formats (KI+CD vs KI+CD+SL) in terms of how much participants' confidence improved. There was a small trend suggesting that practicing teachers who applied the training content in their own classrooms may have felt slightly more empowered, but the difference was minimal.

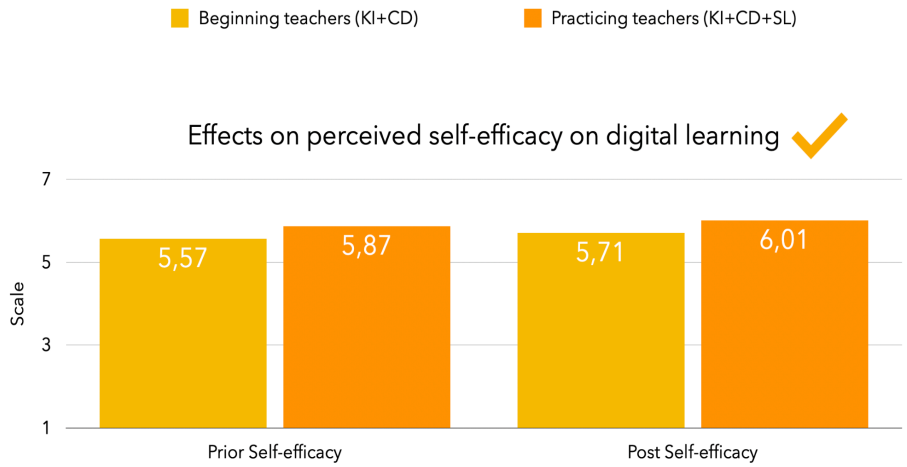

Figure 18. Effects on perceived self-efficacy and digital learning

Why this matters: While improvements in self-efficacy were modest, the results indicate that even short-term interventions can help teachers feel more capable of facilitating digital learning. The lack of strong differences between training formats suggests that self-efficacy may be less influenced by method and more by individual factors, such as prior experience, opportunities to succeed and context. This points to the importance of designing training activities that not only build knowledge but also create moments of success and mastery, especially for those with lower initial confidence in using digital platforms and learning environments.

Participants' perceived adoption and motivational beliefs

What we found: Although the training formats differed in design, participants across both groups reported similar levels of motivation to apply what they had learned

and intention to adopt new digital teaching practices. This included their beliefs about the value of the training, their confidence in being able to implement new approaches, and their openness to future use of digital platforms and environments in their teaching.

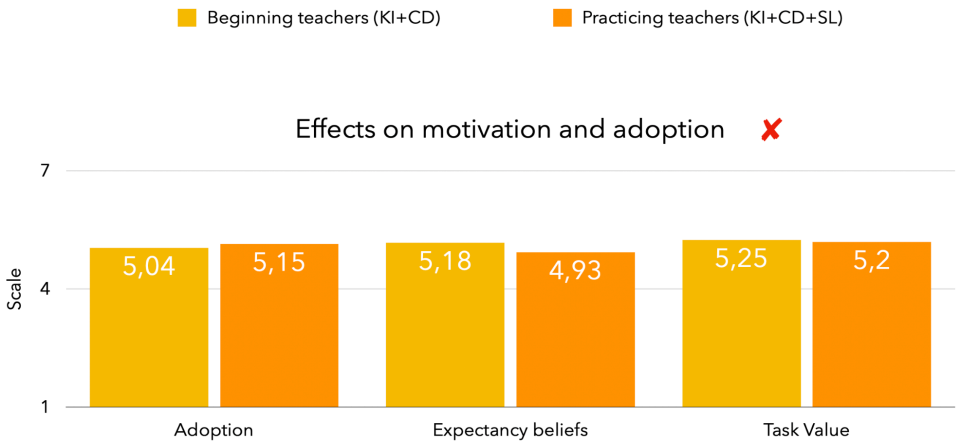

Figure 19. Effects on motivation and adoption

Why this matters: These findings suggest that well-designed training can foster a comparable level of motivation and readiness for change among teachers. This is particularly relevant for large-scale or flexible training programmes, where resource constraints or participant availability may limit the use of more complex formats. As long as the training content is meaningful, relevant and engaging, it is possible to support teachers' motivation and adoption intentions across different methods (workplace related training or general training). However, turning intention into sustained practice likely depends on continued support and opportunities for practical implementation beyond the training itself.

Interpreting individual differences: Self-regulated learning and cognitive demands

Beyond the training format itself, individual learner characteristics played an important role in shaping outcomes. Participants with stronger SRL skills tended to report higher motivation, a stronger belief in their ability to succeed, greater perceived value of the training and a stronger intention to adopt new practices. This suggests that personal learning dispositions, rather than training design alone, can strongly influence the impact of professional development. At the same time, the training format that included workplace-based activities (KI+CD+SL) was experienced as more cognitively demanding. Participants in this group reported

higher levels of both intrinsic and extraneous cognitive load, indicating that while the training supported deeper thinking, it also required more mental effort to process. For some learners, particularly those with weaker SRL skills, this may have reduced the overall benefit of the training.

Why this matters: These findings highlight the importance of aligning the complexity of professional development with participants' readiness and capacity to manage learning demands. More authentic and applied formats can support deeper engagement and learning, but only if participants are equipped with the strategies to navigate the challenges they present. In future programme design, attention should be paid not only to the content and structure of training, but also to how learners are supported in regulating their own learning process.

7.1.2.5 Evaluation and decision making

The logic model of the TLU case provides a structured overview that links the resources invested (inputs), the training activities conducted (activities), the immediate deliverables produced (outputs) and the intended short- and longer-term effects (outcomes and impacts) of the programme. It serves as both an evaluation and a communication tool to clarify how the programme was designed to work and what it actually achieved.

In this case, the model synthesises diverse data sources, including participants' perceptions of training quality, learning outcomes, behavioural intentions and contextual factors to examine how different training methods (KI+CD vs. KI+CD+SL) contribute to change at the teacher level (see Figure 20). By aligning these outcomes with the costs and contextual tensions (such as cognitive load, instructional clarity), the model allows stakeholders to assess not just whether the programme was effective, but for whom, under what conditions, and with what implications. In our case, the model compares two formats:

- Full-time beginning teachers who attend weekly, campus-based sessions (KI+CD)
- Practicing teachers who engage in more flexible, practice-integrated learning approximately once a month (KI+CD+SL).

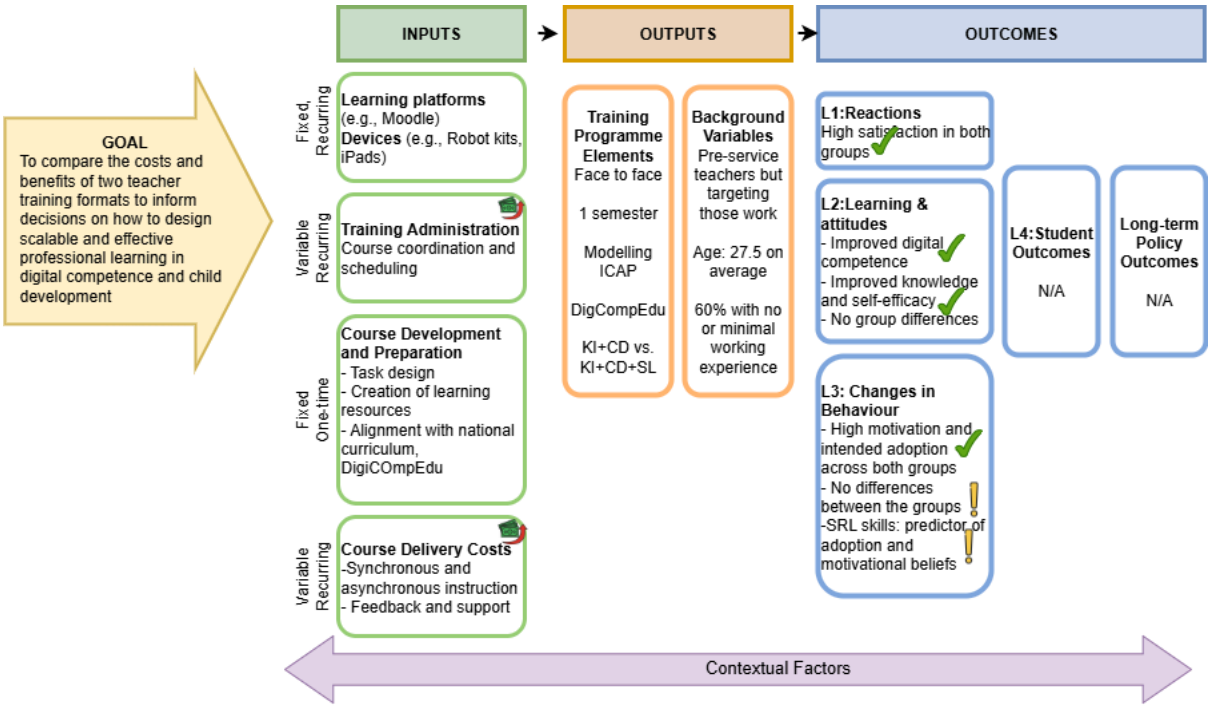

Figure 20. Adapted logic model

Based on the adapted logic model, the key trade-off around effectiveness, efficiency and scalability were discussed below.

