First version of the AI assistant for students prototype

Date – 29.02.2024

Grant Agreement n°	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, Tonepikoinonion 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)

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	14.02.24	-	Draft	ARC
1.0	26.02.24	ALL	Version 1.0	ARC
Validation				
No.	**Action**	**Beneficiary**		**Date**
1	Prepared	ARC		26.02.24
2	Approved	ARC		28.02.24
3	Approved	LTU		29.02.24
4	Released	ARC		29.02.24

Co-funded by the European Union

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Executive Summary

This deliverable outlines the first phase of implementation for the Study Buddy application under the AI4EDU project, introducing an AI-powered platform designed to enhance the student learning experience through advanced dialogue systems and personalized learning strategies. Study Buddy is developed to provide students with a comprehensive support system, facilitating their engagement and learning across various educational activities.

Central to Study Buddy is its AI dialogue system, capable of interacting with students in natural language to help with study-related tasks. This includes explaining concepts, answering questions, and providing study tips, effectively serving as a mentor, tutor, and test facilitator. The integration of advanced language models enables Study Buddy to engage on a wide range of topics, creating a more interactive and responsive learning environment.

The platform offers distinct functionalities tailored to different needs: as a Mentor, it provides feedback on students' work; as a Tutor, it delivers direct instruction and educational guidance; and through its Test Interface, it offers a user-friendly and efficient assessment experience. These features are crafted using sophisticated prompt engineering techniques, allowing Study Buddy to adapt its interactions based on individual learning styles, performance, and prior interactions.

Study Buddy's ability to integrate educational content, especially textbooks, enhances its capacity to provide relevant and curriculum-aligned support. This ensures that the assistance offered is contextually appropriate, improving educational outcomes. The platform also benefits educators by offering insights into student progress, thereby facilitating a more tailored educational approach.

The web-based Test Interface of Study Buddy introduces an intuitive, secure, and effective way for conducting assessments, improving the test-taking experience for students and providing educators with a reliable tool for evaluation and feedback. The platform's emphasis on data privacy and test integrity highlights its commitment to providing a secure educational environment, in line with the European standards and recommendations for ethical AI deployment in educational settings ("Ethical guidelines on the use of artificial intelligence and data in teaching and learning for educators", published by the EC in October 2022).

In summary, Study Buddy offers a comprehensive toolset that enriches the student learning experience and supports educators in delivering more effective instruction. By making learning more accessible, interactive, and personalized, Study Buddy contributes significantly to improving educational outcomes. Furthermore, it provides a unique opportunity for students to familiarize themselves with AI technologies in a safe and controlled environment, fostering an understanding and comfort with these emerging tools.

Acronyms and abbreviations

Abbreviation	Description
AI4EDU	Artificial Intelligence for Education (project name)
SB	Study Buddy
RAG	Retrieval-Augmented Generation
LLM	Large Language Model
AI	Artificial Intelligence
GPT	Generative Pretrained Transformer

1. Introduction - Purpose of the Deliverable

1.1. Introduction

Study Buddy, developed within the AI4EDU project, is a cutting-edge platform aimed at enhancing students' learning experiences by offering personalized academic support. Drawing on the needs identified in Deliverable D2.1 and the framework established in Deliverable D2.2, SB introduces a range of innovative features. These include an AI-driven tutoring system for personalized guidance, integration with educational resources for curriculum alignment, and a secure environment for assessments, all designed to provide a dynamic and tailored learning environment that caters to individual student needs. Importantly, SB is a multilingual platform, offering support in English, Greek, and Swedish, and is tailored to the curricula of Sweden, Ireland, Greece, and Cyprus. Furthermore, it includes accessibility features such as a voice interface equipped with speech-to-text and text-to-speech technologies, ensuring inclusion of students with different level of needs to use the platform effectively.

