Methodology for the evaluation of educational impact

Date: 30 December 2024

Co-funded by the European Union

Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Grant Agreement nº	101087451
Project acronym	AI4EDU
Project title	Conversational AI assistant for teaching and learning
Funding Scheme	ERASMUS-EDU-2022-PI-FORWARD
Project Duration	01/01/2023 – 31/12/2025 (36 months)
Coordinator	Athina-Erevnitiko Kentro Kainotomias Stis Technologies Tis Pliroforias, Ton epikoinonion Kai Tis Gnosis (ARC)
Associated Beneficiaries	▪ LULEA TEKNISKA UNIVERSITET (LTU) ▪ ELLINOGERMANIKI AGOGI SCHOLI PANAGEA SAVVA AE (EA) ▪ PAIDAGOGIKO INSTITOUTO KYPROU (CPI) ▪ UNIVERSITY OF CYPRUS (UCY) ▪ MANAGEMENT COMMITTEE OF DRUMCONDRA EDUCATION CENTRE (DEC)

Document identifier: D6.1
Version: 3.0
Authors: Theodoros Karafyllidis & Marios Papaevripidou (UCY)
Dissemination status: PU - Public
Reviewers: Viktor Gardelli (LTU), Spyridoula Stamouli (ARC)

Co-funded by the European Union

Project no. 101087451
AI4EDU

Conversational AI assistant for teaching and learning

ERASMUS-EDU-2022-PI-FORWARD

Start date of project: 01/01/2023

Duration: 36 months

History Chart				
Issue	**Date**	**Changed page(s)**	**Cause of change**	**Implemented by**
0.1	01.10.2024	Initial draft version with table of contents	Draft	Theodoros Karafyllidis
0.2	17.10.2024	Evaluation methodology overview	Draft	Theodoros Karafyllidis
1.0	15.12.2024	ALL	Additions	Theodoros Karafyllidis & Marios Papaevripidou
2.0	23.12.2024	ALL	Revisions	All Authors and reviewers
3.0	30.12.2024	ALL	Final editing	Theodoros Karafyllidis

Validation			
No.	**Action**	**Beneficiary**	**Date**
1	Prepared	Theodoros Karafyllidis (UCY)	15.12.2024
2	Approved	Viktor Gardelli (LTU), Spyridoula Stamouli (ARC) LTU	23.12.2024
3	Released	Theodoros Karafyllidis (UCY), Marios Papaevripidou (UCY), Spyridoula Stamouli (ARC)	30.12.2024

Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Table of Contents

Executive Summary

This deliverable presents a structured framework for assessing the educational impact of the AI4EDU applications: Study Buddy (SB) and Teacher Mate (TM). These AI-powered tools are designed to enhance teaching and learning by supporting students in self-directed study and assisting teachers in their instructional practices.

The evaluation methodology is rooted in contemporary learning theories, including Constructivist Learning Theory, Self-Determination Theory, and Cognitive Load Theory. These frameworks ensure that the design, implementation, and assessment of the AI4EDU applications align with best practices in education.

The evaluation adopts a mixed-methods experimental design and is organized into three key phases:

Pre-Implementation Phase: This phase focuses on teacher recruitment and training, baseline data collection, and preparing participants for the integration of the AI applications. Teachers will be equipped with the necessary skills to use Teacher Mate, while students in the experimental group will be introduced to Study Buddy's functionalities.

Implementation Phase: During this phase, the AI applications will be deployed in real classroom settings across four European countries - Cyprus, Greece, Ireland, and Sweden. Teachers will engage with Teacher Mate to support their teaching practices, while students in the experimental group will use Study Buddy for self-study. The control group will rely on traditional study practices. Data collection through surveys, tests, and usage logs will capture the impact of the applications on teaching and learning outcomes.

Post-Implementation Phase: focuses on analyzing the collected data using both quantitative and qualitative methods. The findings will be synthesized to identify trends, challenges, and opportunities, offering actionable recommendations for future use and scalability of the applications.

Key evaluation instruments include pre- and post-implementation academic performance tests, motivation and engagement surveys, teacher interviews, and observation protocols. These tools are designed to measure various educational outcomes, including student engagement, motivation, and academic performance, as well as teacher efficiency and instructional practices.

The findings from this evaluation will inform best practices, implementation strategies, and policy recommendations for integrating AI tools in education. By emphasizing ethical considerations, user-centric design, and real-world applicability, the deliverable ensures that the AI4EDU applications can effectively address diverse educational needs while promoting equitable and transparent AI use.

Acronyms and abbreviations

Abbreviation	Description
AI	Artificial Intelligence
AI4EDU	Artificial Intelligence for Education (project short name)
MES	Motivation & Engagement Survey
SCL	Student-Centered Learning
SDT	Self-Determination Theory
SB	Study Buddy
TM	Teacher Mate
WPs	Work Packages

1. Introduction

1.1. Project Background

The Conversational AI assistant for teaching and learning - AI4EDU project aims to enhance educational outcomes by integrating Artificial Intelligence (AI)-powered applications in real-world classroom settings. Its vision is to establish a pedagogical framework that guides the design, implementation, and evaluation of AI applications for teaching and learning. The project focuses on developing two key AI-driven applications: Study Buddy (SB), a conversational assistant for students, and Teacher Mate (TM), a platform designed to support teachers with instruction, assessment, and student monitoring. These applications are developed through iterative cycles of adaptation, testing, and refinement, driven by user requirements and feedback from both students and teachers.

The project methodology emphasizes ethical deployment, user-centered design, and continuous evaluation in diverse educational contexts across Europe. Pilot studies conducted in four countries (Cyprus, Greece, Ireland, and Sweden) assess both the usability and acceptance of these AI applications and their impact on teaching and learning outcomes. The results will inform best practices, implementation guidelines, and policy recommendations to ensure equitable, transparent, and effective use of AI in education.

1.2. Deliverable's Purpose

This deliverable outlines the evaluation methodology and implementation plan for assessing the educational impact of the AI4EDU applications. Specifically, it focuses on the development and implementation of a comprehensive evaluation framework to pilot Study Buddy and Teacher Mate in real educational settings across four European countries: Cyprus, Greece, Ireland, and Sweden.

The document begins with an overview of the theoretical framework underpinning the evaluation methodology. This theoretical foundation, alongside the project's general objectives and underlying goals, supports the development of evaluation objectives and research questions that will guide the assessment of both applications.

Subsequent sections detail the implementation plan, focusing on key areas such as targeted participants, teacher recruitment and training processes, and classroom implementation. The document also provides a thorough description of the materials and evaluation tools to be utilized, ensuring that all necessary resources are well-defined and accessible. Additionally, it elaborates on the approach to analyzing the collected data, outlining methods for evaluating the impact of the AI applications on educational outcomes.

Lastly, the deliverable discusses the planning and organization of the evaluation phases, covering the necessary steps for the effective deployment of the AI applications in diverse educational contexts. This plan ensures a structured approach to future implementation and supports the successful integration and assessment of the AI applications in educational environments.

1.3. Relation to Other Work Packages and Deliverables

This deliverable is integral to the broader framework of the AI4EDU project, building on prior work and informing subsequent activities. Its development is closely linked to several other Work Packages (WPs) and deliverables, ensuring consistency, alignment, and continuity throughout the project.

The evaluation methodology outlined in this deliverable is grounded in the pedagogical framework and user requirements established in WP2, as documented in Deliverable D2.1 “Pedagogical Framework and User Requirements” and Deliverable D2.2 “Technical Specifications.” These deliverables provided the theoretical and technical foundations for the design, development, and implementation of the AI4EDU applications, StudyBuddy and Teacher Mate. The pedagogical insights and user-centered requirements derived from WP2 guide the evaluation objectives and ensure the methodologies are aligned with the project’s overarching goals.

Moreover, this deliverable builds on the iterative design and development work conducted in WP3 “Adaptation and integration of core AI technologies to AI4EDU applications” and WP5 “Revision of the AI4EDU Applications.” Specifically, Deliverables D3.1 and D3.2 introduced the prototypes of the StudyBuddy and Teacher Mate applications, which were refined based on user feedback and technical advancements in D5.1 and D5.2. The evaluation methodology in D6.1 incorporates these iterative enhancements to ensure that the applications are assessed in their final, optimized forms.

D6.1 is also directly informed by the usability testing and technological evaluation results from WP4, as detailed in Deliverable D4.2. The feedback and insights gathered during these stages shaped the evaluation design, ensuring that the methodologies account for practical considerations and real-world use cases identified during earlier pilot implementations.

Finally, the outputs of this deliverable will contribute significantly to the activities in WP6 and beyond. Specifically, it serves as the foundation for evaluating the educational impact of the AI4EDU applications across diverse classroom settings in Cyprus, Greece, Ireland, and Sweden. The results of this evaluation will directly inform the work on WP7 “Implementation guidelines & recommendations for AIEd integration” .

By linking insights from earlier stages of the project to planned evaluation activities, D6.1 ensures a cohesive and systematic approach to understanding and demonstrating the educational value of the AI4EDU applications.

2. Theoretical Framework, Evaluation Objectives & Research Questions

The evaluation of the AI4EDU applications, Study Buddy and Teacher Mate, is grounded in a robust theoretical framework that aligns with contemporary learning and teaching paradigms. By incorporating well-established learning theories into both the design of these applications and the evaluation methodology, the project ensures that its approach is innovative while remaining firmly rooted in proven educational principles. These theories inform the potential ways in which the AI applications can support student learning, facilitate teacher involvement, and enhance the overall educational process. They also shape the evaluation objectives and research questions, guiding the selection of methods and tools to comprehensively assess the educational impact.

2.1. Theoretical Background – Learning Theories

Given the diverse ways Artificial Intelligence can be integrated into education, particularly through chatbots and AI assistants that rely on direct user interaction, the design, development, and evaluation of the AI4EDU applications must be grounded in established learning theories that emphasize user/student-centered, active, and adaptive learning. These theories underpin both the pedagogical foundations of the AI applications, and the evaluation methodologies used to measure their impact.

2.1.1. Constructivist Learning Theory

Student-Centered Learning (SCL) is a learning approach that is broadly related to, and supported by, constructivist theories of learning (Todorovski et al., 2015). Constructivism emphasizes that learning is an active process where learners construct new knowledge by integrating their experiences with prior understanding (Amineh & Asl, 2015). This theory underscores the importance of interactive and meaningful engagement with content, a principle embedded in the design of the AI4EDU applications.

Study Buddy facilitates active learning by allowing students to ask questions, explore topics, and receive personalized responses that cater to their specific needs. By adapting feedback and resources to individual learning levels, Study Buddy encourages learners to critically analyze and internalize new concepts, aligning their learning experiences with constructivist principles. Similarly, Teacher Mate supports constructivist practices by enabling teachers to create dynamic lesson plans, assessments, and learning materials tailored to students' diverse needs and capabilities. This adaptability ensures that instruction is relevant and fosters an environment where knowledge construction is encouraged. By adhering to this approach, the integration of AI4EDU applications in real-life classrooms is anticipated to foster a deeper understanding of the subject matter, thereby enhancing academic performance.

2.1.2. Self-Determination Theory (SDT)

Student-centered learning and teaching play a crucial role in stimulating students' motivation and engagement in the learning process (Gover et al., 2019). Several theories, including Self-Determination Theory (SDT), offer insights into how these factors influence learning outcomes. SDT provides a comprehensive framework for understanding how intrinsic motivation, autonomy, and relatedness drive learning and personal development (Ryan & Deci, 2022). This theory emphasizes the importance of environments that cultivate a sense of control, competence, and connection in fostering optimal engagement and learning outcomes.

