



First version of the AI assistant for teachers prototype

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Author: George Paraskevopoulos (ARC)

Reviewers: Hamam Mokayed (LTU), Foteini Simistira Liwicki (LTU), Spyridoula Stamouli (ARC)

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Executive Summary

This deliverable describes the current progress for the implementation of the Teacher Mate tool for the AI4EDU project. Teacher Mate represents a step forward in integrating technology into the education sector, offering a web-based platform designed to streamline and enhance the learning and teaching process. This platform introduces a comprehensive suite of tools based on modern language technologies, to provide a personalized and efficient educational experience for educators.

Central to the Teacher Mate platform is the Teacher Dashboard, an intuitive interface that allows educators to closely monitor student progress, administer and grade assessments, and deliver focused feedback. This dashboard has been thoughtfully designed to provide an effective tool that accommodates the real needs of educators and learners.

Teacher Mate provides a set of functionalities underpinned by modern prompt engineering techniques. These tools facilitate lesson planning, material preparation, test generation, and automated grading of student assignments, providing an expanding set of tools that both alleviate the load of educators and help them design engaging and interactive material for better educational outcomes.

A key component of Teacher Mate is its chat interface, powered by, but not limited to, GPT-3.5 or GPT-4. This interface acts as an assistant to teachers, aiding in the creation of lesson plans, the development of engaging teaching materials, and the simplification of complex concepts. It facilitates direct, interactive communication with the system for generating various educational resources, including presentation outlines and student worksheets. The chat interface is enhanced with multilingual voice capabilities for better accessibility.

The ability of Teacher Mate to interact with course textbooks through Retrieval Augmented Generation (RAG) is particularly noteworthy. This feature extends across the platform's entire suite of tools, allowing teachers to directly incorporate textbook material into lesson plans, quizzes, presentations, and other teaching resources. This integration ensures that content is closely aligned with the curriculum, making it highly relevant and engaging for students.

In terms of lesson preparation and student assessment, Teacher Mate simplifies the creation of tests, quizzes, and presentations. These tools are not only customizable to fit specific curricular needs but also designed to motivate and challenge students. Furthermore, the platform's automatic grading feature streamlines the evaluation process, reducing the administrative load on teachers and allowing them to concentrate more on instructional activities.

The platform's approach to concept exploration and explanation is grounded in interactive dialogues and prompts, assisting teachers in devising effective strategies for introducing new concepts. This method is built on best pedagogical practices, based on recommendations provided by the pedagogical team of the project and the results of the end-users' needs analysis carried out as part of WP2 activities, offering a variety of perspectives and examples to suit different learning styles and preferences.

To summarize, Teacher Mate brings to the educational sector a set of tools that significantly improve the teaching and learning experience by leveraging prompt engineering, artificial

intelligence, and textbook integration. This approach supports teachers in delivering personalized, curriculum-aligned instruction and provides students with an engaging and interactive learning environment, with the goal of enhancing overall educational outcomes.

Acronyms and abbreviations

Abbreviation	Description
AI4EDU	Artificial Intelligence for Education (project name)
TM	Teacher Mate
RAG	Retrieval-Augmented Generation
LLM	Large Language Model
AI	Artificial Intelligence
GPT	Generative Pre-trained Transformer

1. Introduction - Purpose of the Deliverable

1.1. Introduction

Developed within the scope of the AI4EDU project, Teacher Mate integrates a comprehensive suite of tools designed to enhance the educational process for teachers and students alike. Building on the user requirements identified in Deliverable D2.1 and the technical specifications outlined in Deliverable D2.2, Teacher Mate offers functionalities like the Teacher Dashboard, personalized feedback mechanisms, an expanding set of educator tools grounded on the class curriculum, and an interactive chat interface. These features are specifically designed to address various educational needs, including lesson preparation, student assessment, and the identification of learning gaps.

1.2. Deliverable Purpose

The purpose of this deliverable is to describe the implementation of the Teacher Mate platform, focusing on how it translates the functional and non-functional specifications into a working system. This includes detailing the integration of advanced technologies such as RAG for interacting with course textbooks, and the development of LLM-driven tools for lesson planning, test creation, and personalized feedback.

Teacher Mate is embedded within a broader educational technology framework being developed as part of the project, aimed at serving the needs of its users—teachers and students—for efficient and effective learning experiences. This deliverable specifically covers the subsystems that facilitate automated assessment and interactive learning, enhancing the educational offerings of the platform.