1.2. Deliverable Purpose

The purpose of this document is to detail the realization of the SB platform, emphasizing the incorporation of AI to foster user engagement and the integration of educational content for curriculum relevance. It describes the platform's ability to provide intelligent tutoring, curriculum-aligned educational content, and a user-friendly, secure interface. SB is part of a broader initiative by the AI4EDU project aimed at developing technologies that make learning more interactive, inclusive and individualized, tailored to students' needs. This deliverable focuses on the system components that enable automated and interactive learning, aiming to enhance the educational value of the platform.

1.3. Relation of the Deliverable to Other Work Packages and Deliverables

This deliverable has a direct connection to Deliverable D2.1, which outlined the key needs and expectations of students, and Deliverable D2.2, which provided a comprehensive technical plan for the development of Study Buddy. Following the system architecture and database design specified in D2.2, this document elaborates on the implementation of crucial components. Additionally, it aligns with the broader goals of the AI4EDU project, which seeks to create technological solutions that support personalized, inclusive and interactive learning experiences. Through its development, SB contributes significantly to the educational innovation envisioned by the AI4EDU project, offering a multilingual, accessible platform that meets the diverse needs of students across several countries.

2. Study Buddy: AI Assistant for Students - Key Features and Use Cases

The development of SB is centered around providing a comprehensive suite of tools and features designed to enhance the learning experience for students. These functionalities aim to make studying more personalized, efficient, and interactive. SB is tailored to meet the curricular needs of students in Sweden, Ireland, Greece, and Cyprus and is accessible through the students' native languages. Here, we outline the key components and educational tools offered by SB to its users.

2.1. Key Components

- **AI Dialogue System:** Serves as a virtual tutor, enabling students to have conversations in natural language for explanations, doubts clarification, and learning new concepts.
- **Integration with Educational Content:** Seamlessly integrates with textbooks and educational materials for country-specific, curriculum-aligned learning support.
- **Multilingual Support:** Provides support in English, Greek, and Swedish, ensuring inclusivity across different educational systems.
- **Accessibility Features:** Features a voice interface with speech-to-text and text-to-speech technologies, with the aim of making the platform accessible to all students, including those with special needs.
- **Student Dashboard:** Allows students to monitor their progress, view feedback from teachers, and access personalized learning recommendations.
- **Test-Taking Interface:** Enables students to take tests assigned by teachers directly through Study Buddy, facilitating a seamless and secure assessment process.

2.2. Educational Tools

- **Explain Term:** Delivers clear explanations of terms and concepts, supplemented with examples.
- **Interactive Concept Learning:** Engages students in learning new concepts through interactive methods.
- **Summarize Text:** Summarizes texts to help students grasp main ideas quickly.
- **Extract Key Points:** Identifies and extracts key points from texts, aiding in revision.
- **Assessment Quiz:** Supports students in preparation for exams with self-assessment quizzes.
- **Revise Written Assignment:** Helps improving and polishing written assignments.
- **Grading:** Automatically grades students' answers to questions, offering immediate feedback.

2.3. Use Cases

Study Buddy is tailored around specific use cases to address the academic challenges faced by students.

- **Use Case 1 - "Streamlining Study Sessions and Assessments":** This use case focuses on how students can leverage the Student Dashboard for a comprehensive overview of their academic progress and feedback, as well as utilize the Test-Taking Interface to complete assessments assigned by their teachers. The dashboard and test management features

collectively aim to streamline study sessions and the assessment process, making learning outcomes more transparent and manageable.

- **Use Case 2 - "Dialogue Interface and Tools for Personalized Learning and Assignment Assistance":** In this scenario, students utilize the AI Dialogue System and the suite of educational tools for a tailored learning experience. These features assist in understanding complex concepts, preparing for tests, and enhancing written assignments, supporting personalized learning paths and interactive educational experiences.

In subsequent sections, we will delve deeper into these use cases, illustrating how Study Buddy's comprehensive features and educational tools facilitate a well-rounded and engaging learning journey for students.