Study Buddy aligns with SDT principles by empowering students to take ownership of their learning journey. Through features such as self-paced exploration, tailored feedback, and interactive content, the application builds students' confidence and supports their intrinsic motivation to learn. On the other hand, Teacher Mate is designed to assist teachers in creating learning environments that align with SDT's principles. By enabling differentiated instruction and personalized support, Teacher Mate helps teachers nurture students' autonomy and competence. Additionally, its tools for monitoring student progress allow teachers to provide meaningful feedback and foster a supportive learning environment. Together, these applications aim to enhance engagement and motivation, creating a positive cycle of autonomous and fulfilling learning experiences.

2.1.3. Cognitive Load Theory (CLT)

While student-centered learning approaches offer numerous benefits, their implementation in real educational settings presents significant challenges, particularly the high demands placed on both students and teachers. To address these issues, the design, implementation, and evaluation of the AI4EDU applications must be guided by learning theories that account for these complexities. Cognitive Load Theory (CLT) provides insights into how human cognitive architecture influences learning, emphasizing the need to manage cognitive resources effectively (Sweller, 2011). The theory emphasizes that effective instructional design should reduce extraneous cognitive load, thereby optimizing working memory resources to enhance learning.

Study Buddy incorporates these principles by presenting information in an organized, accessible manner, allowing students to focus on core concepts without feeling overwhelmed. Features such as text summarization, interactive concept exploration, and key points extraction act as scaffolds, reducing extraneous cognitive load and enabling students to better absorb and process information. Similarly, Teacher Mate further aligns with Cognitive Load Theory by offering tools that help teachers design lessons and materials that balance cognitive demands. Its automated content creation capabilities simplify complex instructional tasks, allowing teachers to focus on optimizing the learning experience. By reducing both student and teacher cognitive loads, the AI4EDU applications create an environment where cognitive resources are maximized for effective learning and teaching.

Building on this strong theoretical foundation, the evaluation objectives of the AI4EDU project aim to assess how effectively Study Buddy and Teacher Mate translate these learning theories into tangible educational benefits. By examining their impact on both students and teachers, the evaluation focuses on key areas such as enhancing motivation, fostering deeper engagement, reducing cognitive barriers, and improving learning outcomes. These objectives not only guide the research process but also ensure that the applications meet their intended goals of supporting adaptive, student-centered learning and efficient, effective teaching practices.

2.2. Evaluation Objectives

The AI4EDU project strives to advance educational practices through the integration of cutting-edge AI technologies, aiming to revolutionize the ways in which both teaching and learning are conducted. AI4EDU's overarching goals include the development, implementation, and evaluation of AI-powered educational applications which seek to enhance the learning experience by offering personalized, engaging, and adaptive learning opportunities for students, while also empowering teachers with effective tools for instruction and assessment. The project aims to investigate not only the effectiveness of these tools but also their ethical, transparent, and equitable use in real educational contexts.

In line with these broad objectives, AI4EDU's impact on students and teachers focuses on assessing the specific educational benefits derived from the use of these applications in real classroom settings. This section outlines the evaluation objectives for both students and teachers, highlighting the expected outcomes of incorporating AI tools into everyday teaching and learning practices.

2.2.1. Educational Impact on Students

The integration of Study Buddy into students' learning environments is expected to significantly enhance their educational experiences in a variety of ways. Building on principles of constructivism and self-directed learning, the application focuses on empowering students to take control of their academic journey, improving both the efficiency and the enjoyment of learning processes. Study Buddy's design and functionalities align with AI4EDU's commitment to fostering motivation, autonomy, and meaningful engagement among learners. By integrating Study Buddy into the learning environment, AI4EDU seeks to:

- **Support self-study and school preparation**: Through the personalized feedback and adaptive learning pathways provided by Study Buddy, students will receive targeted support tailored to their individual needs. This approach helps them reinforce key concepts and develop a deeper understanding of the subject matter.
- **Simplifying the identification and mastery of key concepts:** By breaking down complex topics into smaller, more manageable chunks, Study Buddy enables students to grasp core concepts more easily. This promotes better retention and understanding of essential subject matter, which contributes to improved academic performance.
- **Increase engagement, autonomy, and motivation**: AI4EDU aims to foster intrinsic motivation by empowering students to take control of their learning process. Study Buddy's interactive features, such as personalized study goals and instant feedback, create a more engaging and dynamic learning experience, encouraging students to explore content at their own pace.
- **Make learning more interesting and collaborative**: Through its conversational interface, Study Buddy creates an engaging and interactive dynamic that mirrors the guidance of a tutor. This approach not only makes learning more enjoyable but also encourages exploration and dialogue, complementing traditional classroom instruction and enhancing collaboration.

By incorporating these features, Study Buddy aligns with AI4EDU's vision of leveraging advanced AI technology to create meaningful, personalized, and engaging learning experiences. Through its ability to adapt to individual learning needs, simplify complex topics, and foster active participation, Study Buddy not only aims to enhance academic performance but also to inspire a deeper, sustained interest in learning that extends beyond the classroom.

2.2.2. Educational Impact on Teachers

The AI4EDU project recognizes the vital role teachers play in shaping effective and engaging learning environments. Through the development and deployment of Teacher Mate, the project seeks to empower educators by providing advanced tools to enhance their teaching efficiency, and effectiveness. Teacher Mate is specifically designed to alleviate many of the time-consuming preparatory and instructional tasks teachers face daily, allowing them to focus on fostering personalized and dynamic learning experiences for their students.

The evaluation objectives for teachers center on understanding how the integration of Teacher Mate impacts their practices, professional satisfaction, and student outcomes. These objectives include:

- **Providing effective tools for managing daily teaching and assessment tasks**: Teacher Mate supports teachers by automating lesson planning, preparing teaching materials, creating presentations and quizzes, exploring and simplifying concepts, creating rubrics for evaluating assignments, upgrading or simplifying texts, generating original texts, generating assessments, and analyzing student performance. By streamlining these processes, the tool reduces the workload associated with routine activities, enabling teachers to focus more on instructional quality and student engagement.
- **Improving teaching efficiency and freeing up time for creative instruction:** By automating repetitive tasks, Teacher Mate allows teachers to dedicate more time to personalized, innovative, and interactive teaching strategies. This freedom fosters an environment where educators can develop tailored lessons and hands-on activities, to address the diverse needs and abilities of their students.
- **Offering advanced tools for monitoring student progress:** Teacher Mate leverages AI-driven analytics to provide teachers with detailed insights into student performance and learning gaps. This data enables educators to make evidence-based decisions, adapt their instructional strategies, and provide targeted support to help each student thrive.
- **Enhancing overall teaching outcomes:** By equipping teachers with advanced tools, which facilitate personalised and inclusive learning experiences and provide actionable insights, Teacher Mate enables more effective lesson delivery and improved alignment between teaching strategies and student learning needs. This not only boosts learning outcomes but also enhances teachers' ability to achieve their instructional goals with greater precision and confidence.

Teacher Mate serves as a collaborative assistant, enriching teaching practices and fostering a more balanced workload for educators. Its capabilities extend beyond task automation, offering innovative resources that help teachers identify and address learning gaps, align instruction with student needs, and create inclusive and equitable learning experiences. By supporting teachers in these ways, AI4EDU aims to create a more fulfilling and impactful teaching environment, ultimately benefiting both educators and students.

2.3. Evaluation Research Questions

The evaluation of AI4EDU's applications is guided by specific research questions that align with both the theoretical framework and the project's overarching goals. These questions are designed to assess the educational impact of Study Buddy and Teacher Mate, with a particular focus on understanding how these AI tools influence student learning, teacher effectiveness, and the overall educational experience. By addressing distinct areas of impact for both students and teachers, the research questions aim to provide comprehensive insights into the effectiveness of these applications within real classroom settings.

2.3.1. Research Questions Related to Students

The research questions for students focus on assessing the impact of Study Buddy on various dimensions of student learning, including engagement, motivation, autonomy, and academic performance. These questions are formulated to evaluate how well Study Buddy supports personalized, adaptive learning and self-directed educational practices.

1. How does Study Buddy support students in preparing for assessments and tracking their academic progress?
2. To what extent does Study Buddy improve students' understanding and retention of key concepts?
3. How does the use of Study Buddy impacts student engagement and motivation in the learning process?
4. How do students perceive the usability and effectiveness of Study Buddy in enhancing their learning experience?
5. What learning patterns and trends can be observed from students' interactions with Study Buddy, and how do these correlate with their academic outcomes?

These questions aim to uncover both the qualitative and quantitative dimensions of Study Buddy's impact, ensuring that its role in promoting autonomous, effective learning is thoroughly evaluated.

2.3.2. Research Questions Related to Teachers

The research questions for teachers focus on evaluating the effectiveness of Teacher Mate in supporting teaching practices, enhancing efficiency, and improving assessment strategies. These questions will explore the impact of Teacher Mate on instructional delivery, teacher-student interactions, and the overall quality of education.

1 How does Teacher Mate affect teachers' efficiency in lesson planning, instructional delivery, and assessment tasks?
2 In what ways does Teacher Mate support teachers in providing personalized instruction to address diverse student needs?
3 How effective is Teacher Mate in helping teachers monitor student progress and identify areas for improvement?
4 What is the perceived impact of Teacher Mate on reducing teacher workload?
5 How do teachers evaluate the overall impact of Teacher Mate on student learning outcomes?

The research questions outlined above form the foundation of a comprehensive evaluation framework for Study Buddy and Teacher Mate. By addressing distinct yet interconnected impacts on students and teachers, these questions aim to provide actionable insights into the effectiveness and educational benefits of AI4EDU's applications. This dual focus ensures that the evaluation process captures the full spectrum of their contributions to teaching and learning. Ultimately, the findings from these research questions will inform the development of evidence-based strategies to advance innovative, equitable, and effective educational practices, aligning with AI4EDU's commitment to transforming the learning ecosystem.

3. Evaluation Procedure

This chapter outlines the systematic approach used to assess the impact of the AI4EDU applications, Study Buddy and Teacher Mate, in real-world classroom settings. Grounded in established learning theories, the evaluation focuses on capturing the multifaceted educational outcomes for both students and teachers. Aligned with the evaluation objectives and research questions, the procedure provides a comprehensive framework for piloting and assessing these applications across diverse educational contexts in Cyprus, Greece, Ireland, and Sweden, facilitating cross-cultural insights into their effectiveness and adaptability.

The chapter begins with an overview of the evaluation design, followed by a detailed description of the sequence of activities across the pre-implementation, implementation, and post-implementation phases. The aim is to offer clarity on the evaluation process and ensure that all necessary steps are taken to assess the educational impact of these AI-driven applications on both students and teachers.

3.1. Research Design Overview

The evaluation aims to assess the impact of the AI4EDU applications, Study Buddy and Teacher Mate, in real-world classroom settings through a mixed-methods experimental design. This design combines both quantitative and qualitative data collection to capture a wide range of educational outcomes for both students and teachers. Aligned with the research questions, the evaluation examines the effects of these AI applications on student engagement, motivation, academic performance, and on teachers' instructional practices across diverse educational contexts in Cyprus, Greece, Ireland, and Sweden.

A control-experimental group framework will be employed to evaluate the impact of Study Buddy. In the experimental group, students will use Study Buddy outside of class for studying, completing homework, and preparing for tests, while the control group will utilize regular resources provided by the teacher without the use of Study Buddy. By comparing the two groups, the evaluation seeks to identify the specific effects of Study Buddy on the educational parameters mentioned above.

Before and throughout the implementation period, teachers will use Teacher Mate to assist them in lesson planning, creating educational materials, designing assessments, and monitoring student progress. However, the teaching methods employed by the teachers will remain consistent across both the experimental and control groups. This ensures that any differences observed between the groups can be attributed solely to the use of Study Buddy, minimizing potential confounding variables related to teaching styles or methods.