Effectiveness:

Our findings suggest that while the situated learning format **(KI+CD+SL) was perceived as more relevant and higher in quality, it also introduced greater cognitive demands,** which may have limited its effectiveness for some participants. Training focusing on beginner teachers with less authentic experiences, provided clearer guidance and appeared more effective for developing PDC.

Crucially, individual learner characteristics such as **SRL skills, prior experience and motivation strongly influenced outcomes**. Participants with stronger SRL skills benefited more from the training regardless of format. This highlights the need to design training that matches learners' readiness and supports self-regulation explicitly when needed.

Context also played a role: practicing teachers could connect the training with their real-world teaching, enhancing its perceived value. Beginning teachers, for whom the training was more abstract, may have found the experience less authentic.

Efficiency

From an efficiency perspective, the TLU training formats (KI+CD and KI+CD+SL) provided good value when the training was aligned with students' readiness and incorporated opportunities for immediate application and reflection. The relevance and perceived quality of the KI+CD+SL format, particularly for those with stronger prior experience from practicum or work in early childhood settings, justified the higher investment in facilitation and coordination. However, the additional cognitive demands of this format reduced its effectiveness for some learners, suggesting that efficiency gains are best realised when complexity is matched to participants' prior knowledge and self-regulation capacity.

Delivery costs varied slightly between the two formats. The KI+CD format, delivered in weekly campus-based sessions, benefitted from predictable scheduling and existing university infrastructure, which kept marginal costs low. The KI+CD+SL format required more coordination with kindergartens and flexible scheduling for school-based activities, increasing organisational effort. In both cases, efficiency could be improved by better matching students to formats based on readiness, thereby reducing the need for remedial support during or after training.

To further enhance efficiency, streamlining training content to focus on core PDC elements for early childhood education and embedding SRL scaffolding into all formats could reduce the number of sessions needed to reach learning outcomes. This would also mitigate overload for learners in more practice-integrated formats.

Scalability

In the context of initial teacher education for kindergarten teachers, scalability refers to the ability to expand the training formats (KI+CD and KI+CD+SL) to larger cohorts or additional universities while maintaining the high level of domain-specific quality required for early childhood education.

Many of the programme's development costs, such as the design of early childhood–specific materials, digital resources, and trainer preparation, are largely fixed and could be reused across cohorts, making scaling cost-efficient in principle. However, the strong domain focus creates unique scaling challenges, particularly in the KI+CD+SL format. Situated learning for kindergarten teachers relies on access to age-appropriate practicum placements, experienced early childhood mentors and supervision by domain specialists. These resources are limited, meaning that scaling up requires expanding the network of practicum sites and investing in mentor preparation.

The KI+CD format, being campus-based and more structured, is easier to scale in terms of logistics and delivery. It can accommodate larger groups through lecture-based sessions, supplemented with smaller group work and simulated practice, without immediately increasing the demand for practicum placements.

For the KI+CD+SL format, scaling could follow a rotational or block model in which different student groups enter school-based practice at different times during the semester. This would allow partner kindergartens to accommodate more students without overloading staff. Additionally, blended learning approaches could be used to prepare students for practice more effectively, reducing on-site demands.

While the programme's specialised nature is its strength, ensuring scalability will require careful planning to balance authenticity, supervision quality, and logistical feasibility. The domain-specific expertise needed for early childhood education must remain central to the design, even as the programme expands.

Insights for future implementation:

- **Differentiate training designs based on learners' profiles** - . Participants with weaker starting knowledge and lower SRL skills benefit more from structured formats with regular guidance (e.g., beginning teachers), while experienced and self-regulated learners can benefit more from flexible, context-based approaches. Even in formal studies, reinforcing the "why" behind the training can make a difference.
- **Avoid assuming that more complex formats lead to better outcomes**. While KI+CD+SL was perceived as more relevant and engaging, it also introduced higher cognitive demands that may reduce effectiveness for some learners. Complex formats must be well-structured and supported to avoid overload.
- **Support participants'SRL skills explicitly**. SRL emerged as a consistent predictor of positive outcomes across groups and integrating SRL scaffolding into all training formats can help ensure more equitable outcomes.
- Consider grouping participants with similar levels of prior knowledge and experience. In heterogeneous groups, large gaps in readiness can limit collaboration and create challenges in pacing and instructional design.
- **Enhance motivation through relevance and autonomy.** Be transparent about goals and expectations to enhance motivation. Voluntary participants (practicing teachers) tended to show higher motivation and perceived value, suggesting that perceived autonomy and relevance can amplify engagement.

- Efficiency could be improved by narrowing the training content to core PDC elements for early childhood education and integrating SRL support into all formats, helping to achieve learning goals in fewer sessions while preventing overload in practice-heavy formats.
- Scaling the programme could be cost-efficient in principle. However, successful expansion would require careful planning to preserve authenticity, maintain high-quality supervision, and ensure logistical feasibility, while keeping the domain-specific expertise essential for early childhood education at the core of the programme design.
- Use the logic model as a tool for adaptive planning and equity-driven scaling. The logic model helps align programme inputs and activities with context-specific outputs and outcomes.

Connection with policy objectives:

These findings align closely with Estonia's national education priorities, including Lifelong Learning 2020, Tark ja Tegus Eesti 2035, and emerging AI-related strategies, by demonstrating that:

- Digital competence in early childhood teacher education must **go beyond the technical use** of tools and be embedded within pedagogically sound teaching and learning practices. This supports our vision's goals for high-quality, future-ready educators who can integrate technology meaningfully into learning.
- **Integrated training formats such as KI+CD+SL** provide opportunities for student teachers to connect theoretical understanding with design skills and authentic practice. This directly supports visions for competence-based learning and teachers' adaptive expertise.
- By combining **strong pedagogical foundations with flexible, practice-integrated learning** opportunities, programmes can prepare future teachers to use emerging technologies in ways that enhance learning for all students, thereby contributing to both innovation and inclusion targets in Estonia's educational strategies.
- **Context-specific preparation** strengthens workforce sustainability. Domain-focused training for kindergarten teachers ensures that early childhood education benefits from educators who are both digitally competent and pedagogically skilled, addressing long-term workforce quality goals.

7.1.3 Fully online training for pre-service teachers on SRL & Gen-AI chatbots, Israel

7.1.3.1 Policy context

Israel's national strategy for education, titled **"Learning Perception – Skills for the Education System 2021–2031,"** emphasizes the integration of digital tools and advanced learning technologies to promote 21st-century skills. This includes a focus on digital pedagogy, independent learning, and educational equity. The training described in this case study aligns with these priorities, aiming to build pre-service teachers' competence in supporting self-regulated learning (SRL) using generative AI (Gen-AI) chatbots.

7.1.3.2 The goal of the case study

The primary objective of this case study was to **evaluate and compare** the cost–benefit outcomes of two distinct **fully online pre-service** teacher professional development programs conducted at Tel Aviv University (TAU) within the framework of the EffecTive project. Both programs aimed to enhance teachers' ability to promote **self-regulated learning (SRL)** skills among students through the use of **educational technologies**, with a specific focus on **generative AI (Gen-AI) chatbots** as pedagogical tools.

7.1.3.3 Training design elements

The two training programs, titled *"Digital Pedagogy 2.0: Promoting Independent Learners,* " shared the same content, duration, and intended learning objectives. However, they differed in their instructional design:

- One was based on a **Knowledge-Instruction (KI)** method, where participants independently engaged with materials and tasks.
- The other combined **Knowledge-Instruction with Collaborative Design (KI+CD)**, embedding direct instruction within a course structure that was built around **co-design activities**.

The goal was **not only to examine the effectiveness of each training approach**, but also to **systematically compare** their outcomes using the **EffecTive project's cost–benefit framework**. The analysis took into account both fixed and operational costs (e.g., course development, facilitation, digital infrastructure) as well as diverse

educational benefits (e.g., teacher motivation, effective Gen-AI integration, pedagogical application of SRL strategies). By evaluating and comparing these **two training variations,** the case study seeks to generate actionable insights for **teacher training developers and policymakers**, supporting evidence-informed decisions about how to best design and scale impactful professional development that leverages collaborative learning and emerging technologies.

After completing the course, teachers were expected to:

- Acquire theoretical and practical knowledge of **self-regulated learning (SRL)** and how to teach it
- Develop skills in using **generative AI (Gen-AI)** tools, particularly chatbots, to support SRL in educational contexts
- Build confidence, motivation, and pedagogical strategies for integrating **Gen-AI into lessons to promote students' SRL skills**

In line with these goals, the design and content of the training are presented in Table 11 based on the CBF.