3. Use case 1: Streamlining Study Sessions and Assessments

SB facilitates the active participation of students in the classes they are taking. First, students can monitor their progress and receive feedback through a user-friendly student dashboard. This introspection and fast feedback loop can enhance accountability and improve learning outcomes. Fig. 1 shows the student dashboard. The students can view their progress over the school year, detailed grades for each question in their last assessment, and the feedback sent by the teacher in one place.
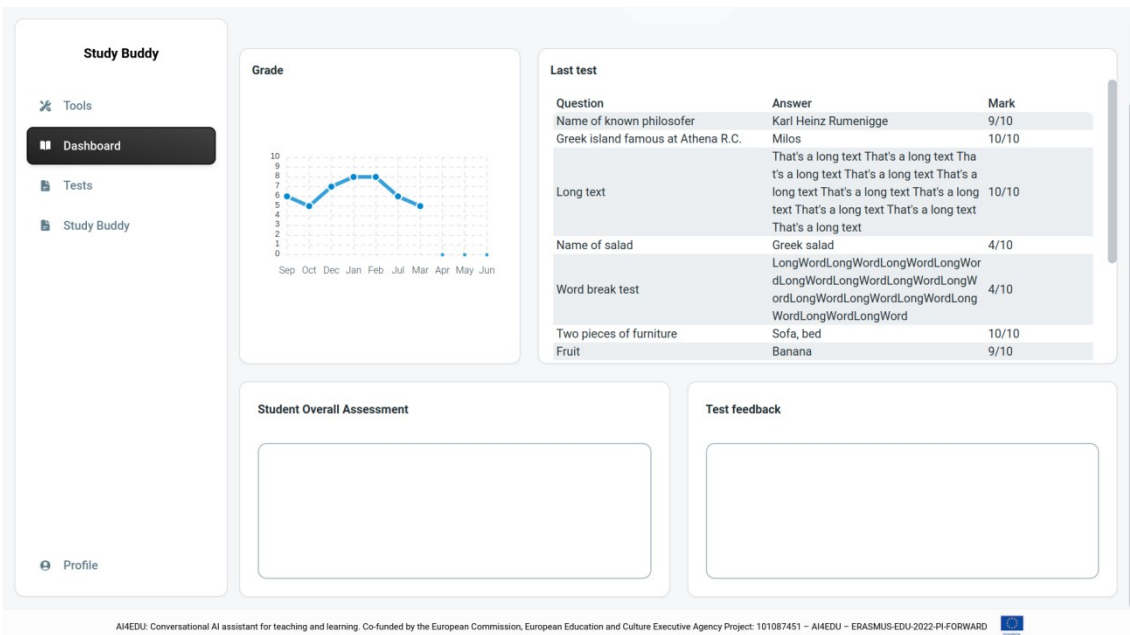