Importantly, the implementation of Study Buddy and Teacher Mate will not disrupt the existing curriculum. Instead, the AI applications will complement and enhance the teaching process within the established curriculum framework, ensuring that the evaluation results accurately reflect real-world educational settings. This approach guarantees that any observed effects can be directly attributed to the integration of the AI applications, without interfering with core educational objectives.

Data will be collected through multiple sources at various stages of the evaluation. Pre-implementation assessments will establish baseline metrics, while post-implementation evaluations will measure changes in the identified educational outcomes. In addition to these assessments, feedback will be gathered from participants via surveys and interviews. Usage data from the AI applications will also be collected to assess their practical use and effectiveness.

The implementation period is structured within a fixed timeline spanning up to four months. The first phase encompasses pre-implementation activities, including teacher recruitment and training, identification and assignment of classes, preparation of teaching materials, selection and preparation of participating students, and collection of baseline data. The implementation phase involves the full deployment of the AI tools in the classroom, integrating Study Buddy and Teacher Mate into the teaching process while collecting relevant data. Finally, the post-implementation phase focuses on data integration, analysis, and reporting.

This evaluation design offers a structured and rigorous approach to understanding the impact of AI tools on students and teachers, while allowing flexibility to adapt to the varying educational contexts across the participating countries. By focusing on a broad range of educational outcomes, the evaluation will provide valuable insights into the potential of AI-driven applications to enhance teaching and learning in diverse classroom settings.

3.2. Pre-Implementation Phase

The pre-implementation phase establishes the foundation for the successful integration of the AI4EDU applications, Study Buddy and Teacher Mate, into classroom settings. This phase focuses on key preparatory tasks to ensure that teachers, students, and other stakeholders are adequately prepared for the upcoming implementation. Activities in this phase include recruiting and training participating teachers, identifying and assigning their classes, and preparing corresponding educational materials. Further steps involve informing students and their parents or guardians about the project, securing informed consent, collecting baseline data through evaluation instruments, and training students in the experimental group on the effective use of Study Buddy. These actions ensure ethical compliance, thorough preparation, and the establishment of key benchmarks for evaluating the impact of the AI applications during the implementation phase.

3.2.1. Teacher Recruitment

To ensure the successful implementation and evaluation of the AI4EDU applications, it is crucial to engage a diverse and representative sample of teachers who will play an integral role in deploying and assessing the applications in the classroom. This section outlines the process for recruiting and training these teachers.

3.2.1.1. Target Audience

The AI4EDU applications are designed to enhance secondary school education in a variety of educational contexts across Cyprus, Greece, Ireland, and Sweden. To ensure a comprehensive and representative evaluation, the implementation will focus on two distinct subject domains within the secondary school curriculum:

1. **Science subjects:** One science subject, such as Biology, Chemistry, or Physics, will be selected in each participating country. The focus in this domain is to evaluate how the AI4EDU applications enhance students' conceptual understanding, practical skills, reasoning abilities, and motivation. Additionally, the effectiveness of the applications in supporting teachers with the design and delivery of science-focused lessons will be assessed.
2. **Humanities or Social subjects:** One humanities or social subject, such as History or Social Education, will be selected per country. The evaluation will explore the applications' ability to foster critical thinking, contextual understanding, and engagement in subjects that often rely on interpretive and discussion-based teaching methods.

To ensure a robust and meaningful evaluation of the AI4EDU applications, approximately 16 teachers will be recruited across the four participating countries. Each country will engage around four teachers, with some specializing in humanities subjects (e.g., History, Social Education) and some specializing in science subjects (e.g., Biology, Physics).

By focusing on these two domains, the evaluation seeks to capture the diverse educational contexts in which the AI4EDU applications can provide meaningful support, thereby ensuring that they meet the varied needs of both teachers and students across different subject areas.

3.2.1.2. Selection Criteria

The selection of teachers will be guided by specific criteria to ensure participants are well-equipped, motivated, and prepared to engage with the AI-driven educational applications, Study Buddy and Teacher Mate. Selection will be based on the following:

- **Subject expertise:** Teachers must specialize in one of the two selected secondary school subjects: a humanities subject (e.g., History, Social Education) or a science subject (e.g., Biology, Physics).
- **Preferred experience:** Teachers with prior experience in using digital tools and innovative teaching methods are preferred. A basic proficiency in using computers and educational software is required.
- **Commitment:** Teachers must express a strong interest in integrating the AI applications into their teaching practice and commit to the full duration of the implementation period. This includes attending pre-implementation training, actively engaging with the applications, providing regular feedback, and participating in post-implementation evaluations.
- **Dual-school preference:** Preference will be given to teachers who teach at two different schools, enabling the creation of distinct experimental and control groups. This arrangement ensures the integrity of the evaluation by allowing teachers to assign specific classes to either the control or experimental groups, in alignment with the evaluation framework.
- **Diversity of educational contexts:** Efforts will be made to recruit teachers from a variety of school types (e.g., public, private, urban, rural). Ensuring a diverse range of educational contexts will help capture the impact of the AI applications across different environments, enhancing the generalizability of the evaluation findings.
- **Openness to collaboration and feedback:** Teachers should be willing to collaborate with the project team, engage in discussions about their experiences, and provide constructive feedback on the applications' impact.

3.2.1.3. Recruitment Process

The recruitment of teachers across the four participating countries will follow a structured and transparent process to identify and select highly suitable candidates for the AI4EDU project. The recruitment process consists of three main steps:

- **Reaching potential participants:** Efforts to identify and engage teacher participants will employ multiple strategies. First, existing networks will be leveraged by prioritizing teachers who have previously participated in workshops or training events associated with the project. These individuals are already familiar with the project's objectives and have demonstrated an interest in innovative teaching practices. Second, collaboration with local educational authorities in each country will facilitate the efficient identification of potential participants, ensuring a diverse representation across various educational contexts. Third, an open call for participation will be

disseminated through multiple channels, including the project's official website, partners' websites, and social media platforms. These announcements will provide comprehensive details about the project's objectives, teacher roles, expected commitments, and selection criteria, ensuring transparency and encouraging widespread engagement.

- **Application and evaluation:** Interested teachers will complete an application form outlining their teaching experience, familiarity with digital tools, and interest in integrating AI into their teaching practices. This application serves as the primary basis for evaluating candidates' suitability. Candidate teachers will meet with the local project partner in their country to discuss the evaluation methodology, including the implementation plan, timelines, and their specific responsibilities.
- **Final selection:** Applications will be reviewed against the established selection criteria, and interviews may be conducted if necessary to assess candidates' enthusiasm for innovation, readiness to integrate AI tools, and overall suitability for the project.
- **Acquisition of consent forms:** Once the final group of teachers is selected, their participation will be formalized through signed informed consent forms. These forms will confirm that participants fully understand their roles, responsibilities, and expectations, fostering a shared commitment to the successful implementation and evaluation of the AI4EDU applications.

3.2.2. Teacher Training and Preparation

The successful implementation of the AI4EDU applications, Study Buddy and Teacher Mate, relies on the thorough preparation of participating teachers. This section outlines the steps taken to ensure that teachers are well-equipped to integrate these tools into their classrooms and effectively contribute to the evaluation process. The training and preparation phase involves equipping teachers with the necessary knowledge and skills, identifying and assigning classes to experimental and control groups, and preparing teaching activities and materials aligned with the curriculum and project objectives.

3.2.2.1. Training Program

The teacher training program is designed to equip selected educators with the knowledge and skills required for the effective integration of the AI4EDU applications into their classrooms. The primary goals of the program are to familiarize teachers with the functionalities of the AI applications, clarify the implementation timeline and objectives, and prepare them for administering evaluation materials throughout the project.

Training will be conducted through a series of meetings organized by local project partners in each participating country. These sessions, which may occur in-person or online, will serve as an introduction to the project's overall goals, implementation procedures, and teachers' specific responsibilities. The aim is to ensure that teachers are fully informed about the project's objectives, the implementation timeline, and their role in the research and evaluation components.

During these initial meetings, teachers will be introduced to the AI applications, Study Buddy and Teacher Mate. A detailed demonstration of each feature of the applications will be provided, allowing teachers to become familiar with the tools they will use to enhance their teaching practice and support students' learning. The demonstrations will cover key functionalities, such as how these tools can facilitate lesson planning, student monitoring and assessment, etc. Teachers will be encouraged to ask questions and explore how these applications can be adapted to their specific teaching contexts.

In addition to familiarizing teachers with the AI applications, the training will include an introduction to the underlying principles of artificial intelligence, ensuring that educators have a basic understanding of how AI works. Teachers will also be informed about the ethical considerations related to the use of AI in education, including issues of data privacy, fairness, transparency, and the responsible application of AI technologies in the classroom.

Furthermore, the training will introduce teachers to the evaluation instruments that must be administered to students. These instruments, which include surveys, assessments, and observation protocols, are essential for gathering data on the effectiveness of the AI tools in real-world classrooms. Teachers will receive training on how to use these materials effectively and will be provided with clear guidelines on how to collect and report data throughout the evaluation process.

By the end of this training phase, teachers will have a comprehensive understanding of the project's aims, the evaluation procedure, and the tools they will be using in the classroom.

3.2.2.2. Identification and Assignment of Classes

After completing the training, teachers proceed to identify and assign two classes from their teaching roster to participate in the evaluation. Each teacher selects one class for the experimental group, where Study Buddy will be integrated into students' learning routines, and one for the control group, which will continue with regular study methods. This clear distinction ensures the integrity of the evaluation and facilitates a robust comparison of the AI applications' impact.

To maintain consistency, selected classes should have similar sample sizes and comparable student demographics in terms of age and academic ability. Both groups must follow an equivalent curriculum, ensuring that the topics covered during the implementation phase are identical across both experimental and control groups. This uniformity minimizes confounding variables and ensures that observed differences in outcomes can be attributed to the use of Study Buddy.

3.2.2.3. Preparation of Teaching Activities and Materials

In collaboration with local project partners, teachers develop a detailed implementation plan that aligns with the project's objectives and timeline, and the specific capabilities of the AI applications. This plan is tailored to the individual classroom contexts, considering factors such as the subject taught, the age and needs of students, and the teacher's instructional style.

Teachers utilize TeacherMate to prepare instructional materials and activities for the implementation phase. This includes designing tailored lesson plans, creating engaging presentations, developing worksheets and handouts, structuring group projects, and crafting assessment tools such as quizzes, homework assignments, and evaluation rubrics. Additionally, teachers can integrate their existing materials, leveraging Teacher Mate's advanced functionalities to interact with custom educational resources while maintaining their established teaching practices. These preparations are essential to ensure that the AI tools effectively complement the existing curriculum and enhance the learning experience without disrupting the overall teaching process.

By the end of this phase, teachers are fully prepared to integrate the AI applications into their classrooms, with all necessary materials and activities ready for deployment. This thorough preparation ensures a smooth transition into the implementation phase and sets the stage for the successful evaluation of Study Buddy and Teacher Mate.

3.2.3. Informing Students and Acquisition of Permission Slips

Informing students and their parents or guardians about the project and securing their consent is a critical step in ensuring transparency, ethical compliance, and trust in the evaluation process. This section outlines how participants will be briefed on their roles and the importance of their contribution to the study.

3.2.3.1. Informing students

Teachers will introduce the project to their students, clearly explaining its purpose, objectives, and the nature of their involvement. For students in the experimental group, this introduction will include an explanation of their use of the Study Buddy application and how it will complement their learning outside the classroom. Conversely, students in the control group will not be informed about Study Buddy, ensuring the integrity of the control-experimental group distinction. Instead, they will be told that they are participating in an evaluation of different educational approaches, focusing solely on regular teaching methods and classroom activities.