Table 11. Training programme elements of the TAU case

Case X	*Pre-Service Teacher Fully Online Training - Digital Pedagogy 2.0: Promoting Independent Learners*
Policy measure	"Learning Perception – Skills for the Education System 2021–2031"
Conditions	
Delivery mode	Fully online (3 months), synchronous + asynchronous
Interaction mode	Group 1: Knowledge Instruction (KI); Group 2: Knowledge Instruction + Collaborative Design (KI + CD):
Training duration	**26 academic hours over 3 months (13 Meetings, fully online - synchronous + asynchronous)**

Target group	
Target	Pre-service teachers
Size of the group	78 enrolled; 54 participated in the study KI: n=43 KI+CD: n=16
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 students' 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	**KI:** Cognitive and motivational self-regulated learning strategies within the context of problem-solving. **Work Samples Analysis:** Evaluation of existing learning technologies in terms of their support for self-regulated learning (SRL) strategies, to develop recommendations for improvement. • *KI: Each participant performs the task individually.* • *KI+CD: Participants engaged in collaborative design, co-constructing proposals for learning technologies improvement.*

	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. • *KI: Participants develop lesson plans individually.* • *KI+CD: Participants collaborate in groups to develop lesson plans, incorporating peer feedback and joint decision-making.*
Modelling SRL	**Direct/explicit instruction:** Engaging with a 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 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 evaluating and offering improvement for 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 a specific context, and refining understanding. **Passive:** processing information about SRL by observing and absorbing content through reading and watching videos, developing a 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.

7.1.3.4 Data collection and analysis

a) Background variables

The training participants were, on average, 30 years old, with a diverse background in mother tongue (77% Hebrew speakers, 23% Arabic speakers) and gender (74% female, 26% male). As the participants were pre-service teachers, student-level data

was not collected. The training took place in a higher education setting, as previously described. These background characteristics offer valuable insight into participants' readiness to engage with digital pedagogy and adopt emerging technologies such as generative AI. Understanding these contextual factors helps interpret their potential responsiveness to training focused on self-regulated learning and digital competence.

Table 12. Background variables

Teacher Background Variables	Student Background Variables	School Context	Classroom Context
Age: 30 years old on average Language: 77% Hebrew speakers, 23% Arabic speakers Gender:74% female, 26% male	Not applicable (training was for pre-service teachers; no students involved)	As previously described	As previously described

b) Costs

In this case study, we collected and analyzed the costs of **two separate training programs** - both versions of the *Digital Pedagogy 2.0* course - delivered at **Tel Aviv University**. One program followed a **Knowledge-Instructional (KI)** model, while the other combined **Knowledge-Instructional with Collaborative Design (KI+CD)**. Using the **EffecTive cost–benefit framework**, we examined all costs in both models, expressed either in monetary terms or time equivalents. The framework organizes costs into three main categories: **technological infrastructure**, **course development**, and **course delivery**. This approach allowed for a detailed comparison of fixed and operational costs between the two training methods, based on actual implementation data and staff input.

As shown in Table 13, **the primary cost drivers for this training were related to technological infrastructure and course development, with identical per-student costs across both models.** Each participant accounted for €90 in general infrastructure and €225 for chatbot-related technology. Course development required 32.5 hours in both the Knowledge Instruction (KI) and Knowledge Instruction + Collaborative Design (KI+CD) models, with no difference in overall development time or material expenses. Although the development effort was equal, the smaller size of the KI+CD group slightly increased the cost per student in relative terms.

More variation emerged in course delivery costs per student, particularly in interaction and task evaluation time. Instructor–student interaction time was significantly higher in the KI+CD model (0.375 hours per student) compared to KI (0.093 hours), due to the emphasis on collaborative design and facilitation. However, this investment was offset by greater efficiency in grading: task evaluation time per student was lower in KI+CD (2.81 hours) versus KI (3.0 hours), thanks to group submissions. Other components, such as instructor salary, teaching assistant time, and total lesson hours, were identical across the two programs. These findings illustrate how collaborative design increased engagement while also streamlining assessment.

Table 13. Costs associated with the training

Category	Sub-category	Description	Cost Unit (Training institution/ School/ Instructor /Participant)	KI (n=43)	KI+CD (n=16)	Difference
1.1. Technological and Physical Infrastructure Costs (fixed)	Network, software and cloud services	Technological Infrastructure	Training institution	€90 per learner	€90 per learner	0
		Specific Tech Cost (Chatbot)	Training institution	€225 per learner	€225 per learner	0
1.2. Training Administration Infrastructure Costs (operational)	Support center, help desk services	Human Support Center	Training institution	0	0	0
2.1. Course development and preparation (fixed)	Curriculum development, course design planning	Content Development Time	Instructor	32.5 hours	32.5 hours	0
	Purchase of learning materials	Purchase of learning materials	Training institution	0	0	0
2.2. Course delivery costs (operational)	Instructional costs	Instructure salary	Training institution	€832 / 26 hours	€832 / 26 hours	0
		Teaching Assistant	Training institution	€576 / 57.6 hours	€576 / 57.6h	0
		Teaching Time (Lessons)	Instructor	26 hours	26 hours	0

Category	Sub-category	Description	Cost Unit (Training institution/ School/ Instructor /Participant)	KI (n=43)	KI+CD (n=16)	Difference
		Students-Instructure interaction time	Instructor	4 hours for teachers/43 students = 0.093 hours per student	6 hours for teachers/ 16 students = 0.375 hours per student	0.282 hours per student
		Task Evaluation Time	Instructor	[0.5 hours (Time for one task evaluation) * 6 number of tasks * 43 number of students=129]/43=3.0 hours per student	[0.5 hours (Time for one task evaluation) * 6 number of tasks* 5 number of groups=15]/16=2.81 hours per student	0.19 hours per student
	Course evaluation and quality assurance	Course Evaluation & Future Planning	Instructor	8 hours	8 hours	0

c) *Benefits*

As seen in Figure 21 below, the analysis revealed that both training method variations, KI and KI+CD, provided notable benefits, particularly in terms of efficiency and learning outcomes. However, the KI+CD model consistently outperformed KI across multiple pedagogical dimensions.

The **learning & attitudes** category includes gains in motivation for self-regulated learning (SRL) and attitudes toward the use of generative AI tools such as chatbots. While the KI group showed modest improvements in SRL motivation, the KI+CD group demonstrated a statistically significant improvement in attitudes toward chatbots.

The **academic performance outcomes** category reflects indicators such as final assignment scores, task submission rates, and the quality of learner interaction. Here, the KI+CD group showed clear advantages: higher final assignment scores (average score of 84 compared to 69 in KI), stronger peer and faculty interaction (as observed

in qualitative analysis), higher retention, and greater consistency in assignment completion.

The **intended behavior change** category relates to participants' reported willingness to adopt chatbots in their future teaching. Only the KI+CD group exhibited a significant increase in this area between pre- and post-measurements.

The **efficiency** category encompasses resource-related benefits such as reduced grading time (2.81 hours per student vs. 3.0 in KI), lower coordination demands, savings due to online delivery, and support from chatbots for immediate learner assistance and emotional regulation. Both models demonstrated strong performance in this category. In contrast, while the KI model also delivered value, primarily in terms of instructional efficiency, via a low-interaction and structured design, it lacked the broader pedagogical benefits evident in the collaborative approach. Overall, the KI+CD method was particularly effective in translating collaborative instructional design into measurable gains in engagement, learning outcomes, and future teaching intentions.

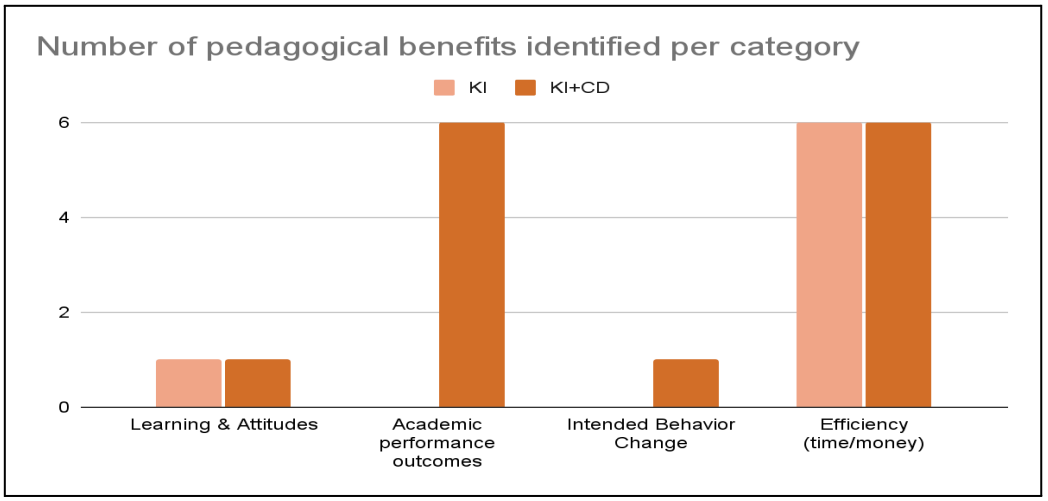

Figure 21. Core Benefits

Overall, the study demonstrated valuable outcomes across both training method variations. While both KI and KI+CD achieved strong efficiency-related benefits (in terms of time, cost, and instructional workload), the **KI+CD model showed broader pedagogical value**. As shown in Table 14, the KI group demonstrated improvement in **SRL motivational factors** (Level 2: Learning & Attitudes), whereas the KI+CD group showed a **statistically significant improvement in attitudes toward chatbots** and outperformed KI in multiple academic performance indicators (e.g., assignment scores, retention, and interaction).