Figure 1: Student Dashboard

Second, SB facilitates test-taking, where students can complete short assessment tests assigned by the teacher. The test-taking interface is shown in Fig. 2. Each type of exercise (open, cloze, multiple choice, matching) is represented with different UI elements allowing for a user-friendly interface and better student experience.
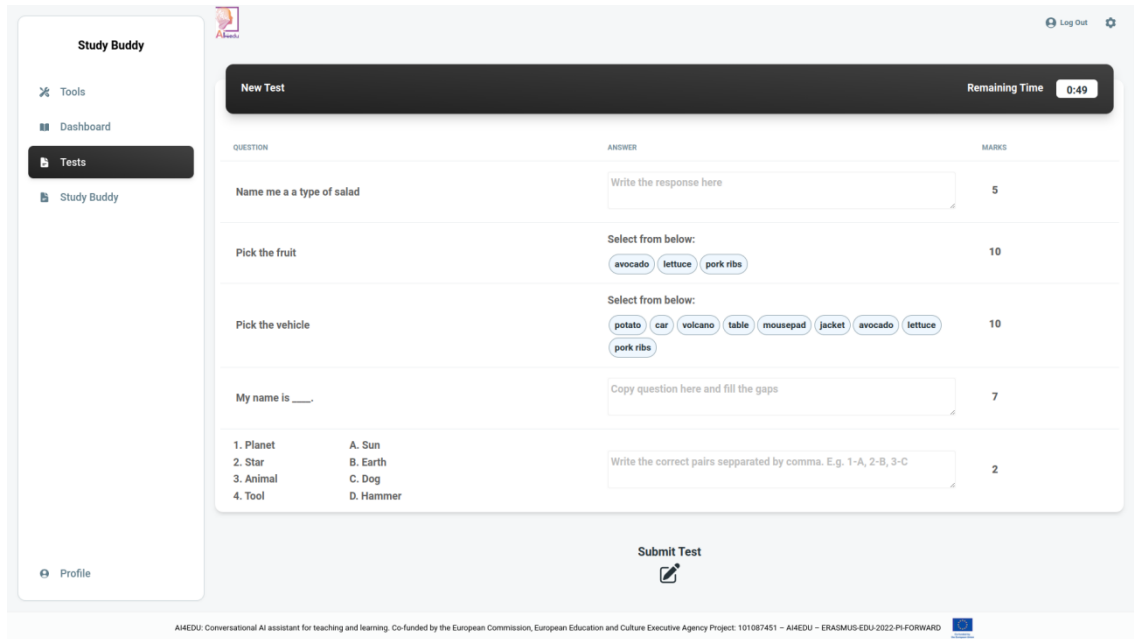
Figure 2: Test taking interface

Teacher feedback and test-taking functionality are available through the integration of Study Buddy with the Teacher Mate tool, described in D3.2. These functionalities become available to student accounts that are enrolled to classes, taught by educators who use the Teacher Mate.

4. Use case 2: Dialogue Interface and Tools for Personalized Learning and Assignment Assistance

SB offers a set of tools, tailored towards student needs. The tools are implemented through prompts and configured using dynamically created forms. This allows for easy extensibility and the fast incorporation of new tools. Furthermore, the prompts are transparent to the students, familiarizing them with modern ways to interact with LLMs, which is an essential skill for the future. This is done in the context of a controlled environment, where the LLM is primed to interact safely with students through system prompts in the backend, and the student chats can be monitored by the responsible parties for unsafe content.

The currently implemented tools aim to act either as mentors, using the Socratic method, to facilitate learning, or as tutors, aiming to assist with different learning tasks.

In Fig. 3 we can see the configuration of "Interactive concept learning", a mentor tool that gives short explanations to student queries about different concepts, while prompting the student with relevant questions, allowing them to come to a deeper understanding. In this example the student wants to learn about the concept "Settlement patterns" in the context of the "Climate change" module of the "Sustainable development" course. Note that the student can choose to either chat with the "General chat" (i.e. the LLM without a textbook backbone), or to use the course material to ground the LLM response to the class curriculum (the dropdown menu above the "Generate" button). In this case they choose the latter.
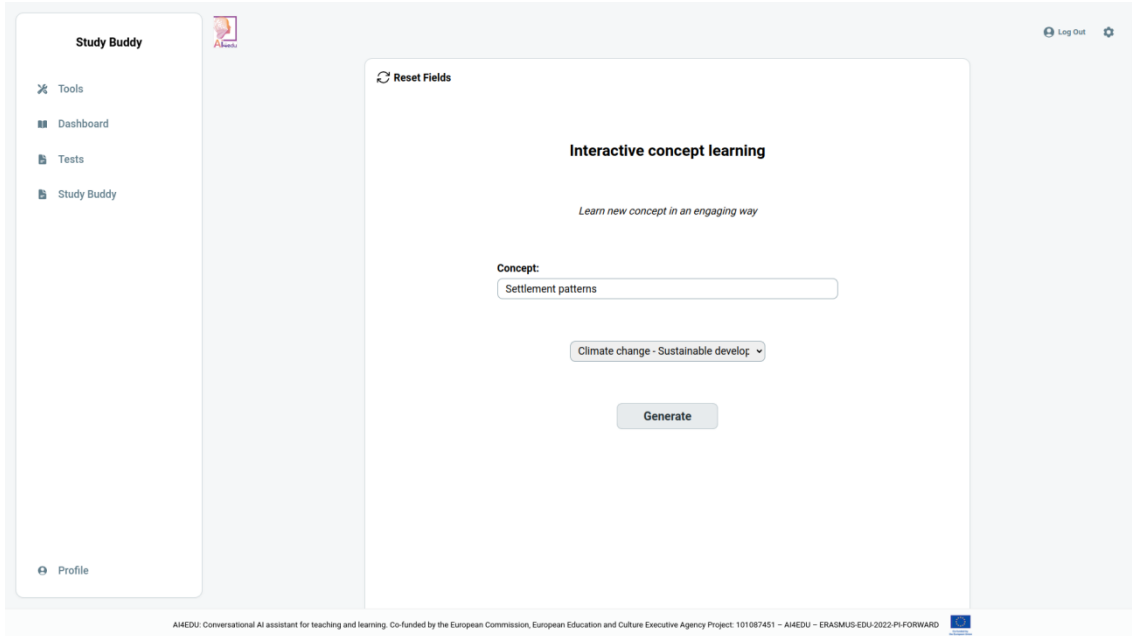
Figure 3: Interactive concept learning configuration.