To foster understanding and cooperation, all students will be briefed on their responsibilities during the implementation phase. These responsibilities include attending classes regularly, completing assignments, and participating in evaluation activities such as surveys, tests, and observations. Students will also be informed about the type of data to be collected (e.g., academic performance, engagement levels, and demographic information) and the significance of their participation in the project.

3.2.3.2. Informing parents/guardians

A comprehensive information package will be sent to parents or guardians, providing them with a detailed overview of the AI4EDU project. This package will include the project's objectives, their child's role in the study, and a description of the tools being used. For parents of experimental group students, specific details about Study Buddy will be included. For parents of control group students, the package will focus on the evaluation of regular educational approaches without referencing Study Buddy.

The package will outline how the project will be conducted, the types of data collected, and how that data will be used. It will also reassure parents or guardians about ethical considerations, including data privacy and security, emphasizing that all collected data will remain confidential and be used solely for the evaluation.

3.2.3.3. Obtaining Informed Consent

To formalize participation, parents or guardians will be asked to sign an informed consent form. This document will detail the voluntary nature of participation, what participation entails (e.g., use of Study Buddy for the experimental group, reliance on regular teaching resources for the control group, and data collection procedures), and assurances regarding confidentiality and data protection. The form will also inform parents and guardians of their right to withdraw their child from the project at any time without facing any repercussions.

Additionally, any permissions required by local regulations or school policies will be obtained to ensure compliance with legal and ethical standards. Once all consent forms have been collected, teachers will compile and verify them, ensuring that all students in both the experimental and control groups are officially enrolled and prepared for the next phase of the evaluation.

3.2.4. Baseline Data Collection

Baseline data collection is a critical preparatory step to establish reference points for evaluating the impact of the AI4EDU applications, Study Buddy and Teacher Mate. By collecting this data before implementation, the research team can ensure meaningful comparisons between the experimental and control groups and identify any pre-existing differences that may influence outcomes. The primary objective is to attribute observed changes during the implementation phase to the use of the AI applications rather than to variations in student characteristics or performance.

Baseline data will facilitate a robust evaluation by providing initial measures of key variables, including demographic factors, academic performance, and student engagement. This step ensures the validity and reliability of comparisons during post-implementation analyses and strengthens the study's methodological rigor.

Baseline data collection will occur during the first week after classes are assigned to control and experimental groups and consent forms have been secured. Teachers supported by the project team will administer the evaluation instruments to ensure consistent and accurate data collection. Surveys and pre-tests will be conducted during class time, with students in both groups receiving identical instructions to minimize biases. Observation protocols will be applied by teachers or local partners during this period to capture qualitative insights into the initial classroom context.

The data will focus on the following key areas:

- **Demographic and contextual factors:** Basic demographic data (e.g., age, gender) and contextual information (e.g., school type, prior experience with digital tools) will be gathered to ensure group comparability and to serve as control variables in subsequent analyses.
- **Academic performance:** Pre-tests will assess students' understanding of the subject-specific content covered during the implementation phase. These tests may include multiple-choice, short-answer, and essay-style questions, as well as hands-on exercises or small individual or group projects, where applicable, ensuring a comprehensive evaluation of baseline performance.
- **Engagement and motivation:** Students' engagement with the subject and their motivation for learning will be assessed through the Motivation and Engagement Survey, which will measure students' psychological and behavioral readiness to learn, providing baseline scores for cognitive, emotional, and agentic engagement. These scores will later be compared to post-implementation data to assess the impact of Study Buddy on student motivation and engagement. Additionally, teachers may complete short observation checklists or provide initial qualitative feedback on students' participation, attitudes, and overall engagement in class.
- **Initial observations:** Classroom observations will document initial teaching practices, classroom management, and student behaviors to provide qualitative context for interpreting later findings.

All baseline data will be treated with the highest level of confidentiality. Data will be anonymized to ensure student privacy, and only aggregate data will be used in the evaluation. A secure, centralized database will be established to store the data. By the end of the baseline data collection process, the research team will have a clear understanding of the starting points for each group, enabling them to accurately assess the subsequent impact of the AI4EDU applications on student engagement, performance, and learning outcomes.

3.2.5. Experimental Group Training

The effective integration of Study Buddy into students' study routines requires thorough preparation to ensure they can navigate and utilize the application confidently. This sub-phase focuses on training students in the experimental group, equipping them with the skills and knowledge necessary to independently and effectively engage with Study Buddy's features throughout the implementation phase.

The training sessions will introduce students to Study Buddy's core functionalities, such as interactive concept learning, text summarization, quiz generation, and assignment review. New, enhanced tools, such as text adaptation, chronological ordering of events, conversations across time and debate preparation will also be presented. Conducted as hands-on workshops during regular class hours, these sessions will provide practical demonstrations and guided exercises. Each session, not exceeding two hours, will take place within the first two weeks of the pre-implementation phase and may be facilitated by teachers with support from the project team or led directly by the local project partner.

This workshop will ensure that students are comfortable using Study Buddy and ready to integrate it into their study routines. Any technical issues or gaps in understanding will be addressed during the session, ensuring a smooth transition into the implementation phase. The workshops will also emphasize the ethical and responsible use of AI tools, educating students on appropriate behavior while using the application, such as data privacy awareness and adhering to academic integrity.

By the conclusion of the training, students will have a thorough understanding of how to use Study Buddy effectively to support their learning. This preparation will ensure a seamless transition into the implementation phase, during which they will rely on Study Buddy to complete assignments, prepare for tests, and engage in independent study.

The completion of this sub-phase, alongside the other preparatory activities in the pre-implementation phase, ensures that the AI4EDU applications are set up for successful deployment, laying a strong foundation for achieving the project's evaluation goals.

3.3. Implementation Phase

The implementation phase marks the active deployment of the AI4EDU applications, Study Buddy and Teacher Mate, in the classrooms. Building on the preparatory work completed during the pre-implementation phase, this phase focuses on the seamless integration of these AI applications into daily teaching and learning activities. The primary objectives are to enhance instructional effectiveness, monitor initial outcomes, and collect data for evaluation. This phase spans the entire duration of classroom deployment, ensuring smooth operation through ongoing observation and comprehensive support for both teachers and students.

3.3.1. Integration of AI4EDU Applications into Classroom Activities

With baseline data collected, the implementation phase begins with a standardized teaching process in both experimental and control groups. This approach ensures consistency in classroom activities, while differentiating the interventions applied outside the classroom.

Teaching process: Teachers in both the experimental and control groups follow a uniform instructional approach to maintain consistency and comparability. This ensures that any observed differences between the groups can be attributed to the use of Study Buddy in the experimental group.

- **Standardized delivery:** Teachers deliver lessons using the prepared materials, addressing the same topics and curriculum objectives across both groups.
- **Engaging pedagogy:** Established teaching practices, such as direct instruction, group discussions, and problem-solving exercises, are employed to engage students and reinforce key concepts.
- **Uniform assessments:** In-class assessments and activities are identical for both groups, as far as possible, ensuring fairness and alignment with curriculum goals.

Engagement with Study Buddy (Experimental group): Students in the experimental group supplement their classroom learning by using Study Buddy for self-study and homework. Teachers play a key role in guiding students to integrate the application into their study routines effectively. The use of Study Buddy focuses on three main areas:

- **Homework assignments:** Study Buddy's tools, such as written assignment revision feature, assist students in assessing their understanding and progress.
- **Independent study:** Tools like Explain Term, Interactive Concept Exploration, Text Adaptation, Chronological Ordering of Events, Summarize Text, and Extract Key Points enable students to independently explore topics and reinforce their learning. Moreover, interactive and engaging tools, such as the Debate tool and Conversations Across Time facilitate critical thinking, collaborative exploration, and deeper engagement with the subject matter.
- **Test preparation:** Adaptive learning features of all Study Buddy tools help students focus on challenging topics, complete self-assessment quizzes, and prepare for tests effectively.

Teachers set clear expectations for the application's use in alignment with learning objectives, ensuring that Study Buddy serves as a structured and purposeful learning aid.

Regular teaching procedures (Control group): Students in the control group continue their learning using regular methods and resources. These methods are designed to provide a comparable workload and scope to those of the experimental group, ensuring alignment with curriculum objectives.

- **Homework assignments:** Students complete assignments using regular resources such as textbooks, worksheets, and teacher-prepared materials.
- **Independent study:** Regular study methods, including note-taking, textbook review, and self-created practice exercises, are employed.
- **Test preparation:** Students prepare for assessments using teacher-provided review materials and established study routines.

By maintaining equivalent classroom activities and differentiating only the out-of-class study methods, this approach ensures that the primary distinction between the two groups lies in the integration of Study Buddy, enabling a focused evaluation of its impact on student outcomes.

3.3.2. Classroom Monitoring and Support

The effective implementation of the AI4EDU applications, Study Buddy and Teacher Mate, hinges on continuous collaboration, robust monitoring, and timely support for teachers throughout the deployment phase. This section outlines the mechanisms for ensuring a seamless integration of these applications into teaching and learning processes while addressing challenges and optimizing their use.

Continuous communication with local partners: To provide real-time assistance and foster confidence in using the applications, teachers will maintain ongoing communication with their designated local project partners. These partners serve as the primary support system during the implementation phase and play a pivotal role in:

- **Resolve issues promptly:** Teachers can report technical difficulties with the apps, as well as pedagogical challenges, for immediate resolution by local partners.
- **Provide practical guidance:** Local partners will offer tailored advice to help align classroom practices with the objectives of the AI4EDU applications, ensuring their effective and appropriate use.
- **Foster confidence:** Regular check-ins will address teachers' concerns, reinforce their established instructional routines, and help them adapt to the new technologies without disruption.

Monitoring and feedback mechanisms: To assess the effective deployment of the AI applications structured monitoring and feedback mechanisms will be implemented throughout the implementation phase.

- **Teacher feedback:** Teachers may submit regular reports detailing their experiences with the AI applications. These reports will highlight successes, challenges, and observations on student outcomes, providing valuable qualitative data for evaluation.
- **Classroom observations:** Local partners may conduct periodic classroom visits to observe teaching practices and collect qualitative data. These observations will focus on assessing fidelity to the implementation protocols, the integration of AI applications into teaching, and alignment with the project's objectives.
- **Student performance and engagement insights:** Teachers will monitor students' engagement and motivation during classroom sessions, providing informal feedback on their overall learning experiences. These observations will capture qualitative insights into how students interact with the curriculum and the applications.
- **Usage analytics:** Data from Study Buddy and Teacher Mate log files will be gathered to evaluate the frequency and nature of usage. Further analysis will identify patterns, such as the most commonly used tools, and provide insights into how effectively the applications are being utilized by both students and teachers.

Iterative refinement based on feedback: Insights gathered through the monitoring and feedback mechanisms will facilitate the effective integration of the AI applications into classroom activities.

- **Targeted support:** Teachers will receive recommendations, additional resources, or further training to address specific challenges or refine their use of the applications.
- **Process optimization:** Feedback and patterns identified in the data will inform adjustments to maximize the impact of Teacher Mate and Study Buddy on teaching and learning outcomes.
- **Ongoing improvements of AI integration:** The structured approach to monitoring ensures that the AI integration in real educational settings remains responsive to emerging needs, continually adapting to support teaching quality and student success.

By prioritizing localized, responsive support and employing comprehensive monitoring systems, this approach empowers teachers to effectively integrate Study Buddy and Teacher Mate into their teaching practises. These efforts foster a high-quality teaching and learning

environment, maximizing the potential of the AI4EDU applications to enhance educational experiences.