In terms of **Level 3 (Changes in Behaviour)**, only the KI+CD group reported an **increased intention to adopt chatbots** in future teaching. **Level 4 (Student Results)** was not applicable in this context, as all participants were pre-service teachers. No satisfaction data were collected for **Level 1 (Reactions)**.

Table 14. Outcomes Based on Kirkpatrick's Training Evaluation Model (KI vs. KI+CD)

Kirkpatrick Level	Description	KI	KI+CD
Level 1. Reactions	Learner satisfaction, perceived quality	N/A	N/A
Level 2. Learning & Attitudes	SRL motivational factors, attitudes toward chatbots	+ (SRL motivation)	+* (chatbots attitudes)
Level 2. Academic Performance	Final assignment, retention, submission rate, peer interaction	0	+
Level 3. Behavior Change	Intention to use chatbots in future teaching	0	+*
Level 4. Student Results	Not applicable (pre-service only)	N/A	N/A
Efficiency (Time/Cost)	Chatbot support and online delivery	+	+

"+" = positive outcome or improvement; "+*" = statistically significant improvement; "0" = no or little change; "N/A" = not applicable

7.1.3.5 Evaluation and decision-making

To support evidence-informed decision-making, the evaluation of this case study applied the EffecTive project's cost–benefit framework and was guided by a logic model adapted specifically for the two training method variations implemented at Tel Aviv University: **Knowledge-Instruction (KI)** and **Knowledge-Instruction +** Collaborative Design (KI+CD).

As shown in **Figure 22 (Logic Model – KI)** and **Figure 3 (Logic Model – KI+CD)**, both models share similar inputs and goals, yet differ in the extent to which collaborative design tasks are embedded, leading to varying pedagogical outcomes.

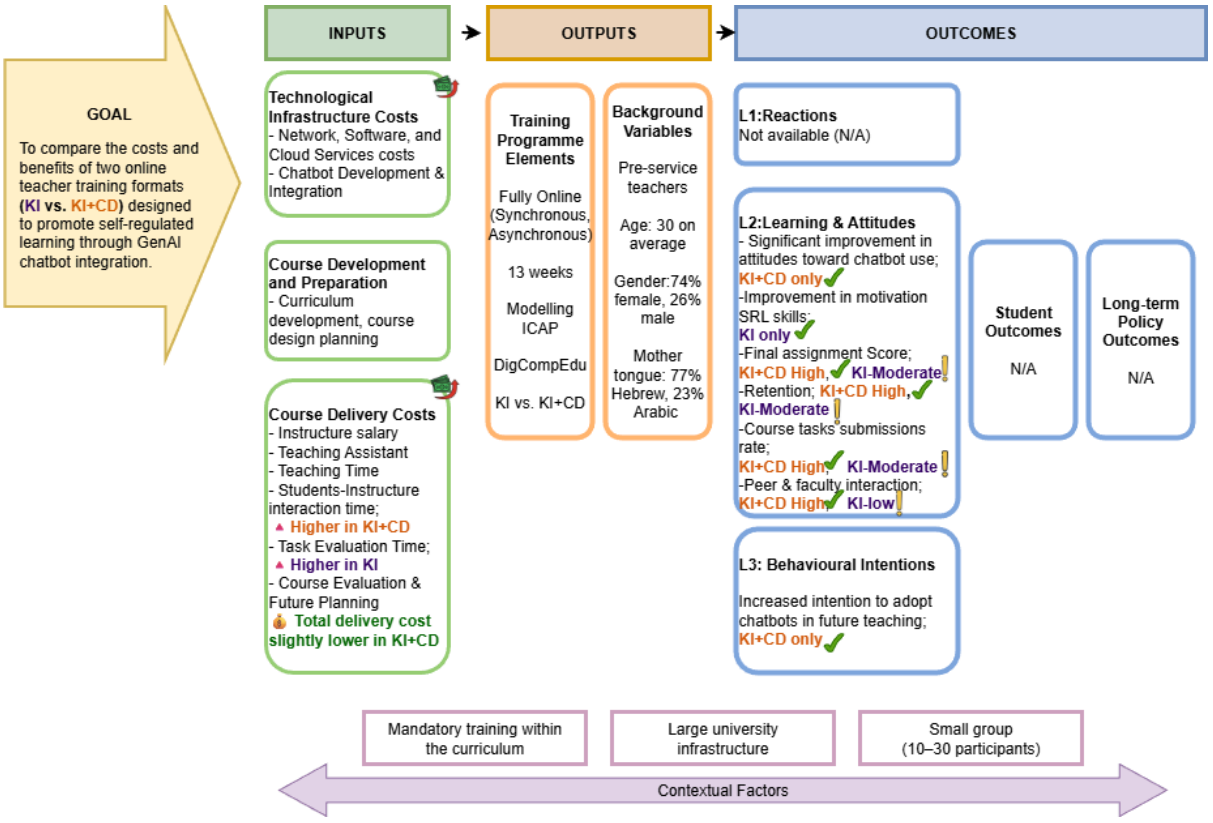

Figure 22. Adapted logic model -KI+CD

Effectiveness:

Both training models resulted in significant improvements in participants' learning outcomes (Level 2). The **KI model** contributed to improved motivation for Self-Regulated Learning (SRL), while the **KI+CD model** resulted in statistically significant gains in attitudes toward chatbots, stronger academic performance (e.g., higher assignment scores and completion rates), and greater engagement with the training tasks. Furthermore, only the KI+CD model yielded a positive shift in participants' **intended behavior change** (Level 3), with increased intention to adopt AI tools in future teaching.

Efficiency:

Both models benefited from the fully online format and the integration of generative AI chatbots. These design elements reduced instructional and logistical costs, such as travel, coordination, and infrastructure use. Notably, the **KI+CD model** further enhanced efficiency by using **group-based task submissions**, which significantly reduced grading workload without compromising the quality of learning outcomes.

Scalability:

The scalability of both models is supported by their online delivery, modular structure, and chatbot-supported activities. However, the **KI+CD model's collaborative components**, though more resource-intensive per interaction, provide a richer foundation for deeper learning and engagement. This approach is especially promising for programs that aim to balance pedagogical innovation with sustainable delivery.

Insights for Future Implementation:

For future implementation, institutions should **adopt structured cost–benefit evaluation frameworks**, like the current framework, to guide **data-informed decisions** about teacher training design, delivery, and scalability. Programs should **embed collaborative design tasks as core elements**, not add-ons, to enhance **engagement, learning outcomes**, and **technology adoption**. **Fully online formats**, especially those supported by **generative AI tools like chatbots**, offer promising pathways for **scalable, flexible, and cost-efficient** professional development. However, future efforts should include **long-term impact monitoring**, **student-level data**, and **behavioral validation** of self-reported outcomes.

7.2. Engaging with educational policy makers and practitioners

To ensure the Cost–Benefit Framework is practically relevant, **engagement with policymakers and educational practitioners has been central to its development**. As part of this effort, **the first round of communication** took place in January 2025, where we shared early findings from the Austrian pilot studies and introduced the CBF as a tool for guiding cost-benefit informed planning and evaluation of teacher training. This session served as a first opportunity to gather preliminary feedback on the CBF's structure and practical fit.

Building on this, we organized **a hybrid stakeholder workshop** in May 2025 in Austria. This workshop was designed to gather more targeted **feedback on the usability, relevance and institutional alignment of the CBF**. During the session, participants applied the framework to evaluate trade-offs using cost and benefit data from one of our real-life case studies. To deepen our understanding of what challenges and opportunities CBF might bring, we employed the stakeholder journey mapping technique. This activity enabled participants to reflect on the decision-making

processes in their institutions providing critical insight into how the CBF can be better integrated into their contexts.

Findings from the stakeholder journey mapping exercise revealed several critical themes shaping the further refinement of the CBF as summarized in Table 15. Accordingly, institutions face pressure to make strategic training decisions due to limited resources, evolving policy priorities, and a growing emphasis on innovation. **Current evaluation practices, however, tend to focus narrowly on participant reactions, with limited attention to actual learning outcomes, changes in teaching practice or cost-efficiency.** In response, the CBF was refined to address these gaps by covering refined outcomes at multiple levels and clear cost categories and linking them while evaluating training programmes. **While stakeholders recognized the potential of the CBF to improve transparency, comparability, and resource allocation, concerns were raised about time, capacity and readiness for adopting new evaluation tools.** To address these challenges, the CBF will be implemented and refined iteratively through continued stakeholder engagement, supported by practical tools, clearly defined parameters, and real-life case studies to facilitate use across diverse contexts.

Table 15. Summary of the findings and action points

Key Themes	What we have found	How we (will) address them
Decision-making triggers	Institutions need to make informed decisions due to limited resources, alignment with visions and political push for innovation.	Refined CBF is designed to support these decisions by linking cost and benefit considerations to real institutional priorities. We also highlighted the policy priorities and contextual factors and will define it further for interventions.
Identified challenges	Current evaluations mostly focus on participant reactions; limited attention to learning outcomes, teaching practice changes, and cost-efficiency.	From reactions, knowledge and practices to student outcomes, CBF addresses different levels for learning outcomes as well as associated costs and background variables.