In Fig. 4 we see the response of the LLM to this query. The LLM provides a short explanation and then engages the student in an interactive dialogue to help the student expand their understanding on this concept, while guiding the student through the process.
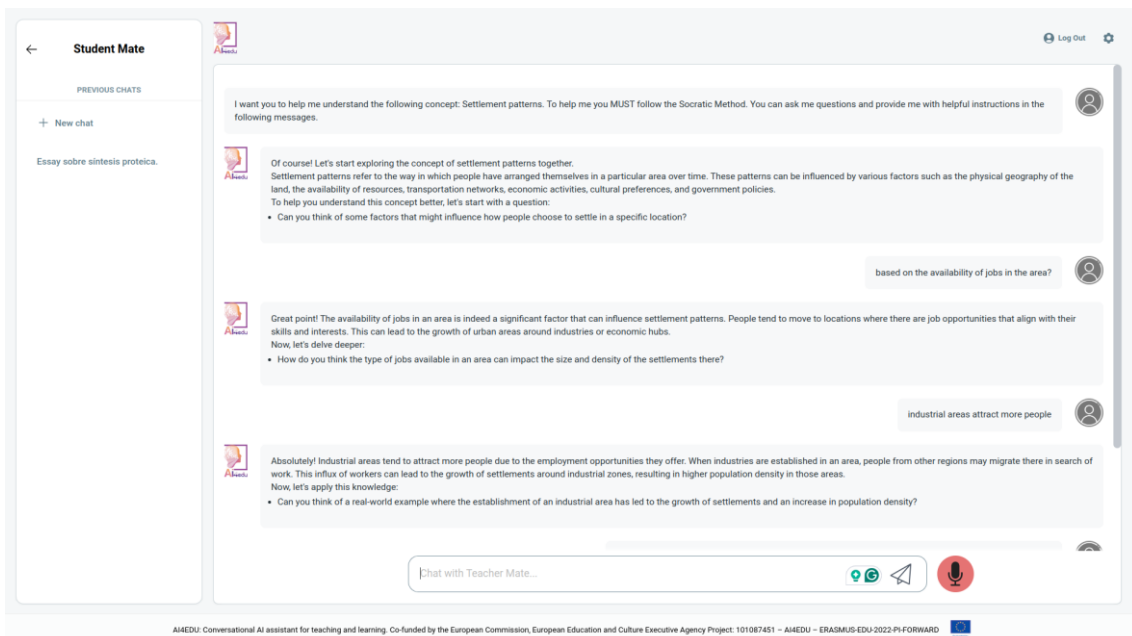