3.3.3. Data Collection

The final stage of the implementation phase involves the systematic collection of data required to evaluate the effectiveness of the AI4EDU applications in achieving the project's objectives. This data collection process will provide the foundation for assessing the impact of the applications, comparing the outcomes of the experimental and control groups, and generating insights into AI-enhanced teaching and learning.

Timing and Exposure: Data collection will be conducted at the conclusion of the implementation phase, ensuring that both students and teachers have had sufficient exposure to the applications. By this stage, students in the experimental group will have used Study Buddy extensively for homework, independent study, and test preparation, while teachers will have engaged with Teacher Mate to refine their instructional practices.

Coordination and Support: Teachers, with guidance from local partners, will coordinate the data collection process. Detailed instructions will be provided to ensure consistent administration of final assessments, surveys, and observational feedback across all classrooms. Teachers will schedule class time for students to complete the required instruments and oversee the secure collection and submission of data.

Instruments and Data Collection Methods: The following instrumentswill be utilized.

- **Post-tests:** Students will complete subject-specific post-tests designed to measure their academic progress relative to the pre-tests administered during the pre-implementation phase. These assessments, developed in collaboration with teachers and local researchers, will align with curriculum objectives and address key learning outcomes. By comparing pre- and post-test results, the research team will evaluate the impact of Study Buddy on academic performance.
- **Motivation and Engagement Survey:** The Motivation and Engagement Survey will be administered to assess changes in students' motivation and engagement. The survey will capture post-implementation levels of behavioral, emotional, cognitive, and agentic engagement, providing valuable insights into how the AI tools influenced students' attitudes and behaviors towards learning.
- **Student Questionnaire:** Students in the experimental group will complete a questionnaire to provide feedback on their experiences with Study Buddy. This tool will explore usage patterns, perceived benefits, and challenges, offering qualitative data to complement the quantitative findings from the tests and surveys.
- **Teacher Interviews:** Teachers will provide feedback reflecting on their use of Teacher Mate during the implementation phase. This feedback will address its influence on lesson planning, instructional delivery, and classroom dynamics, as well as perceived benefits and challenges.
- **Classroom Observations:** Teachers, or local partners will conduct classroom observations using the structured protocol outlined in Chapter 4, incorporating SWOT and NOISE analyses. These observations will focus on teaching practices, student engagement, and classroom dynamics, while also identifying best practices and potential areas better integration of the applications in the learning and teaching practice.
- **Usage Logs:** At the end of the implementation phase, usage data will be retrieved from the Study Buddy and Teacher Mate platforms. This data will include metrics such as frequency of use, specific features accessed, and patterns of engagement.

By correlating this data with academic performance and engagement outcomes, the research team will gain insights into the effectiveness of the tools in supporting teaching and learning.

Ensuring consistency and reliability: To ensure consistency and reliability, a standardized approach will be maintained throughout the data collection process. Teachers across all participating classrooms will follow uniform procedures for administering assessments and surveys, with clear instructions provided to ensure accuracy and comparability. Local partners will offer ongoing support to address any issues and ensure adherence to the established protocols.

As with all stages of the project, the ethical handling of data is paramount. All collected data will be anonymized to protect the identities of participants, and no personal information will be linked to performance data. The data will be securely stored in a centralized database, with access limited to authorized personnel only. These measures ensure compliance with local regulations and school policies, safeguarding confidentiality and ensuring that the data is used exclusively for evaluation purposes.

By adhering to these structured, standardized, and ethical procedures, this data collection phase will yield robust evidence for evaluating the impact of Study Buddy and Teacher Mate. The comprehensive insights gained will guide their broader application in educational contexts.

3.4. Post-Implementation Phase

The post-implementation phase focuses on systematically analyzing the data collected during the implementation phase to evaluate the effectiveness of the AI4EDU applications, Study Buddy and Teacher Mate. This stage is critical for drawing meaningful conclusions about the impact of these tools on teaching and learning processes.

3.4.1. Methods of Analysis

To ensure a comprehensive evaluation, the analysis employs a combination of quantitative and qualitative methods. This mixed-methods approach integrates statistical evaluations with contextual insights to assess the AI applications' overall impact.

3.4.1.1. Quantitative Analysis

Quantitative analysis involves statistical techniques to assess academic performance, engagement levels, and usage patterns. The methodologies include:

- **Descriptive statistics:** Summary measures such as mean, median, and standard deviation provide an overview of trends in academic outcomes, including performance changes from pre- to post-tests for both experimental and control groups.
- **Inferential statistics:** Paired t-tests are conducted to evaluate the significance of changes in academic performance within each group from pre-test to post-test phases. Independent t-tests or ANOVA compare performance differences between the experimental and control groups, determining the impact of Study Buddy.
- **Correlation analysis:** Correlations between usage patterns (e.g., frequency and specific features accessed) and academic outcomes are analyzed to identify relationships between engagement with Study Buddy and learning results.

- **Regression analysis:** Multiple regression models are used to determine how various factors, such as engagement levels with Study Buddy, teacher interactions with Teacher Mate, and baseline performance, contribute to observed outcomes.

3.4.1.2. Qualitative Analysis

Qualitative analysis complements quantitative findings by capturing nuanced insights into user experiences, contextual factors, and implementation fidelity. The methods include:

- **Thematic Analysis:** Teacher feedback forms and observation notes are analyzed to identify recurring themes, such as usability, perceived effectiveness, and challenges of Teacher Mate and Study Buddy.
- **Content Analysis:** Open-ended responses from students and teachers are analyzed to extract qualitative insights into their perceptions and learning experiences.
- **Classroom Observations:** Data from final classroom observations are reviewed systematically to assess the integration of AI applications into teaching practices, classroom dynamics, and their influence on learning processes.

3.4.2. Data Processing

Each country's partners are responsible for processing the data collected during the implementation phase. This includes organizing, cleaning, and preparing datasets for analysis while ensuring data integrity and security. The process includes:

- **Data organization:** Collected data, including test scores, survey responses, feedback forms, and usage logs, are systematically organized by type and source.
- **Data cleaning:** Partners verify the accuracy and completeness of datasets, addressing inconsistencies or missing data to ensure reliable analysis.
- **Standardization:** To ensure coherence across countries, all data is standardized according to predefined formats and coding schemes.
- **Translation and validation:** Qualitative data from non-English-speaking countries are translated into English while maintaining accuracy and context. This ensures consistency in analysis.

3.4.3. Integration of Findings

Following data processing, findings from each country are synthesized to provide a holistic understanding of the AI4EDU applications' impact across diverse educational contexts. The process includes:

- **Cross-country quantitative comparison:** Pre- and post-test results and motivation and engagement survey data from all countries are aggregated to identify trends and variations in outcomes between experimental and control groups.
- **Correlation across usage patterns:** Study Buddy usage data is correlated with academic performance across all countries to explore relationships between tool engagement and learning outcomes. Teacher Mate usage data is analyzed to determine the most frequently utilized features and their contribution to teaching efficiency.
- **Synthesis of qualitative themes:** Themes emerging from teacher interviews, feedback forms, and open-ended survey responses are synthesized to highlight shared experiences, challenges, and successes across different countries.
- **Contextual analysis:** Differences in classroom dynamics, implementation fidelity, and cultural factors are examined to contextualize the findings and account for variations in outcomes.

3.4.4. Reporting Findings

Following the analysis, a comprehensive report will be compiled to present the findings of the pilot study. The report will include:

- **Comparison of outcomes:** Detailed comparisons of academic performance and engagement levels between experimental and control groups.
- **Impact analysis:** Insights into Study Buddy's effectiveness in enhancing learning outcomes and motivation and Teacher Mate's role in improving instructional efficiency.
- **Implementation feedback:** Qualitative reflections from teachers and students, highlighting successes, challenges, and areas for improvement.
- **Recommendations:** Practical recommendations for optimizing implementation strategies, and scaling the applications to broader educational settings.

The findings will provide actionable insights for educators, policymakers, and researchers, guiding the future development and application of AI4EDU technologies to enhance teaching and learning experiences.

4. Tools and Evaluation Instruments

This chapter outlines the materials and tools utilized in the AI4EDU project, focusing on both the AI applications implemented and the evaluation instruments employed to assess their impact. The purpose of this chapter is to provide a detailed description of the technological and methodological resources used, ensuring transparency and facilitating replicability of the study.

4.1. AI Applications: Study Buddy and Teacher Mate

The first section introduces the AI applications, Study Buddy and Teacher Mate, detailing their purpose, functionalities, and role within the educational framework. These applications represent the core interventions of the AI4EDU project, designed to enhance student learning and support teachers in managing instructional tasks.

4.1.1. Study Buddy

Study Buddy is an AI-driven application designed to act as a virtual study companion for students. Its primary purpose is to support students in their academic journey by providing assistance tailored to their study needs. By leveraging a range of interactive tools and features, Study Buddy empowers students to reinforce their understanding of subjects, efficiently manage learning tasks, and develop effective study habits.

The application's robust suite of tools includes:

- **Summarizer:** Condenses lengthy texts into concise summaries, enabling students to focus on key information.
- **Interactive concept exploration:** Facilitates dynamic, guided sessions to deepen students' understanding of complex topics.
- **Chronological order of events:** Generates detailed timelines from inputted events or time periods, complete with explanatory transitions and comprehension questions.
- **Extract key points:** Identifies critical elements in texts, making note-taking and study preparation more efficient.
- **Revise tool:** Reviews student-written assignments, offering constructive feedback and actionable suggestions for improvement.
- **Auto-grade exercise:** Evaluates responses to questions instantly, providing detailed feedback to support continuous learning.
- **Explain term:** Delivers clear explanations of academic terms and concepts, helping students quickly grasp essential knowledge.
- **Text adaptation:** Modifies text to align with students' reading abilities, skills, and learning objectives.
- **Conversations across time:** Encourages critical thinking and creativity by allowing students to engage in imaginative dialogues with historical figures, cultural icons, or scientists.
- **Debate tool:** Prepares students for debates by simulating an interactive experience where the AI acts as a debate partner.
- **Self-assessment quiz:** Creates customized quizzes based on students' study materials, promoting mastery of topics through self-assessment.

The application offers a dedicated space where students can complete tests assigned by their teachers. This is complemented by a Dashboard, which enables students to review their grades, access teacher feedback, and track their overall academic progress over time.

Additionally, Study Buddy includes a **Conversational Chatbot** that facilitates freeform interaction via text or voice input. This feature enables intuitive, natural communication, allowing students to ask questions, request explanations, or receive guidance tailored to their study requirements.

Overall, Study Buddy represents a dynamic tool aimed at enhancing learning efficiency and engagement, equipping students with the resources they need to excel in their academic pursuits.