Key Themes	What we have found	How we (will) address them
CBF potential	CBF can enhance transparency, support cross-programme comparisons, and guide resource allocation.	We propose application of CBF for key decision-making situations. We plan to carry out cross-case analysis with the intervention studies implemented in different countries.
Barriers	Concerns around time, capacity and institutional/cultural readiness to adopt new evaluation approaches.	CBF implementation will be gradual and context-sensitive with stakeholder involvement. Policy briefs, engagements with the related stakeholders to introduce and further refine CBF will continue throughout the project.
Suggestions	Clear cost-benefit parameters, tools for data collection and prioritization, and standardized evaluation procedures are needed.	We present clearly defined cost-benefit categories (as provided in the glossary), checklists, practical guidelines for data collection and analysis, reflection tools for trade-offs, systematic evaluation process and case studies as real life examples.

In this Deliverable, therefore, we present a refined, user-oriented version of the Cost–Benefit Framework with clearly defined cost-benefit categories (as provided in the glossary in Appendix 2), checklists, practical guidelines for data collection and analysis, reflection tools for trade-offs, systematic evaluation process and case studies as real life examples. Moving forward, **our aim is to further refine and validate the CBF as a boundary object**—a shared tool that facilitates informed decision-making on the effectiveness and efficiency of teacher training across different contexts.

7.4 Implications

Findings from the case studies, together with stakeholder feedback, point to implications for enhancing teacher training on PDC and improving the CBF itself which are outlined below:

Policy implications for PDC training:

➔ **Tailor training in line with national policy priorities.**

The favourable policy orientation towards digital developments could have a positive impact on school leaders' and teachers' attitudes and their uptake of training. All the cases are explicitly linked to national educational policy reforms such as digitalisation, AI and inclusion. Teacher professional development initiatives should address long-term policy objectives.

➔ **Align training design with local realities.**

The three pilot cases clearly demonstrate that effective teacher training cannot rely on a one-size-fits-all approach. The diversity of teacher profiles, institutional/school development stages, and national education contexts calls for training models that are flexible, responsive, and context-sensitive. In Austria, for example, alignment with individual school development plans was essential for effectiveness. In Estonia, tailoring to participants' prior knowledge and learning profiles (e.g., self-regulation skills, autonomy) emerged as a key success factor. Therefore, training models that address both institutional and individual needs should be prioritised for equitable and expected outcomes.

➔ **Consider training duration.**

Longer-duration training interventions have proven more effective in supporting sustained changes in teaching practices. In Austria, where the training was relatively short, positive outcomes were observed in reactions such as training quality, but limited change in intended adoption. This highlights the importance of incorporating follow-up sessions to support ongoing implementation. Since we have collected cost information, with the help of the CBF, it is now possible to estimate the additional costs that an extension of the training would entail. In contrast, the longer interventions in Estonia and Israel revealed more meaningful improvements in areas such as teachers' knowledge, attitudes, and intentions to adopt new practices. These findings underscore the importance of sustained training for translating the knowledge into practice.

➔ **Make strategic use of training methods.**

Combining diverse training methods can enhance relevance, overly complex approaches may reduce effectiveness if they exceed participants' cognitive capacity. Findings show that effective teacher training programmes often integrate key practices of different training methods (e.g. KI+SL, KI+CD, KI+CD+SL). For example, KI+CD model showed broader pedagogical value compared to KI only in the Israeli case. On the other hand, as for Estonia, although the KI+CD+SL format was seen as more relevant and engaging than KI+CD, its complexity placed greater cognitive demands on participants, which could hinder effectiveness for some participants. In Israel, the KI+CD model showed greater pedagogical value than KI alone. In Estonia, the KI+CD+SL approach was seen as more engaging and relevant than KI+CD, but the added complexity placed higher cognitive demands on participants, which reduced its effectiveness for some. These findings suggest that while combining methods can strengthen training, the design must be carefully adapted to participants' needs and capacities. Therefore, integrating different training methods needs to be carefully designed and well-supported.

➔ **Consider embedding inclusion awareness and SRL in teacher training.**

The case study findings (e.g. TLU) suggest that training programmes which explicitly address inclusion and embed SRL support not only strengthen teachers' professional competencies but also create more equitable learning environments for students. By fostering teachers' capacity to recognize diverse learner needs and manage their own learning effectively, programmes can enhance the transfer of training into classroom practice and ensure that digital competence development benefits all students, including those at risk of exclusion.

➔ **Improve efficiency through delivery format.**

Blended and online formats increase scalability and reduce costs, but must ensure interactivity and relevance to the needs of teachers to remain effective. Blended learning formats, as concluded in the Austrian case, can reduce logistical costs while still maintaining engagement. Stakeholders were in agreement that the training should be conducted face-to-face in most parts to preserve its special character of integration in the school. Fully online models, such as those used in Israel, especially when supported by tools like chatbots, can further expand reach and scalability. However, digital delivery should be carefully designed including sufficient interactivity and collaboration not to compromise the effectiveness.

Implications for further refinement of the CBF:

➔ **Use the CBF for evidence-informed decision-making for teacher training programmes.**

The CBF is a practical tool for improving the planning and evaluation of teacher training. The case studies demonstrate the practical value of the CBF in linking programme outcomes to their costs and identifying trade-offs, based on the discussions held with the training institutions and policy-makers on the case studies. It provides a structured approach to support decisions about programme design, continuation or scaling. Facilitating future planning with the estimations of the additional costs and achievement of the goals in connection with the expected outcomes in specific contexts, CBF promotes informed-decision making for TPD programmes. During the pilot phase, the CBF also served as a common reference across diverse national contexts which demonstrates its potential to foster shared understanding and collaboration among education stakeholders.

➔ **Align training methods across contexts to support comparability and shared learning.**

Training methods were implemented differently across pilot countries, indicating the need to adapt and align for the follow-up interventions to improve comparability and cross-country learning. Coordinated adjustments in follow-up interventions would enhance the ability to draw insights across contexts.

➔ **Strengthen the inclusion and equity dimension of the CBF.**

While the current CBF and case studies focused primarily on teacher-level outcomes, dimensions of inclusion and equity—particularly impacts on diverse student groups—remain underexplored. In the upcoming intervention studies, inclusion-related variables and student-level data will be integrated to enable a more comprehensive analysis of how training programmes support equitable and sustainable outcomes. Future refinements of the framework should therefore explicitly address these dimensions.

➔ **Adapt the CBF to reflect diverse cost structures and policy contexts.**

Significant variation in financial planning—especially in capturing indirect costs—indicates the need for a flexible CBF that can be adapted to different institutional and policy contexts. Direct costs were generally easier to identify, but indirect costs varied widely depending on training structures and delivery models. A

modular, context-sensitive CBF would allow better more accurate reflection of cost–benefit dynamics at school, provider, and system levels.

8. Conclusion and outlook

The current report presents a refined Cost–Benefit Framework following its initial piloting. In the first version (Wagner et al., 2024b), t**he CBF's core components** - training **programme elements, background variables**, **costs** and **benefits** - were introduced. We then tested the framework through pilot studies in partner countries and developed **case studies** in the contexts of Austria, Estonia, and Israel to illustrate its application in real-world settings. These case studies also formed the basis for **policy engagement** events with relevant stakeholders enabling us to gather valuable feedback on the framework's relevance and usability. In these engagements, while stakeholders recognised the CBF's potential to enhance transparency, enable comparisons across programmes and inform resource allocation, they also expressed concerns about the time, capacity, and institutional readiness required to adopt such an evaluation tool.

Building on the lessons learned from these pilots and stakeholder insights, in this deliverable, we provide **a step-by-step guide to making informed decisions** using the CBF. The process involves: (1) identifying policy priorities and contextual factors; (2) determining goals; (3) defining training programme elements; (4) collecting and analysing data on costs, benefits, and background variables; and (5) evaluation and decision-making. The included case studies follow these steps, offering concrete examples of how the CBF can be applied to **balance effectiveness, efficiency and scalability.** Altogether, these demonstrate how the CBF can serve as a practical, adaptable tool for guiding strategic decisions in teacher training.

However, the current findings are based on pilot data collected at the teacher level and rely largely on quantitative measures. Policy engagement activities were conducted in Austria, and further validation is needed across other partner countries. Looking ahead, we will broaden our scope by conducting case studies based on intervention studies and policy engagements in different countries, integrating more diverse contexts and methods. Our goal is to deliver **a final, validated cost benefit framework as a boundary object**, accompanied by a practical toolkit that can be applied internationally to assess the effectiveness and efficiency of teacher training programmes.