Figure 4: Interactive concept learning response

As a second example we include a "tutor" task, where the student can ask the LLM to prepare short assessment quizzes, in order to prepare for upcoming exams. This further builds upon our goal of active student participation and accountability about their learning journey. In this example the student wants to prepare for an upcoming Biology test on mitochondria, DNA, and RNA, using the "General Chat".
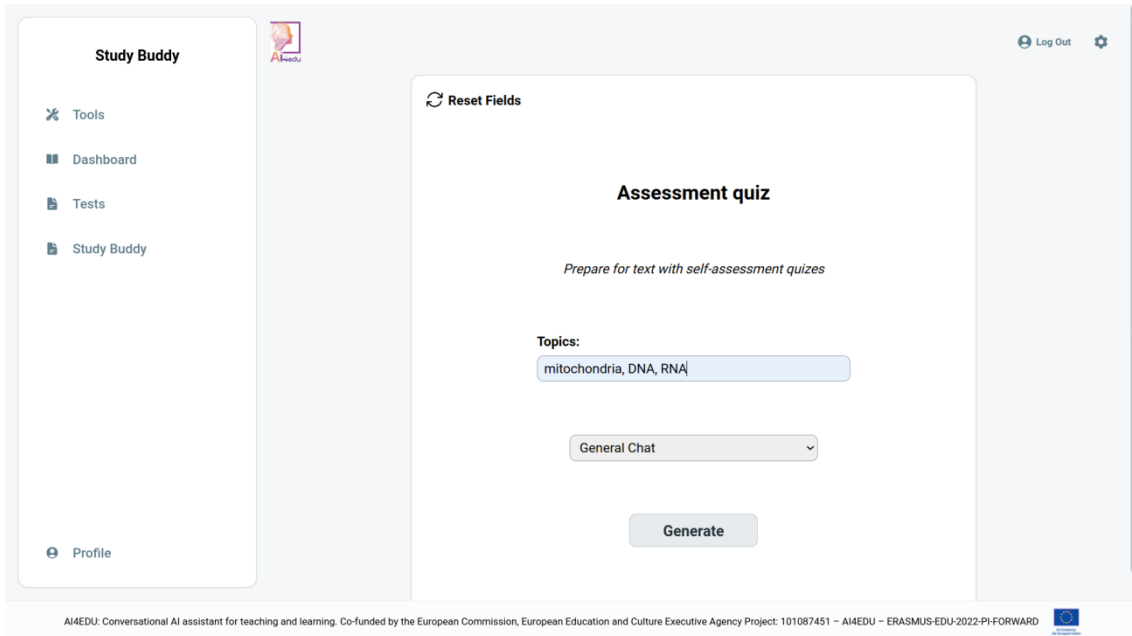
Figure 5: Assessment quiz tool configuration.