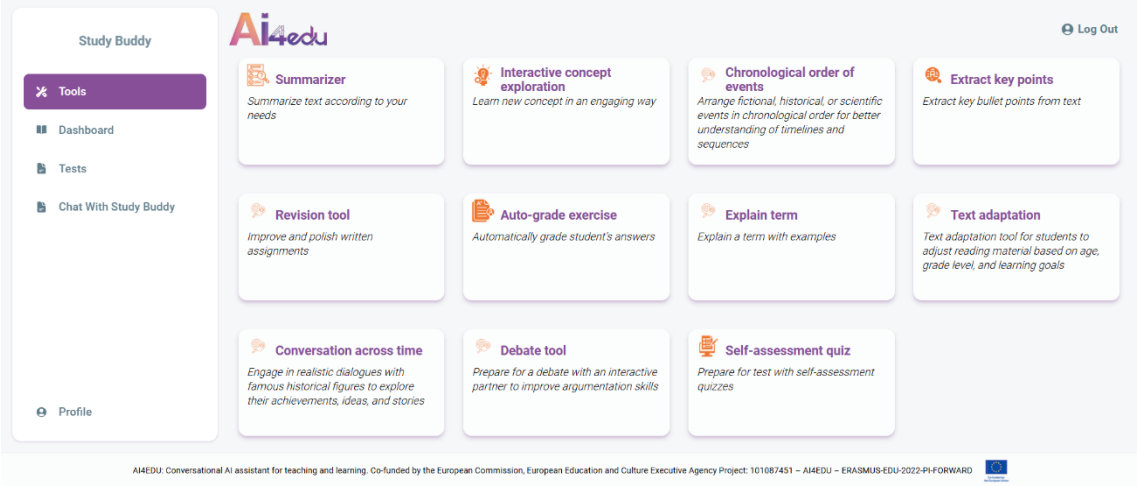

Figure 1: Study Buddy interface

4.1.2. Teacher Mate

Teacher Mate is an AI-powered assistant designed to support educators by streamlining instructional and administrative tasks. Its primary objective is to alleviate teachers' workloads while enhancing the personalization and effectiveness of teaching. By providing a range of versatile tools, Teacher Mate empowers educators to dedicate more time to meaningful student interactions and strategic lesson planning.

Teacher Mate offers a comprehensive array of tools tailored to meet the diverse needs of educators:

- **Generate Test:** Enables teachers to create customized tests aligned with specific curriculum needs and assign them to students.
- **Quiz Creator:** Automatically generates assessment quizzes in various formats, facilitating comprehensive evaluation of student knowledge.
- **Presentation Planner:** Assists in crafting engaging and visually impactful presentations with structured content ideas to enhance lesson delivery.
- **Lesson Plan Generator:** Streamlines the creation of structured lesson plans by helping educators define learning objectives, organize content, and schedule activities effectively.
- **Create Rubric:** Allows teachers to develop customized rubrics for evaluating assignments, defining criteria, performance levels, and grading parameters.
- **Teaching Material Creator:** Assists in developing study materials tailored to specific topics or student needs, supporting adaptable and targeted learning experiences.
- **Text generator:** Produces engaging, original texts customized to any topic, genre, or grade level, enhancing lesson content.
- **Concept Exploration Assistant:** Supports teachers in crafting accessible explanations for complex concepts, tailored to students' grade levels and learning preferences.

- **Text adaptation:** Adjusts text content to align with students' grade levels, reading abilities, and learning objectives, fostering accessibility.
- **Grading and Evaluation Assistant:** Automates the grading process, ensuring consistent, efficient evaluation of student work while providing instant feedback based on predefined criteria.
- **Chronological Ordering of Events**: Organizes events into clear timelines, supporting disciplines like history, literature, and science.
- **Design group project:** Helps teachers create collaborative and engaging group projects suited to various subjects and grade levels.

Teacher Mate, in addition to the pre-loaded resources from each country's respective curriculum, allows educators to upload their own content. This flexibility enables the tools to generate responses and resources tailored to specific teaching materials or unique classroom needs.

The platform also features a library of previously created tests, providing educators with quick access to reusable resources for various classes. Moreover, Teacher Mate offers a Dashboard that serves as a centralized hub for class management. From this interface, teachers can effortlessly add new classes, track the progress of ongoing ones, and access detailed analytics on individual student performance.

Finally, Teacher Mate incorporates a Conversational Chatbot that facilitates freeform interaction via written or verbal input. This feature offers teachers instant guidance, answers to queries, and suggestions for optimizing their instructional strategies.

Teacher Mate represents an essential tool for modern educators, enhancing efficiency and enabling a more student-centered approach to teaching.

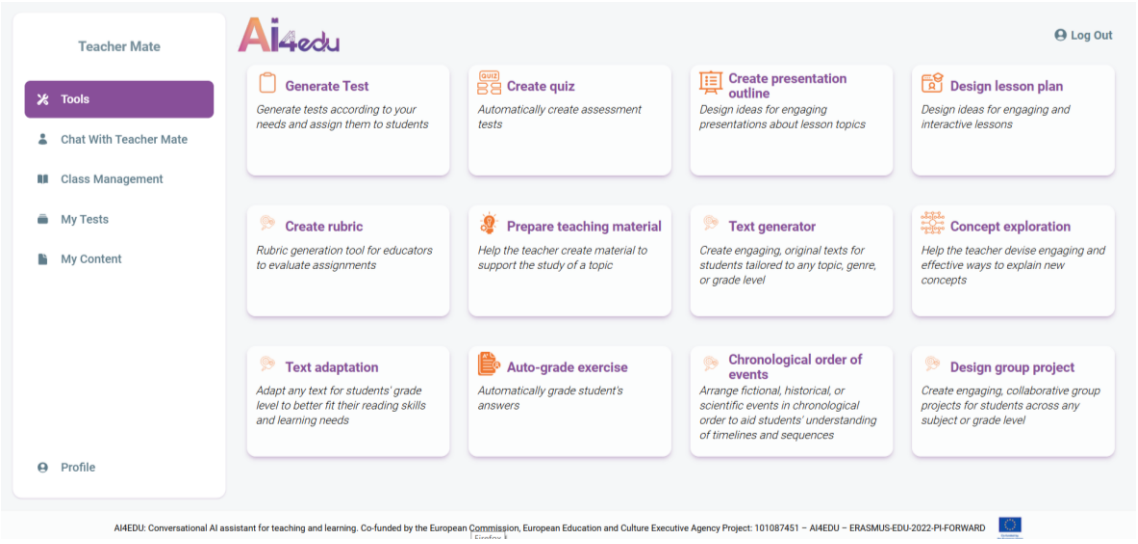

Figure 2: Teacher Mate interface

4.2. Evaluation Instruments

This section describes the evaluation instruments employed to measure the effectiveness of these tools. These include assessments, surveys, and observation protocols, each tailored to capture different aspects of the project's outcomes. The structure, purpose, and method of administration for each instrument are elaborated to ensure a comprehensive understanding of the evaluation process.

4.2.1. Motivation & Engagement survey

The Motivation and Engagement Survey (Lee & Reeve, 2012) is a comprehensive tool designed to evaluate students' engagement levels and motivational states in their respective subjects. Adapted from established psychological frameworks, this survey employs 38 statements structured on a 5-point Likert scale. Students express their agreement or disagreement with each statement, offering insights into their attitudes and behaviors towards learning.

This instrument measures critical dimensions of student engagement, including behavioral, emotional, cognitive, and agentic aspects, as well as motivational constructs such as psychological need satisfaction, self-efficacy, and mastery goals. By doing so, it provides a multifaceted understanding of how students interact with their learning environment, their intrinsic and extrinsic drivers, and their commitment to academic tasks.

The survey is administered before and after the implementation phase, enabling comparisons over time to assess the impact of the AI applications. Data collected through this survey are anonymized and aggregated to ensure ethical compliance and privacy.

4.2.2. Pre & post- academic performance tests

To evaluate students' academic performance and understanding of key concepts, subject-specific pre- and post-tests will be designed and administered. These assessments aim to measure students' baseline knowledge at the beginning of the implementation phase and their progress after exposure to the AI4EDU applications.

Test design: The pre- and post-tests are collaboratively designed by the participating teachers and local partners to ensure alignment with the subject curriculum and learning objectives. Each test focuses on the core concepts and skills relevant to the subject and reflects the specific topics covered during the implementation period. This approach ensures the assessments are contextually appropriate and directly linked to the instructional content.

Structure and Administration: The assessments may include a variety of formats to cater to different learning domains and subject requirements:

- **Multiple-choice questions** to evaluate conceptual understanding and factual recall.
- **Short-answer questions** to assess application and analytical skills.
- **Essay-style prompts** (where applicable) to gauge higher-order thinking and synthesis.
- **Hands-on exercises** to evaluate practical application of concepts and problem-solving skills.
- **Small projects** that encourage deeper exploration of topics and showcase creativity and critical thinking.

The tests are administered in two stages:

Pre-tests: Conducted during the pre-implementation phase, these tests establish baseline academic performance for both the experimental and control groups.

Post-tests: Administered at the conclusion of the implementation phase, these tests measure students' progress and provide insights on the effectiveness of the AI applications in enhancing learning outcomes.

By incorporating a variety of assessment formats and aligning them closely with curriculum goals, the subject-specific pre- and post-tests provide a comprehensive measure of students' academic performance and learning progress.

4.2.3. Usage Logs

The log files generated by Study Buddy and Teacher Mate serve as a valuable source of data for evaluating the usage patterns and engagement levels of students and teachers with the AI4EDU applications. These logs provide insights into how the various tools are utilized and their potential impact on teaching and learning processes.

The primary purpose of analyzing log files is to understand how users interact with the applications, identify patterns of usage, and explore correlations between engagement levels and educational outcomes. This data complements the results from other evaluation instruments, providing a holistic view of the AI tools' effectiveness.

Data Captured: Each application collects detailed logs during its use, including:

For Study Buddy:

- Frequency and duration of student interactions.
- Specific tools accessed (e.g., Explain Term, Summarize Text, Assessment Quiz).
- Number and type of quizzes completed.
- Revision and feedback requests for written assignments.
- Usage of the chatbot feature, including the nature of student queries and interactions.
- Test submissions and performance tracking on assigned assessments.

For Teacher Mate:

- Tools used for lesson preparation, such as Create Lesson Plan, Create Quiz, and Generate Test.
- Frequency and type of content uploaded or generated by teachers.
- Features utilized for grading and feedback.
- Teacher interaction with the dashboard, including monitoring class progress and reviewing student performance.

Analysis: The usage logs will undergo detailed analysis to:

- **Evaluate Engagement:** Determine the extent and consistency of usage across different user groups.
- **Feature Utilization:** Identify the most and least used features, providing insights into user preferences and application usability.
- **Correlate with Outcomes:** Explore relationships between usage metrics (e.g., frequency of interactions, time spent on tasks) and academic performance or engagement outcomes, as measured by other instruments.
- **Identify Challenges:** Pinpoint areas where users faced difficulties or underutilized tools or features.

Ethical Considerations: The collection and analysis of log files will strictly adhere to ethical guidelines, ensuring data privacy and security:

- No personally identifiable information contained in the log data will be revealed in any of the reports, deliverables or datasets that might be compiled as a result of the evaluation activities.
- Logs will be securely stored in a centralized database with restricted access to authorized personnel. Any computer hosting log files will have password protection

to block access by unauthorized users. Only members of the AI4EDU research team will have access to the passwords.
- The data will solely be used for the purpose of evaluating the AI4EDU applications and investigating their impact on teaching and learning.

By providing detailed insights into user behavior, the log files play a critical role in assessing the real-world impact of Study Buddy and Teacher Mate on teaching and learning, while also informing potential enhancements to these tools.

4.2.4. Teacher Interviews

Semi-structured interviews serve as an essential qualitative instrument for gaining deeper insights into the experiences, perceptions, and challenges faced by teachers during the whole process. These interviews provide a platform for participants to share their perspectives in their own words, complementing quantitative data and offering a richer understanding of the tools' impact.

4.2.4.1. Teacher Initial Interview

The initial semi-structured interviews with teachers aim to establish a baseline understanding of their instructional practices, resource selection methods, assessment strategies, and familiarity with AI tools before the implementation of Teacher Mate and Study Buddy. These interviews also explore teachers' expectations, concerns, and perspectives regarding the integration of AI-driven applications into their classrooms, providing qualitative insights that complement other evaluation instruments.