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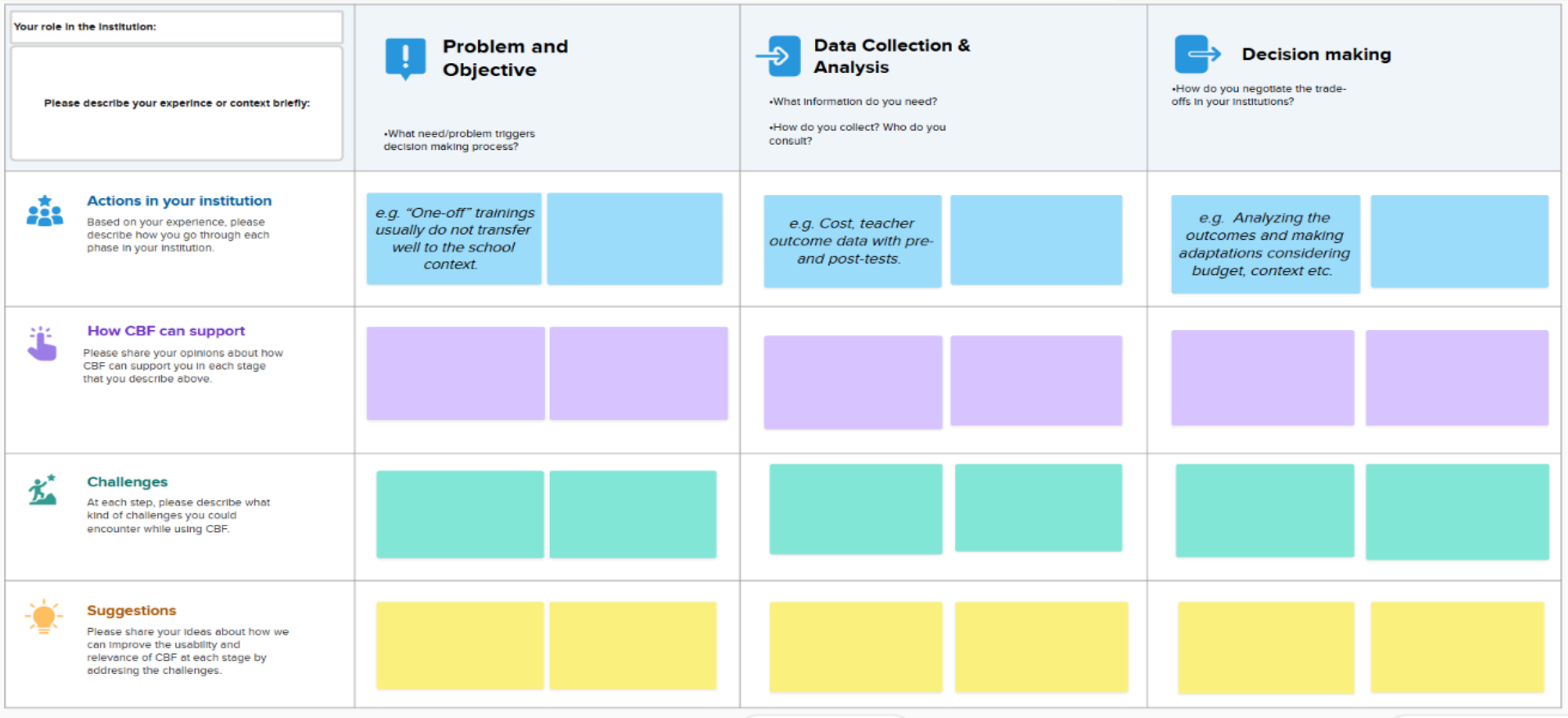
Appendix

1. Stakeholder Journey Mapping Exercise



2. Cost-Benefit Framework Glossary

The Cost-Benefit Framework (CBF) consists of four main components which are namely 1) training programme elements, 2) background variables, 3) costs and 4) benefits. In this section, you could find the sub-categories of each component along with their definitions.

1. Training programme elements

TERM	**DEFINITION**
1. Delivery mode: format used to conduct the training sessions	
Face-to-face instruction	Content is delivered in the same classroom with the requirement of the presence of both the teacher and student.[3]
Online instruction	Online instruction refers to the way that content is delivered completely over the internet.[4]
Blended instruction	Blended instruction is the effective integration of online communication technology and face-to-face teaching context.[5]
Hybrid instruction	Hybrid courses are taught synchronously in person and online.[6]
2. Interaction mode: format through which communication and collaboration occur between individuals in a training	
Synchronous interaction	Synchronous interaction in online settings is real-time communication where spatially separated individuals are online at the same time and receive instantaneous feedback from each other. It is normally achieved via real-time

[3] Wang & Wang (2021, p. 267)
[4] Wang & Wang (2021, p. 267)
[5] Wang & Wang (2021, p. 267)
[6] Raes et al. (2020, p. 269)

	computer-mediated communication technologies, such as online video/audio meetings, instant messaging or chat.[7]
Asynchronous interaction	Asynchronous interaction in online settings is delayed communication that happens at different times. It is normally achieved through text-based computer-mediated communication technologies such as online forums, e-mails, and web pages.[8]
3. Duration of the training: length of the training	
Duration of training in academic hours	Continuous variable
Half day	Training that only lasts one morning or afternoon
One day („one-shot-workshop")	Training that only takes place one day
Several weeks	Training that takes place several weeks
One semester	Training that is happening over one semester
One year	Training that is happening over one year
4. Size of the group: number of training participants	
Group size	Continuous variable
Individual mentoring	1:1 relationship between a mentor and a mentee
Group mentoring	One mentor guiding multiple mentees simultaneously
Teacher design teams	Groups of teachers (2-4 in one group)[9]

[7] Wang & Wang (2021, p. 268)
[8] Wang & Wang (2021, p. 268)
[9] See for example Koh et al. (2017)

Small group	10 – 30 participants
Bigger group	31 – 100 participants
Large group	More than 100 participants
5. Target group	
Pre-service teachers	Individuals who are in the process of receiving their education and training to become teachers, but have not yet begun full-time teaching as a profession
In-service teachers	Individuals who are currently employed as teachers, they have completed their initial training
Train-the-trainer	Training a group of teachers who afterwards train a new group of teachers
Alternatively-certified teachers	Individuals who have become qualified to teach through non-traditional teacher education programmes
Student teachers	Individuals who are engaged in part-time work in a school setting while enrolled in a teacher education programme[10]
6. Content of the training	
Technological knowledge (TK)	Training that focuses on teachers' technological knowledge. Teachers learn how to operate hardware and software commonly used in educational settings.[11]
Technological pedagogical knowledge (TPK)	Training that involves the intersection of technological knowledge and pedagogical knowledge. Teachers learn how to integrate technology to enhance teaching and learning

[10] Meyer et al. (2024)
[11] Mishra & Koehler (2006, p. 1027)

	practices in general (not related to a particular school subject).[12]
Technological pedagogical content knowledge (TPCK)	Training that involves the intersection of technological, pedagogical and content knowledge. Teachers learn how to integrate technology to enhance teaching and learning practices in a particular subject (e.g. Maths).[13]
7. Modelling of Self-Regulated Learning (SRL) in the Training: refers to the incorporation and demonstration of self-regulated learning strategies within the training programme.	
Direct instruction	Self-regulation strategies are explicitly trained and discussed with their functions for learning. Mostly, the strategies are trained with rather artificial learning material which is not part of the content to be learned.
Indirect instruction	Self-regulation strategies are enabled by providing content-related tasks in which those strategies need to be applied. The strategies are therefore embedded in the content to be learned. They are not necessarily obvious or explicitly mentioned or discussed.
8. Modelling of ICAP in the Training: refers to the integration and demonstration of the ICAP (Interactive, Constructive, Active and Passive) framework[14] within training programmes.	
Interactive learning activities	Learners work together, build on each other's ideas and co-construct new knowledge (e.g. think-pair-share, debating).

[12] Mishra & Koehler (2006, p. 1028)
[13] Mishra & Koehler (2006, p. 1028-1029)
[14] Chi & Wylie (2014)

Constructive learning activities	Learners generate new knowledge by combining content in new ways of expression that are not verbatim from the class (e.g. synthesising, predicting).
Active learning activities	Learners manipulate the given content/curricular materials (e.g. copying verbatim notes, answering questions with wording from a text).
Passive learning activities	Learners pay attention and receive information, without doing anything else with the information, as is typical in lecture classes.
9. **Modelling of DigCompEdu:** refers to the application of key areas of competence determined in DigCompEdu framework for designing interventions. Teacher training grounded in DigCompEdu ensures teachers not only build their own digital competence but also transfer these skills to their students.	
Professional engagement	Using digital technologies for professional interactions, collaboration, and continuous development. (e.g. 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. (e.g. 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. (e.g. 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. (e.g. introducing tools like Google Forms or Quizalize for formative and summative assessments.)

Empowering learners	Using technology to address learners' needs, fostering autonomy and engagement. (e.g. 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.
10. Training methods: Building on the literature on effective teacher training, we propose four different training methods in the EffecTive project, which will be combined in studies to investigate the effectiveness of teacher training.	
Knowledge instruction and training (e.g. technological pedagogical knowledge)	Training method that fosters teachers' learning through promoting active engagement in new materials, discussions, asking questions, and activating prior knowledge to impart specific knowledge and skills. Example: a lecture on SRL strategies in a technology-enhanced environment and individual exercises.
Collaborative design	Training method that fosters a collaborative learning process in which teachers and trainers work together to create a shared understanding of teaching practices, theories, and methods, which results in new artefacts. This training method emphasises the active participation of teachers and recognises that knowledge is not just transferred from trainer to trainee but is constructed through a collective process. Example: collaborative design of lesson plan on supporting students' SRL in a group of teachers

Situated learning	Training method where teachers are supported to (iteratively) design new practices based on methodological and theoretical principles, apply new practices in their classrooms to understand their effect on students' learning, systematically reflect on their own teaching experiences and improve the design. Example: design of lesson plans, implementation in own context, reflection, refinement of the lesson plan
Mentoring/Coaching (the two terms are used interchangeably)	Training method where one-to-one relationships are formed to focus on the diverse objectives and needs of individual teachers[15]. The support can be offered by teacher trainers, educational researchers, or in-service teachers for pre-service teachers. Example: Coach supports the teacher in preparing the lesson on applying SRL strategies, observes teacher practice and then provides feedback.