The Teacher Mate subsystems, developed under Work Package 3 (WP3): "First version of the AI assistant for teachers prototype", have been crafted with the collaboration of educational experts, technology developers, and user experience designers to ensure a system that not only meets educational standards but also enhances the teaching experience. Furthermore, the development adhered to EU standards and recommendations for ethical deployment for AI in education, taking into account EC's guidelines ("Ethical guidelines on the use of artificial intelligence and data in teaching and learning for educators", published by the EC in October 2022), to ensure that the system aligns with European values and regulations for AI-enhanced learning environments.

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

This deliverable is directly linked to Deliverable D2.1, "User Requirements," where the foundational needs and expectations of the teachers and students were captured. It also builds upon Deliverable D2.2, "Technical Specifications," which provided the detailed blueprint for the development of Teacher Mate. Specifically, D2.2 provides an overview of the overall system architecture and the database schema. This design has been followed to implement the components described in this deliverable. Furthermore, it connects with the overall objectives of the AI4EDU project, particularly focusing on the development of educational technologies that leverage artificial intelligence to support personalized learning

paths and interactive educational experiences. This integration ensures that Teacher Mate not only meets the specified requirements but also contributes to the innovative educational ecosystem envisioned by the AI4EDU project.

2. Teacher Mate: AI assistant for teacher - Key features and use cases

In the implementation of Teacher Mate, several key features and tools have been developed to enhance the educational experience for teachers and students alike. These functionalities are designed to streamline the teaching and learning process, making it more efficient, personalized, and engaging. TM supports multiple languages, i.e. English, Greek, and Swedish, and is customized to incorporate the educational material for classes provide in the Greek, Irish, Swedish, and Cyprus educational curricula. Below, we outline the key components and educational tools offered by the application.

2.1. Key components

- **Teacher dashboard:** A centralized hub for educators to monitor student progress, administer and grade assessments, and provide personalized feedback.
- **Chat interface with advanced language model:** Serves as a virtual assistant to help teachers with lesson planning, creating engaging teaching materials, and simplifying complex concepts.
- **Integration with course textbooks through RAG:** Allows for seamless incorporation of textbook content into lesson plans, assessments, and teaching materials, grounding the generated content in the class curriculum.
- **Accessibility features:** The chat interface is further enhanced with a voice interface, with a speech-to-text and text-to-speech module. Educators can submit their voice query through their microphone. The voice query is then converted to text format. When the LLM answer is generated, it is submitted to a text-to-speech system and the resulting audio is played for the user.

2.2. Educational tools

- **Customizable Test and Quiz Creation:** Enables teachers to generate tests and quizzes tailored to their curriculum, designed to engage and challenge students.
- **Automated Grading System:** Reduces the administrative burden on teachers by automatically grading student responses.
- **Lesson Plan Generation:** Assists in the design of lesson plans that are interactive and cater to various learning styles.
- **Presentation Design Tools:** Provides support for creating engaging presentations related to lesson topics.
- **Concept Exploration and Explanation:** Offers interactive dialogues and prompts to help teachers effectively convey new concepts and ensure student understanding.

2.3. Use cases

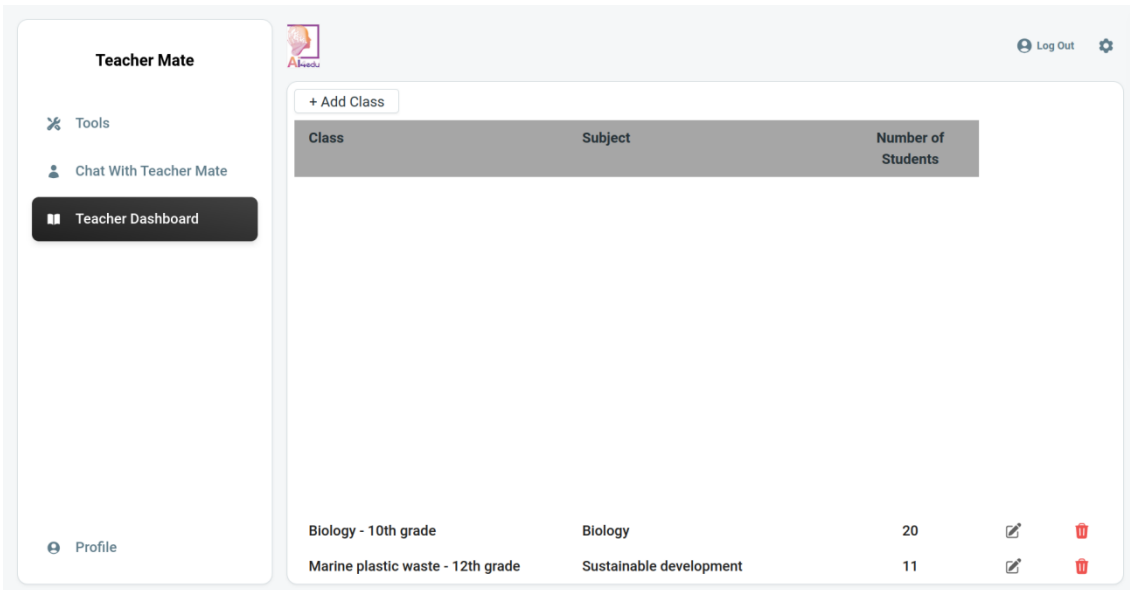
The current implementation of TM is designed around the following use cases, tackling real world challenges faced by educators.