Protocol for Conduction:

- **Participants:** All teachers recruited for the AI4EDU project will participate in the initial interviews.
- **Format:** Semi-structured interviews, conducted either in person or via an online platform, based on the availability and preference of the teacher.
- **Duration:** Approximately 30.
- **Facilitator:** The local project partner will conduct the interview, ensuring a comfortable and open environment that encourages honest and thoughtful responses.
- **Recording and notes:** With the consent of the participants, interviews will be audio-recorded for transcription and analysis. Key points will also be documented by the facilitator during the session.
- **Confidentiality:** Participants will be assured that their responses will remain confidential, anonymized in reports, and used solely for the purposes of the AI4EDU evaluation.

Axes of Inquiry and Sample Questions

Section 1: Teaching Practices and Procedural Considerations

This section aims to understand teachers' current instructional methods, resource utilization, and evaluation strategies.

1. **Lesson Planning:**
   - Can you describe your typical process for designing a lesson plan?
   - What factors do you consider most important when developing a lesson?
   - How do you ensure that your lesson plans cater to different learning styles and needs?

2. Resource Development and Selection
   - What resources do you typically use to support your lessons?
   - Do you prefer creating your own teaching materials or adapting existing ones? Why?
   - How do you decide which teaching resources to use for a particular topic or lesson?
3. Evaluation and Assessment
   - How do you develop evaluation activities for your students?
   - Can you walk me through the process you follow when designing assessment tasks?
   - What challenges do you face in evaluating students' learning outcomes?

Section 2: Experiences with AI Tools

This section seeks to gauge teachers' familiarity with and attitudes toward AI in their professional and personal lives.

4. Personal Use of AI
   - Have you used AI tools in your daily life outside of teaching? If so, which ones?
   - How comfortable are you with using AI technologies in general?
5. AI in Teaching Practices
   - Have you ever integrated any AI tools into your teaching? If yes, how?
   - What has been your experience using AI in the classroom, if any?

Section 3: Expectations and Concerns about Teacher Mate and Study Buddy

This section delves into teachers' perceptions, expectations, and apprehensions regarding the AI4EDU applications.

6. Expectations for Teacher Mate
   - What are your initial thoughts on using Teacher Mate as part of your teaching practice?
   - What potential benefits do you anticipate from using Teacher Mate in lesson planning or student assessment?
7. Concerns for Teacher Mate
   - Do you have any concerns about using Teacher Mate? If so, what are they?
   - How do you think it might impact your current teaching methods?
8. Students' Use of Study Buddy
   - How do you envision your students using Study Buddy?
   - What potential benefits or challenges do you foresee in your students' interaction with Study Buddy?
9. Ideas and Dilemmas Related to AI Tools
   - What ideas or suggestions do you have for improving the integration of AI tools in education?
   - Are there any dilemmas or ethical concerns that come to mind regarding the use of AI in education, either by teachers or students?

Outputs and Use of Data: The data gathered from these interviews will be transcribed, anonymized, and analyzed thematically to identify patterns in teaching practices, AI familiarity, and expectations. These findings will provide a qualitative baseline for comparing post-implementation teacher experiences.

4.2.4.2. Post-Implementation Teacher Interviews

The Post-Implementation Teacher Interviews aim to capture teachers' reflections, experiences, and perceptions after integrating Teacher Mate into their instructional practices. These interviews provide valuable qualitative data on the challenges, successes, and overall impact of the AI4EDU applications on teaching efficacy and student engagement, complementing the findings from other evaluation instruments.

Protocol for Conduction

- **Participants:** All participating teachers will be interviewed.
- **Format:** Semi-structured interviews conducted either in person or online, depending on teachers' availability and preference.
- **Duration:** Approximately 30 minutes.
- **Facilitator:** Local project partners will conduct the interviews to ensure continuity and rapport with participants.
- **Recording and Notes:** With consent, interviews will be recorded for transcription and analysis, and facilitators will also take notes on key observations during the session.
- **Confidentiality:** Teachers will be reassured that all responses will be anonymized and used exclusively for the evaluation purposes of the AI4EDU project.

Axes of Inquiry and Sample Questions

Section 1: Reflections on Teaching Practices

This section seeks to understand how Teacher Mate influenced teachers' instructional strategies and overall teaching experience.

1. **Integration of Teacher Mate**
   - How did you integrate Teacher Mate into your daily teaching activities?
   - Which features of Teacher Mate did you find most useful for lesson planning, creating resources, or assessments?
   - Were there any specific tasks where Teacher Mate significantly reduced your workload or improved efficiency?
2. **Teaching Adjustments**
   - Did Teacher Mate prompt any changes in your teaching practices or instructional strategies? If yes, what were they?
   - How did the use of Teacher Mate align with your existing teaching methods?
3. **Challenges and Barriers**
   - What challenges did you encounter while using Teacher Mate?
   - Were there any technical difficulties or usability issues that affected your experience?
   - Did you face any resistance or skepticism from students or colleagues regarding the use of AI tools?

Section 2: Observations on Student Engagement and Performance

This section focuses on teachers' perceptions of how Study Buddy influenced students' learning behavior and outcomes.

4. **Student Engagement**
   - How did students in the experimental group respond to Study Buddy?
   - Did you observe any changes in their in-class engagement, motivation, or study habits after using Study Buddy?

5. **Student Performance**
   - Based on your observations, how did the academic performance of students in the experimental group compare to those in the control group?
   - Were there specific tasks or subjects where Study Buddy seemed particularly beneficial for students?
6. Student Challenges
   - Did students encounter any difficulties in using Study Buddy?
   - Were there instances where students misused or underutilized Study Buddy?

Section 3: Overall Experience and Feedback on AI4EDU Applications

This section allows teachers to share their overall impressions of both AI applications.

7. **Teacher Mate**
   - What are your overall impressions of Teacher Mate as a tool for teaching?
8. **Study Buddy**
   - How effective was Study Buddy in supporting students' independent learning?
9. **Suggestions for Future Use**
   - What recommendations would you make for integrating AI tools like Teacher Mate and Study Buddy into broader teaching practices or curricula?
   - How likely are you to continue using these tools in your teaching, and why?

Outputs and Use of Data

The qualitative data gathered from these interviews will be analyzed to identify recurring themes and unique insights into the implementation process. Key findings will help assess the real-world applicability of Teacher Mate and Study Buddy, refine their functionalities, and inform recommendations for broader adoption in educational settings.

4.2.5. Observation protocols

Observation protocols serve as a qualitative tool for systematically documenting teaching practices, classroom dynamics, and student behavior during the implementation phase. These protocols ensure that the integration of the AI4EDU applications aligns with the intended goals and implementation guidelines, while also providing insights into the real-world interactions between teachers, students, and the AI applications.

The primary goal of the observation protocol is to gather data on the fidelity of implementation, the effectiveness of the AI applications, and their influence on teaching and learning processes. Specifically, observations will focus on:

- **Teacher practices:** How teachers use Teacher Mate for lesson delivery, assessment creation, and classroom management.
- **Student engagement:** How students interact with Study Buddy and their level of engagement during classroom activities.
- **Classroom dynamics:** The overall flow of lessons, collaboration among students, and the role of the AI applications in shaping classroom interactions.
- **Challenges and successes:** Any obstacles or breakthroughs experienced by teachers and students when using the AI tools.

To provide a structured evaluation framework, the observation protocol will incorporate SWOT Analysis (Keban et al., 2019) and NOISE Analysis (Yusoff, 2024), ensuring that all critical aspects of the AI applications' impact are captured comprehensively.

SWOT Analysis: Observers will assess the following:

- **Strengths (S):** What aspects of Teacher Mate and Study Buddy are facilitating effective teaching and learning? For example, are there specific features that enhance lesson delivery or student understanding?
- **Weaknesses (W):** What difficulties do teachers or students encounter while using the applications? These could include technical issues, usability challenges, or pedagogical limitations.
- **Opportunities (O):** Are there areas where the AI tools could be further leveraged to improve educational outcomes? For instance, could specific features be used more creatively or frequently?
- **Threats (T):** What risks or barriers could undermine the success of the implementation? These might include resistance to change, lack of training, or resource limitations.

NOISE Analysis: Observers will also address:

- **Needs:** What additional support, resources, or adjustments are required for successful implementation? This could include teacher training, technical support, or clearer instructional materials.
- **Opportunities:** What innovative or unexpected uses of the AI tools have emerged during implementation? How can these use cases be expanded upon?
- **Improvements:** What specific recommendations can be made to enhance the integration of the tools in the learning and teaching practice?
- **Strengths:** What positive practices or successful integrations of the AI tools stand out and should be continued or scaled up?
- **Exceptions:** Are there any unique scenarios or deviations from expectations that warrant further exploration or adjustment?

Observation Schedule and Administration

Observations will be conducted throughout the implementation phase by the teachers or the local project partners who may visit classrooms, ensuring consistency in the application of the protocol. Observation sessions will typically last for the duration of a lesson, capturing:

- Teacher and student interactions with the AI tools.
- The flow of activities, from lesson delivery to student tasks.
- Responses to challenges or technical issues encountered during the session.

Data collected through the observation protocols will be analyzed qualitatively to identify trends, patterns, and areas for improvement. Findings from SWOT and NOISE analyses will be synthesized into actionable recommendations, which will inform future implementation strategies. These insights will also complement quantitative data, providing a holistic view of the AI4EDU applications' impact on teaching and learning.

By integrating SWOT and NOISE frameworks, the observation protocols ensure a comprehensive and balanced evaluation of the AI applications, capturing their strengths, challenges, and areas for growth.

4.2.6. Students' Questionnaire

The Student Post-Implementation Questionnaire is designed to gather insights into students' experiences and perceptions of Study Buddy, capturing their engagement with the application and its impact on their learning process. Administered at the conclusion of the

implementation phase, this questionnaire serves as a vital instrument for assessing the qualitative and subjective dimensions of the AI4EDU project.

Purpose and Objectives: The primary objectives of the tool are to:

1. Evaluate students' satisfaction with the Study Buddy application.
2. Understand how students utilized the various features of Study Buddy in their study routines.
3. Identify perceived benefits, challenges, and areas for improvement regarding the integration of the platform in their everyday practice.
4. Measure the impact of Study Buddy on students' engagement, motivation, and overall academic experience.

The questionnaire complements the quantitative data collected through academic performance tests and usage logs by providing a direct account of students' experiences, offering context to the observed outcomes.

Questionnaire Structure and Administration: The questionnaire will consist of three sections, featuring both closed-ended and open-ended questions:

- **Section 1:** Usage and Engagement (Closed-ended questions) Focused on how frequently and extensively students used Study Buddy and which features were most utilized.
- **Section 2:** Perceived Impact (Closed-ended and Likert-scale questions) Addressing students' perceptions of how Study Buddy influenced their learning, motivation, and confidence.
- **Section 3:** Open Feedback (Open-ended questions) Encouraging students to provide qualitative feedback on their overall experience, highlighting specific challenges or suggestions for improved integration of the platform in their everyday studying practice.

The questionnaire will be administered in person or online during the final week of the implementation phase, ensuring that all students in the experimental group have adequate time to reflect on their experiences. Responses will remain anonymous to encourage honesty and reduce bias.

Data Analysis and Reporting: The data collected from the questionnaire will be analyzed using a combination of quantitative and qualitative methods:

- **Quantitative Data:** Responses from closed-ended questions will be aggregated and analyzed statistically to identify usage patterns, satisfaction levels, and common challenges. Descriptive statistics such as means and percentages will be calculated to summarize the data.
- **Qualitative Data:** Open-ended responses will undergo thematic analysis to extract recurring themes, providing deeper insights into students' experiences and suggestions.

Findings from the questionnaire will be integrated with the results from other evaluation instruments to present a comprehensive assessment of Study Buddy's impact on students' learning experiences. This will inform recommendations for its broader application.