Those training methods, in turn, may consist of different key practices, which are further specified in the table below.

Training method	**Key practices**	**Definition**
Knowledge instruction and training	Instruction	Teachers learn through the provision of directive advice on how to implement teaching methods.[16]
	Hands-on learning	Teachers learn through a process of experiences that holistically allow them to interact with their environment (e.g. technologies) to create knowledge.[17]

[15] European Commission (2022)
[16] Sims et al. (2023, p. 8)
[17] Wilson et al. (2020, p. 4)

	Work sample analysis	Teachers critique or review practitioner-created materials (e.g. lesson plans) or enacted lessons (e.g. via video analysis) that involve technology-integrated lessons.[18]
	Practice lesson planning	Teachers plan a simulated technology-integrated lesson individually.
Collaborative design	Shared understanding	Teachers have a common understanding about the design goals, target group, and role of learning technologies to ensure that everyone is aligned on what needs to be designed.
	Activating background knowledge	Teachers have a solid understanding of the subject matter or instructional content they are designing for.
	Analysing case studies and examples	Teachers analyse case studies or examples of successful technology-integrated lessons and instructional designs to understand effective practices and innovative strategies, while providing inspiration for their own collaborative design efforts.
	Design sessions	Teachers collaboratively plan and develop technology-integrated lessons in groups.

[18] Wilson et al. (2020, p. 4)

	Implementation planning	Teachers devise strategies for applying the designed materials in the classroom and receive guidance on adapting the designs to different classroom environments.
Situated learning	Goal setting	Teachers set specific goals for the improvement of their technology integration practices. These goals should focus on students' needs, particularly when making decisions related to classroom implementation. [19]
	Action planning	Action planning involves specifying when and how a change in practice will be made in a future lesson.[20]
	Practice lesson planning	Teachers plan technology-integrated lessons for their own context.
	Rehearsal/field experience	Teachers implement technology-integrated lessons in their own context with actual students.[21]
	Reflection/self-evaluation	Teachers systematically reflect on and/or self-evaluate their technology integration practices.[22]
	Practical social support	Practical social support involves arranging advice on how to implement

[19] Wilson et al. (2020, p. 4)
[20] Sims et al. (2023, p. 8)
[21] Wilson (2023, p. 260)
[22] Wilson et al. (2020, p. 4)

		a practice from a teacher's colleagues.[23]
Mentoring/Coaching	Modelling	Modelling involves providing an observable example of the target teaching practice, which provides a visual guide for subsequent practice.[24]
	Observation	Teachers can watch another teacher effectively integrate technology in the classroom.[25]
	Practice lesson planning	Teachers plan technology-integrated lessons for their own context.
	Continuous, individualised feedback	Feedback is the provision of evaluative guidance based on prior observation of the focal practice. It works by identifying and then advising on areas for improvement.[26]

2. Background variables

TERM	**DEFINITION**
1. Teacher Background Variables	
Sex	Biological characteristics of teachers
Gender	Socially constructed roles, behaviours, expressions and identities of teachers

[23] Sims et al. (2023, p. 8)
[24] Sims et al. (2023, p. 8)
[25] Wilson et al. (2020, p. 4)
[26] Sims et al. (2023, p. 8)

Age	Chronological age of teachers
Mother tongue	The language a person has learned from birth
Education	Teacher qualification yes/no
Level of Education	BA, MA, PhD
Trained subjects	Specific academic disciplines or subject areas in which teachers have received formal education and training, determining the areas of their expertise and the subjects they are qualified to teach
Teacher salary	The amount of money paid to teachers for their work in teaching and instructing students
Training participation status	Voluntary participation (teachers choose to attend the training of their own accord) vs. mandatory training (teachers are required to attend the training as part of their professional development)
Working experience	Duration of a teacher's professional teaching career
Migration background and ethnicity	The country of origin of the teacher (if different from the country of residence) and the teacher stated ethnic affiliation.
Prior professional development courses taken	Training opportunities that teachers have undergone before engaging in the current teacher training programme
2. Student Background Variables	
Sex	Biological characteristics of student
Gender	Socially constructed roles, behaviours, expressions and identities of students

Age	Chronological age of students
Socio-economic background (student-reported)	Economic, social and cultural status (ESCS) of a student[27] (index used in PISA, includes the indicators parental education, highest parental occupation and household possessions including books at home).
Migration background and ethnicity	The country of origin of the student (if different from the country of residence) and the student stated ethnic affiliation.
3. School Context	
Level of education	Primary or secondary education
School size	Number of students enrolled in a school
Teacher staffing	Number of teachers employed or teaching at the school
Type of school	Public schools (government-funded and operated, free to attend for local residents, must adhere to state-mandated curriculum and standards) vs. private schools (independently funded through tuition or donations, operated by private organisations or religious institutions, have the flexibility to create their own curriculum)
School location	Geographical setting of the school: urban vs. suburban vs. rural
Technology availability	Access to digital devices (computers, tablets…) and internet connectivity
Learning management system	Presence and usage of digital platforms for instructional delivery
Technical support	Availability of IT support staff and resources

[27] Avvisati (2020)

School leadership	Refers to the process of influence exercised by school headmasters based on clear values and beliefs, leading to a vision for the school. It encompasses the behaviours and practices headmasters use to shape the school's organisation, culture, norms and practices, thereby impacting teaching and learning.[28]
Headmaster's support	Refers to the extent of a headmaster's involvement in and encouragement of integrating digital technology within a school. It includes the headmaster's visible and active support for digital initiatives, their responsiveness to innovative ideas from staff, and their awareness of how digital tools are utilised in teaching practices.[29]
Teachers' informal collaboration	Refers to the degree to which teachers engage in spontaneous and voluntary cooperation with each other regarding the use of digital technology in teaching. It includes activities such as jointly preparing technology-supported lessons, sharing and discussing experiences and good practices related to digital teaching and staying informed about the digital initiatives within and outside their school.[30]
Teachers' formal collaboration	Refers to the extent of structured and organised cooperative activities among teachers concerning the use of educational technology. It includes participation in events such as conferences, presentations and poster sessions where teachers share their technological practices, school-wide information sessions on educational technology, and interactions with external partners through invited lectures or excursions.[31]

[28] Kemethofer et al. (2023), Tammets et al. (2024)
[29] Petko et al. (2018)
[30] Petko et al. (2018)
[31] Petko et al. (2018)

Importance of digital technology in school	Refers to the priority and emphasis placed on digital technology within a school. It includes the perceived significance of topics such as computers and the internet, the encouragement for teachers to participate in professional development activities related to ICT and the value placed on active engagement with digital technologies by teacher colleagues.[32]
4. Classroom Context	
Grade level	The specific year or level of education that students are enrolled in within a formal educational system (e.g. 5th grade)
Class size	Number of students in a class
Number of teachers	Number of teachers in a class
Inclusion of special education needs (SEN) students	Yes/no
Degree of diversity	The extent to which a variety of student backgrounds, experiences and perspectives are represented and integrated within the classroom. It encompasses factors such as cultural, ethnic, linguistic, socio-economic and ability diversity.

3. Costs

TERM		Definition
1. Infrastructure costs: Costs associated with establishing, maintaining and upgrading the physical, technological and administration infrastructure to support the operations and activities of a teacher training programme		

[32] Petko et al. (2018)

TERM		Definition
(1.1) Technological and physical infrastructure costs (fixed costs)	*Hardware costs*	Personal computers
		Projectors
		Sound systems
		Specific equipment (e.g. virtual reality headsets, simulation tools)
		Servers
		Peripheral equipment (e.g. printers, smart boards, additional accessories)
	Network, software and cloud services	Internet services
		Cloud computing services
		Learning management system (LMS) software licenses or subscription fees
		Dedicated software/environment tailored to training needs
		Server maintenance (regular maintenance schedules, writing running programmes,

TERM		Definition
		compatibility interfaces between the platform and university systems)
		Video conferencing software (e.g. ZOOM)
		Accessibility tools (i.e. assistive technologies for people with disabilities)
	Physical infrastructure	Class (room)
		Libraries services (resource needs, digital access)
(1.2) Training administration infrastructure costs (Variable costs - changes according to number of courses/students)	*Support centre - Help desk services*	Pedagogical support for trainers
		Didactic consulting (i.e. costs associated with providing advice, guidance and support to trainers involved in delivering the training programmes)
		Initial support for trainers (onboarding)
		Professional development workshops for trainers
		Ongoing technical support

TERM		Definition
		Mentoring
		[Online] forums
		Instructional Manuals (Development, printing costs)
	Course management, administrators	Certificates and supplements (i.e. all expenses associated with the issuance and management of certificates and their supplements provided upon completion of the teacher training programme)
		Management office (i.e. costs associated with the managerial functions necessary for overseeing and coordinating the overall operation of the training institution)
		Secretary office (i.e. costs associated with the administrative support provided by secretarial staff to the management office of a training institution)
		Study programme coordination (i.e. costs associated with the management, development and oversight of a specific academic programme or curriculum)
		LMS supervision (i.e. costs associated with overseeing and managing the operation, maintenance and support of the learning management system used within an educational institution)