- **Use Case 1 - Class administration automation:** Educators can use the TM application to ease the administrative load incurred during teaching. Specifically the teacher dashboard can provide an eagle-eyed-view of the progress of each student and the overall class statistics, facilitating the creation of fair grading curves. Furthermore, the teacher is notified for unfinished grading tasks, and can provide personalized feedback to their students through the TM interface. The integration with state-of-the-art AI technologies provides automated grading capabilities, further streamlining the administrative tasks. This feature is designed as a human-in-the-loop process, where the teacher reviews and corrects the automatically graded exercises, before submitting their final grades and feedback to be viewed by the students
- **Use Case 2 - Educational material generation:** TM is further expanded with a set of educational tools, aiming to facilitate the generation of accurate, interactive and engaging lesson materials. These tools are obtained through a list of carefully curated prompts and integrated with a chat interface for multi-turn material refinement. The generated prompts are shared with the educators, This will help to learn how to interact with the LLM and makes the process feel open and trustworthy.

In Section 3 we will describe the first use case by showcasing the capabilities offered by the teacher dashboard, while in Section 4 we will delve into Use Case 2 and describe the educational tools offered by TM in detail.

3. Use case 1: Automation of class administration

When the educator logs in to their account, they are greeted with a list of the classes they are teaching, as shown in Fig. 1. The teacher can create new classes and delete or select to view existing ones. When a class is created, the teacher specifies the number of students, and the system generates new student accounts for that class.



The screenshot shows the 'Teacher Mate' interface. On the left is a sidebar with navigation options: 'Tools', 'Chat With Teacher Mate', 'Teacher Dashboard' (highlighted), and 'Profile'. The main area features a '+ Add Class' button and a table of existing classes. The table has columns for 'Class', 'Subject', and 'Number of Students'. Two classes are listed: 'Biology - 10th grade' with 20 students and 'Marine plastic waste - 12th grade' with 11 students. Each row includes edit and delete icons.

Class	Subject	Number of Students
Biology - 10th grade	Biology	20
Marine plastic waste - 12th grade	Sustainable development	11

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Figure 1: The teacher dashboard, class information.

When the teacher selects one of their classes, they receive an overview of their students' progress and valuable overall class statistics. This eagle-eye view offers immediate feedback to the teacher, such as identifying students who are excelling and those who are struggling, the need to adjust the grading curve or the material difficulty, etc. Additionally, the teacher can see their pending grading tasks. The class dashboard can be seen in Fig. 2.