5. Conclusions

This deliverable provides a comprehensive evaluation methodology for assessing the impact of the AI4EDU applications, Study Buddy and Teacher Mate, in real-world classroom settings. The methodology outlined in this document is designed to ensure that the evaluation process is robust, inclusive, and adaptable to diverse educational contexts across the participating countries. The conclusions summarize the key aspects of the proposed methodology and its significance in achieving the project's objectives.

5.1. Key Insights

Systematic and Phased Approach: The evaluation is structured into three distinct phases, pre-implementation, implementation, and post-implementation. Each phase encompasses clearly defined activities, ensuring a logical flow and thorough preparation, deployment, and analysis. This phased approach ensures alignment between the objectives of the project and the data collection and analysis methods.

Comprehensive Evaluation Instruments: The methodology employs a mixed-methods approach, integrating quantitative and qualitative tools to capture the multifaceted impact of the AI applications. The evaluation instruments include:

- Pre- and post-tests to assess academic performance.
- Motivation and engagement surveys to capture students' learning attitudes.
- Semi-structured teacher interviews to understand instructional practices, expectations, and experiences.
- Observation protocols enriched with SWOT and NOISE analyses to evaluate classroom dynamics and tool implementation fidelity.
- Usage logs from Study Buddy and Teacher Mate to analyze user engagement and feature utilization.
- A post-implementation student questionnaire to gather feedback on the application's perceived impact.

Alignment with Research Questions: The methodology has been carefully designed to address the key research questions of the project. By combining data from multiple sources, the evaluation aims to provide a holistic understanding of how Study Buddy and Teacher Mate influence teaching efficiency, student motivation, engagement, and learning outcomes.

Ethical and Context-Sensitive Framework: Ethical considerations are central to the proposed methodology. Measures include informed consent, data anonymization, and secure storage, ensuring participant privacy and compliance with ethical standards. The methodology also emphasizes adaptability to the cultural and educational contexts of the participating countries, ensuring relevance and inclusivity.

5.2. Anticipated Contributions

The proposed methodology aims to contribute significantly to the understanding and application of AI-driven applications in education. Specifically, it is expected to:

Provide Actionable Insights: By employing rigorous evaluation methods, the project will generate evidence-based insights into the benefits and challenges of integrating AI applications into teaching and learning. These insights will inform the development of best practices for AI adoption in education.

Inform Policy and Practice: The findings derived from this methodology will offer valuable guidance to educators, policymakers, and developers seeking to leverage AI technologies in educational settings. The evidence will support informed decision-making on the design, implementation, and scaling of AI tools.

Foster Innovation: The evaluation framework highlights areas for iterative improvement, ensuring that Study Buddy and Teacher Mate continue to evolve based on user needs and contextual requirements. This adaptability will enhance their relevance and effectiveness in diverse educational environments.

5.3. Future Directions

The methodology outlined in this deliverable represents the foundation for the evaluation phase of the AI4EDU project. The next steps involve implementing the proposed framework, gathering and analyzing data, and synthesizing findings to provide a comprehensive understanding of the applications' impact. Future iterations of the evaluation process may incorporate additional tools and methods based on emerging insights and technological advancements.

By adopting a thorough and forward-looking approach, the AI4EDU project positions itself to contribute meaningfully to the integration of AI in education, fostering a more inclusive, engaging, and effective learning ecosystem.

6. References

Amineh, R. J., & Asl, H. D. (2015). Review of constructivism and social constructivism. *Journal of social sciences, literature and languages*, *1*(1), 9-16.

Gover, A., Loukkola, T., & Peterbauer, H. (2019). *Student-centred learning: approaches to quality assurance*. www.eua.eu

Gover, A., Loukkola, T., & Peterbauer, H. (2019). Student-centred learning: approaches to quality assurance. *EUA (European University Association)*.

Keban, Y. B., Arifin, S., & Wahyono, R. (2019). SWOT analysis and its implementation strategies in educational management. *Journal of Education and Practice*, *10*(12), 86-92.

Lee, W., & Reeve, J. (2012). Teachers' estimates of their students' motivation and engagement: Being in synch with students. *Educational Psychology*, *32*(6), 727–747. https://doi.org/10.1080/01443410.2012.732385

Ryan, R. M., & Deci, E. L. (2022). Self-Determination Theory. In *Encyclopedia of Quality of Life and Well-Being Research* (pp. 1–7). Springer International Publishing. https://doi.org/10.1007/978-3-319-69909-7_2630-2

Sweller, J. (2011). Cognitive Load Theory. The Psychology of Learning and Motivation, 55, 37–76. https://doi.org/10.1016/B978-0-12-387691-1.X0001-4

Todorovski, B., Nordal, E., & Isoski, T. (2015). Overview on Student-Centered Learning in Higher Education in Europe: Research Study. *European Students' Union*.

Yusoff, M. S. B. (2024). A Practical Guide Using the NOISE Analysis Model for Strategic Action Planning in Health Profession Education. *Education in Medicine Journal*, *16*(2), 199–210. https://doi.org/10.21315/eimj2024.16.2.15

7. Appendices

7.1. Motivation & Engagement Survey

Instructions for students

This questionnaire contains statements about your willingness in participating in this class. You will be asked to express your agreement on each statement. There are no "right" or "wrong" answers. Your opinion is what is wanted. Think about how well each statement describes your willingness in participating in this class.

Draw a circle around:

1. if you strongly disagree with the statement
2. if you disagree with the statement
3. if you have no opinion on the statement
4. if you agree with the statement
5. if you strongly agree with the statement

Some statements in this survey are fairly similar to other statements. Don't worry about this, just be sure to give an answer for all statements. If you change your mind about an answer, just cross it out and circle another.

Your Name/ personal code: _____ Grade: ____ Gender: _____

Teacher's Name: _____ School: _____ Subject: _____

1. What resources do you typically use when studying at home?

- ☐ Textbooks
- ☐ Class notes
- ☐ Digital tools
- ☐ Other: _____

2. Do you currently use any digital tools or applications to assist you in studying? What type of digital tools do you use? (Select all that apply)

- ☐ Online learning platforms (e.g., Khan Academy, Coursera, edX)
- ☐ Educational apps (e.g., Duolingo, Quizlet, WolframAlpha)
- ☐ Digital textbooks and e-books
- ☐ Study planners or task management tools (e.g., Google Calendar, Todoist, Trello)
- ☐ AI-based tools (e.g., ChatGPT, AI tutors, automated writing assistants)
- ☐ Flashcard or quiz apps (e.g., Anki, Cram)
- ☐ Other: _____

No	Statement	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
1	During the class, I feel free.	1	2	3	4	5
2	During the class, I feel I am doing what I want to do.	1	2	3	4	5
3	During the class, I feel free to decide for myself what to do.	1	2	3	4	5
4	During the class, I feel pushed and pressured. (-)	1	2	3	4	5
5	During the class, I feel capable.	1	2	3	4	5
6	During the class, I feel competent.	1	2	3	4	5
7	During the class, I feel my skills are improving.	1	2	3	4	5
8	During the class, I feel I belong and the people here care about me.	1	2	3	4	5
9	During the class, I feel involved with close friends.	1	2	3	4	5
10	During the class, I feel emotionally close to the people around me.	1	2	3	4	5
11	I am certain I can master the skills taught in class this year.	1	2	3	4	5
12	I am certain I can figure out how to do the most difficult class work.	1	2	3	4	5
13	I can do almost all of the work in this class if I do not give up.	1	2	3	4	5
14	Even if the work is hard, I can learn it.	1	2	3	4	5
15	I can do even the hardest work in this class if I try.	1	2	3	4	5
16	I am striving to understand the content of this course as thoroughly as possible.	1	2	3	4	5
17	My aim is to completely master the material presented in this class.	1	2	3	4	5
18	In this class, my goal is to learn as much as possible.	1	2	3	4	5
19	I try to work very hard in this class.	1	2	3	4	5
20	When I am in this class, I listen very carefully.	1	2	3	4	5
21	I put a lot of effort into this class.	1	2	3	4	5
22	Even with really difficult problems, I keep working hard.	1	2	3	4	5
23	When I am in class, my mind often wanders, and I think about other things (-)	1	2	3	4	5

24	When I am in this class, I feel good.	1	2	3	4	5
25	The class is fun.	1	2	3	4	5
26	This class is very interesting to me.	1	2	3	4	5
27	My curiosity is constantly stimulated in this class.	1	2	3	4	5
28	During this class, I often feel unhappy and discouraged. (-)	1	2	3	4	5
29	Before starting an assignment for this class, I try to figure out the best way to do it.	1	2	3	4	5
30	In this class, I keep track of how much I understand the work, not just if I am getting the right answers.	1	2	3	4	5
31	If what I am working on in this class is difficult for me to understand, I figure out how to change the way I learn the material for the better.	1	2	3	4	5
32	When I study for this course, I often don't know where to start or what to do. (-)	1	2	3	4	5
33	I find it difficult to make sense of what we are learning in this class (-)	1	2	3	4	5
34	During this class, I ask questions.	1	2	3	4	5
35	I tell my teacher what I like and what I do not like.	1	2	3	4	5
36	I let my teacher know what I am interested in.	1	2	3	4	5
37	During this class, I express my preferences and opinions.	1	2	3	4	5
38	I offer suggestions about how to make the class better.	1	2	3	4	5

7.2. Student Post-Implementation Questionnaire

Thank you for participating in this study! This questionnaire is designed to gather your feedback about your experiences using the Study Buddy application. Your honest and thoughtful responses will help us better understand how it supports learning.

- Your answers are anonymous, so please feel free to share your true opinions.
- There are no right or wrong answers. Your personal experiences and thoughts matter most.
- Please complete all sections of the questionnaire to the best of your ability.

If you have any questions about how to complete it, feel free to ask your teacher for clarification.

Section 1: Usage and Engagement

1. How often did you use Study Buddy during the implementation period?

☐ Daily

☐ Several times a week

☐ Once a week

☐ Less than once a week

2. How much time did you typically spend using Study Buddy in a single session?

☐ Less than 10 minutes

☐ 10–30 minutes

☐ 30–60 minutes

☐ More than 60 minutes

3. Which Study Buddy features did you use most frequently? (Select all that apply)

☐ Explain Term

☐ Summarize Text

☐ Extract Key Points

☐ Assessment Quiz

☐ Revise Written Assignment

☐ Grading

☐ Conversational Chatbot

Section 2: Perceived Impact

4. To what extent do you agree with the following statements?
   a. Study Buddy helped me better understand the subject material.

☐ Strongly disagree ☐ Disagree ☐ No opinion ☐ Agree ☐ Strongly agree

   b. Study Buddy made studying more engaging and enjoyable.

☐ Strongly disagree ☐ Disagree ☐ No opinion ☐ Agree ☐ Strongly agree

   c. Study Buddy helped me stay organized and manage my time effectively.

☐ Strongly disagree ☐ Disagree ☐ No opinion ☐ Agree ☐ Strongly agree

   d. Study Buddy improved my confidence in completing assignments and tests.

☐ Strongly disagree ☐ Disagree ☐ No opinion ☐ Agree ☐ Strongly agree

5. How would you rate the overall ease of using Study Buddy?

- ☐ Very Easy
- ☐ Easy
- ☐ Neutral
- ☐ Difficult
- ☐ Very Difficult

6. Did you encounter any technical issues while using Study Buddy?

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently

Section 3: Open Feedback

7. What did you like most about Study Buddy?

.....

.....

.....

.....

.....

8. What did you find challenging or frustrating about using Study Buddy?

.....

.....

.....

.....

.....

9. If you could change one thing about Study Buddy, what would it be?

.....

.....

.....

.....

.....

10. Do you think Study Buddy should be used in other subjects or classrooms? Why or why not?

.....

.....

.....

.....

.....