TERM		Definition
		Marketing - Promotion/ Distribution Processes – Campus Exposure (i.e. costs associated with promoting and advertising the training programmes to attract participants)
	Miscellaneous costs	Miscellaneous (e.g. expenses for print digital items)
2. Pedagogical/Instruction Costs: Expenses directly related to the preparation and delivery of instructional activities within a teacher training programme		
(2.1) Course development and preparation (Fixed costs)	Curriculum development - course design planning (including the evaluation process)	Planning and designing training courses, including defining learning objectives, structuring content and activities, and integrating evaluation mechanisms.
	Development of learning materials	Local development / (digital) adaptation of learning materials (i.e. adaptation and development of learning materials to suit the local context or to be delivered in digital formats)
		Purchase of learning materials (e.g. physical textbooks, digital resources or other instructional aids)
		Self-developed educational resources such as handouts, textbooks and educational resources (physical or digital)

TERM		Definition
	Media production	Media production (i.e. cCosts associated with creating audiovisual content such as videos, animations, presentations and other multimedia materials used within a training programme)
(2.2) Course delivery costs (Variable costs)	*Instructional costs*	Trainer personal costs (i.e. all expenses related to compensating the trainers who deliver the teacher training programme including salaries, benefits and other expenses associated with the trainers' involvement in the programme).
		Teacher assistant personal costs (i.e. all expenses related to compensating teacher assistants who support the primary trainers in delivering the teacher training programme including salary, benefits and other expenses)
		Teaching/learning time for trainers (i.e. all expenses related to the time trainers spend both teaching and preparing to teach the teacher training programme. It covers the time trainers dedicate to delivering instruction, as well as the time required for lesson planning, material preparation, and ongoing professional development)
		Teaching/learning time for teachers as participants of the training (i.e. time teachers spend in training rather than teaching[33], expenses

[33] Levin & McEwan, (2001)

TERM		Definition
		related to the substitution during teacher`s absence
		Student interaction time (i.e. all expenses related to the time trainers spend interacting with students outside of formal instructional hours through online platforms such as bulletin boards, newsgroups, forums, and other digital communication tools)
		Support staff (i.e. all expenses related to compensating support staff, such as student helpers, who assist in the delivery and management of the teacher training programme. These individuals provide various forms of support, including administrative assistance, technical help, and logistical coordination).
		Learning evaluation tools (i.e. all expenses related to the development, implementation, and use of learning evaluation tools designed to assess the effectiveness and impact of the teacher training programme on participants' learning outcomes. These tools include surveys, assessments, tracking systems, and other methods used to gather feedback, measure progress, and evaluate the attainment of learning objectives)

TERM		Definition
	Travel and accommodation costs	Transportation costs for trainers and, in some cases, for teachers (e.g. trains, local transport)
		Hotel or lodging expenses for trainers or teachers from out of town
		Expenses for meals, refreshments, snacks and other food-related costs incurred while attending training activities
	Learning/ instruction management	Learning assessment process management time (i.e. all expenses related to managing the learning assessment process within the teacher training programme. It includes the time and resources dedicated to tracking, evaluating performance through tasks and tests, and managing the accumulation and dissemination of knowledge. This process involves overseeing assessments, analysing results, and ensuring that assessment data informs instructional strategies and curriculum development)
		Working time with external entities (collaboration with external partners, e.g. guest lecturer)
		Management costs (i.e. all expenses associated with the day-to-day management and administration of the teacher training programme)

TERM		Definition
	Course evaluation and quality assurance	Course evaluation tools e.g. surveys, tracking systems (i.e. costs associated with assessing and measuring the effectiveness, impact and outcomes of a teacher training programme)
		Course assessment time (i.e. dedicated effort in evaluating the effectiveness, quality, and outcomes of the teacher training courses)
		Instruction quality questionnaire (development, distribution, analysis) Quality Surveys (Development, distribution, analysis)
		Future planning (i.e. activities and resources allocated for strategic sessions and follow-up actions that occur after the assessment phase of teacher training courses. These sessions and actions focus on analysing assessment outcomes, setting future goals, implementing improvements, and ensuring continuous quality enhancement in the training programme)

4. Benefits

TERM	DEFINITION
Level 0: Participation (Teacher Level)	
Attendance to the training	Refers to the initial participation, whether teachers registered for the training and showed up at the beginning.

Completion of the training	Refers to the commitment of the teachers, whether they stayed throughout the whole programme.
Level 1: Reactions (Teacher Level)	
High satisfaction with the training	Refers to teachers' overall contentment with the teacher training programme. It includes teachers' enjoyment, perceived usefulness and perceived difficulty of the training.[34]
High training quality	Refers to teachers' evaluation of the effectiveness, engagement, and coherence of the training programme. This category encompasses aspects such as cognitive activation, collaboration among participants, clarity and structure and practical relevance[35].
Positive attitude towards training[36]	Refers to teachers' favourable perceptions, beliefs and emotional responses towards the teacher training programme.
Level 2: Learning and Attitudes (Teacher Level)	
Increased knowledge	Refers to teachers' increase in knowledge, understanding and skills acquired as a result of participating in the teacher training programme.
Positive attitudes towards digital learning	Refer to the favourable beliefs that teachers hold regarding the use and effectiveness of digital technologies in teaching and learning processes.
Increased readiness for technology integration	Refers to teachers' willingness to integrate digital technologies in their classroom

[34] Ritzmann et al. (2014)
[35] Richter & Richter (2024)
[36] Ritzmann et al. (2014)

Increased motivation to apply knowledge and skills	Refers to teachers' increased determination to implement the knowledge and skills acquired in the training into their professional practice. It encompasses teachers' expectancy for success, task value and perceived costs.[37]
Positive beliefs and increased knowledge of SRL	Refer to teachers' improved understanding and perceptions of self-regulated learning (SRL)
Increased self-efficacy	Refers to the strengthening of teachers' beliefs in their ability to teach effectively.
Improved pedagogical digital competence (PDC)	Refers to the 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), their cultural awareness and abilities to promote equity in a specific learning situation[38]
Improved TPACK	Refers to the enhancement of teachers' Technological Pedagogical Content Knowledge (TPACK), which is a framework that conceptualises the knowledge required by teachers for effective technology integration in their teaching practices. These include Technological Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK) and their intersections: e.g., TK, TPK, TPCK.[39]
Improved situation-specific skills (in training situations)	Refers to the enhancement of teachers' situation-specific skills in training, which include perception, interpretation and

[37] Osman & Warner (2020)
[38] Blömeke et al. (2015), Roth et al. (2023), Skantz-Åberg et al. (2022)
[39] Mishra (2019)

	decision-making based on the PID-model by Blömeke et al. (2015).
Improved cultural awareness (e.g. awareness of how to effectively engage in diverse classrooms; awareness of social background-mediated learning)	Refers to the social and cultural component of teachers' professionalism that enables teachers to improve equity and inclusion and mitigate digital divides in technology-enhanced classrooms. Cultural awareness has an overlap with SRL, situation-specific skills and other social-emotional skills of teachers but has some distinguishable components to foster equity and inclusion.
Level 3: Changes in Behaviour (Teacher Level)	
Higher intended adoption of technology-enhanced learning methods	Refers to teachers' likelihood that the innovative teaching and learning practices will be adopted by the teachers in their classroom after the end of the training[40]
Improved performance	Refers to teachers' improved performance, i.e. their observed behaviour including planning, implementation and evaluation of teaching[41]
Improved situation-specific skills (in own professional context)	Refers to the enhancement of teachers' situation-specific skills, which include perception, interpretation and decision-making based on the PID-model by Blömeke et al. (2015).
Improved technology integration practices	Refer to teachers' improved methods and strategies used to integrate technology in the classroom (e.g. based on the ICAP framework[42])

[40] Ley et al. (2021)
[41] Roth et al. (2023)
[42] Chi & Wylie (2014)

Level 4: Results at the Organisational Level (Student Level)	
Improved SRL skills	Students' improved abilities to self-regulate their learning, involving skills like goal-setting, self-monitoring, time management and self-assessment
Improved subject-specific skills	Students' improved competences and knowledge in a particular academic subject (e.g. Maths)
Improved digital competence	Students' improved ability to effectively and responsibly use digital technology and tools for communication, information search and processing, content creation, problem-solving and critical thinking in the digital world (DigComp 2.2 framework[43])
Increased subject-specific interest	Students' increased enthusiasm and curiosity in a particular academic subject (e.g. Maths), which drives their engagement and motivation to learn and explore more in that specific field
Inclusion (measured as students' sense of belonging to the classroom)	Students' feeling of being welcomed, valued and respected within the classroom environment is influencing student outcomes, especially in technology-enhanced classrooms.
Equity (measured as heterogeneous effects of PDC on student outcomes)	Equity in educational outcomes refers to the low level of educational inequality, i.e. the relationship between student outcomes and family background (or other social-demographic measures such as immigrant background, gender). We expect the increased PDC to improve equity (i.e. to diminish the link between outcome and background).

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