The generated assessment quiz can be seen in Fig. 6, while an interactive dialogue based on this quiz can be seen in Fig. 7.
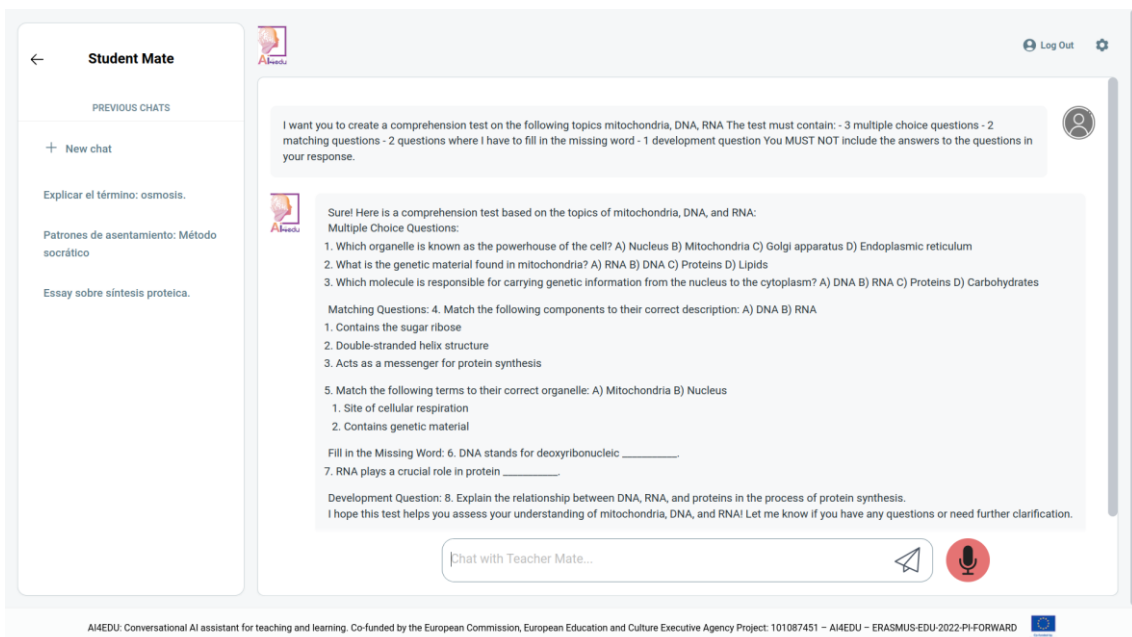

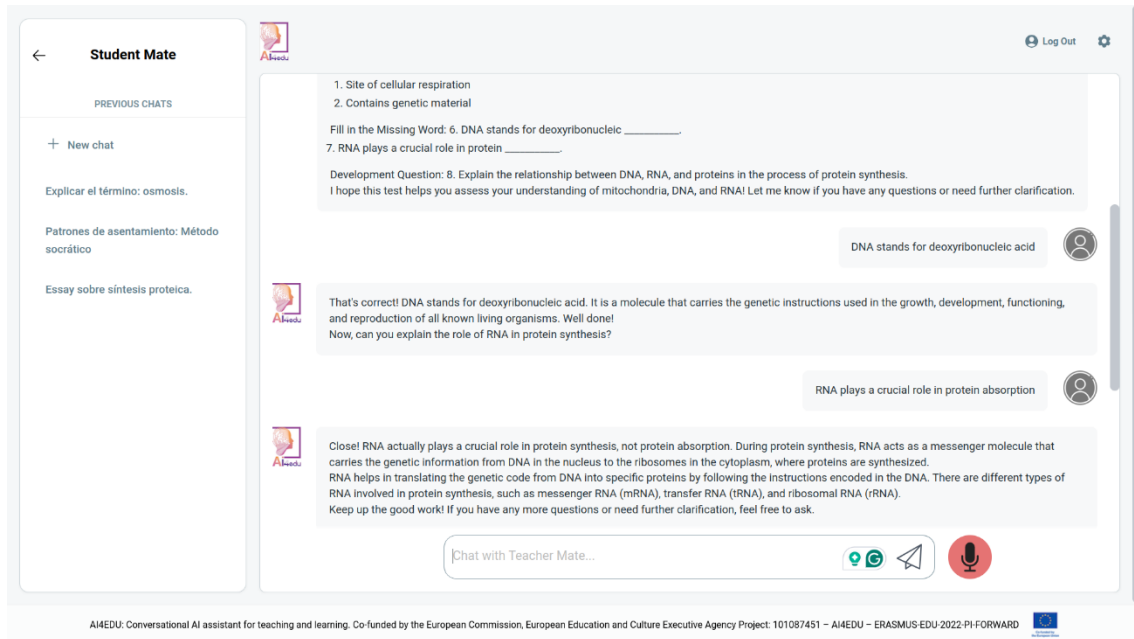Figure 6: Quiz generated using the "assessment quiz" tool.

Figure 7: SB tutors the student during their practice quiz by providing feedback to their answers, while maintaining a positive and pleasant conversation.

5. Technical details

The Study Buddy backend is implemented in Python using fastapi (https://fastapi.tiangolo.com/) and MongoDB (https://www.mongodb.com/). The frontend is implemented using ReactJS (https://react.dev/). At the current stage of development, the LLM of choice is GPT-4 (https://openai.com/research/gpt-4), specifically due to its state-of-the-art, multi-lingual capabilities. For the same reasons, we utilize Whisper (https://openai.com/research/whisper) for speech-to-text and OpenAI's text-to-speech service (https://platform.openai.com/docs/guides/text-to-speech). Nevertheless, the SB backend is designed with the ease of transition between different AI technologies in mind, and we plan to include options to integrate open, off-the-cloud LLMs and speech models as they become available for the project's target languages. To access the Study Buddy prototype development repository, please visit our GitLab repository at https://gitlab.com/ilsp-spmd-all/dialogue/chatbot-ui.

The Study Buddy prototype is accessible at the address https://apps.ilsp.gr/ai4edu/ for users who register as students. For optimal performance and user experience, it is recommended to use the Google Chrome browser (and derivatives).

6. Conclusion

In this deliverable, we presented the implementation of the Study Buddy prototype, developed as part of Work Package 3 (WP3): "First version of the AI assistant for students' prototype." Study Buddy incorporates a wide range of functionalities aimed at enhancing the learning process, including an AI Dialogue System with voice interface, a student dashboard, and a test-taking interface, alongside an array of educational tools. The system allows curriculum-aligned dialogue via RAG on the course textbooks. These components are carefully crafted based on the requirements specified in D2.2 and are tailored to support the curricula of Sweden, Ireland, Greece, and Cyprus, offering a personalized, inclusive and interactive learning experience.

The initial version of Study Buddy is set to be introduced in secondary schools across the four participating countries, targeting a diverse group of students. This phase is a crucial part of Work Package 4 (WP4): "Evaluation of Usability and Technology Acceptance," where students will engage with Study Buddy through hands-on sessions. These sessions are designed to assess the platform's usability and how well students accept the technology, including its interface, educational tools, and overall functionality. Feedback will be collected via questionnaires, observations, and analysis of student interactions with Study Buddy. The insights gained from these pilot tests will be invaluable for refining and enhancing Study Buddy. The collected data will be thoroughly reviewed and integrated into the final iteration of the Study Buddy prototype. This process is a key component of Work Package 5 (WP5): "Revision of the AI4EDU applications," ensuring that the AI assistant evolves to meet the educational needs and preferences of students effectively.

7. Appendix A: Prompts used for the Study Buddy educational tools

7.1. Explain term

Prompt: I want you to explain the following term in detail: {term}.

In your explanation you MUST include at least 1-2 examples.

At the end of the explanation you MUST include 1-2 comprehension questions.

7.2. Interactive concept learning

Prompt: I want you to help me understand the following concept: {concept}.

To help me you MUST follow the Socratic Method.

You can ask me questions and provide me with helpful instructions in the following messages.

7.3. Summarize text

Prompt: I want you to summarize the following text: {text}

7.4. Extract key points

Prompt: I want you to give me the key points to study from the following text: {text}

7.5. Assessment quiz

Prompt: I want you to create a comprehension test on the following topics: {topic_list}

The test must contain:

- 3 multiple choice questions

- 2 matching questions

- 2 questions where I have to fill in the missing word

- 1 development question

You MUST NOT include the answers to the questions in your response.

7.6. Revise written assignment

Prompt: I have to write an assignment for the subject of {school_subject} about the following topic {topic}.

My current progress is as following: {text}

I want you to help me improve and revise my draft.

The target length in words is {num_words}.

The instructions I have from my teacher are: {instructions}.

7.7. Grading

Prompt: I want you to grade the following exercise

Utterance: {question}

ANSWER: {answer}

You MUST give a score from 0 to 10.

You MUST include explanatory comments and suggestions for improvement where needed.