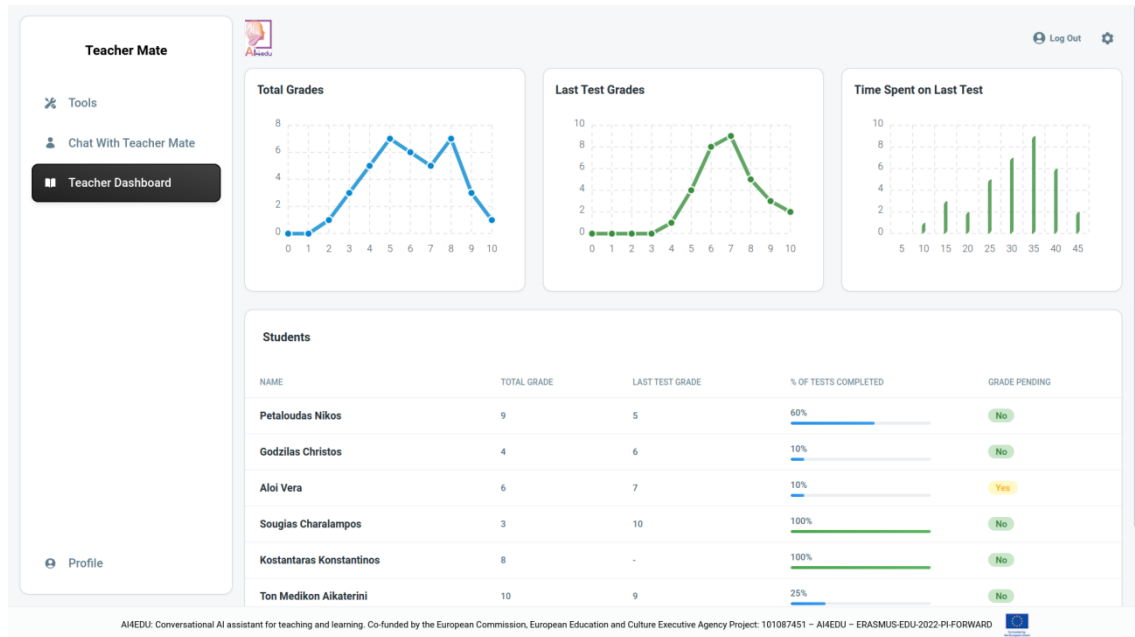


Figure 2: The teacher dashboard, student and class statistics.

In this interface, the teacher can select any student. This action opens the student dashboard (Fig. 3), where the teacher can view the student's progress, review and correct the last automatically graded assessment test, send feedback to the student, and offer an overall assessment for the student.

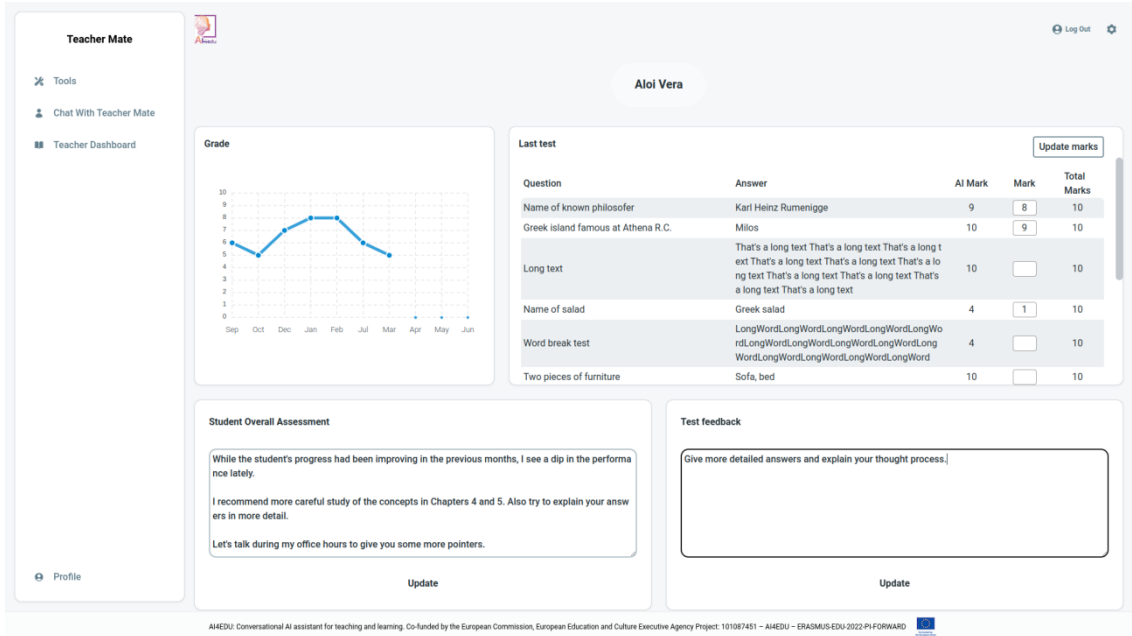


Figure 3: Student dashboard, showing the student's progress, and providing grading and personalized feedback capabilities.

4. Use case 2: Educational material generation

TM includes a functional dialogue interface that allows teachers to interact with state-of-the-art LLMs. The chat interface is shown in Fig. 4. The dialogue is primed with a system prompt that instructs the LLM to act as an educational assistant. Furthermore, it greets the teacher with a predefined welcome message. The teacher can either type their query or record their query through the voice interface. The LLM's responses are streamed to the teacher. If the teacher opted to use the voice interface, the response is voiced through text-to-speech.

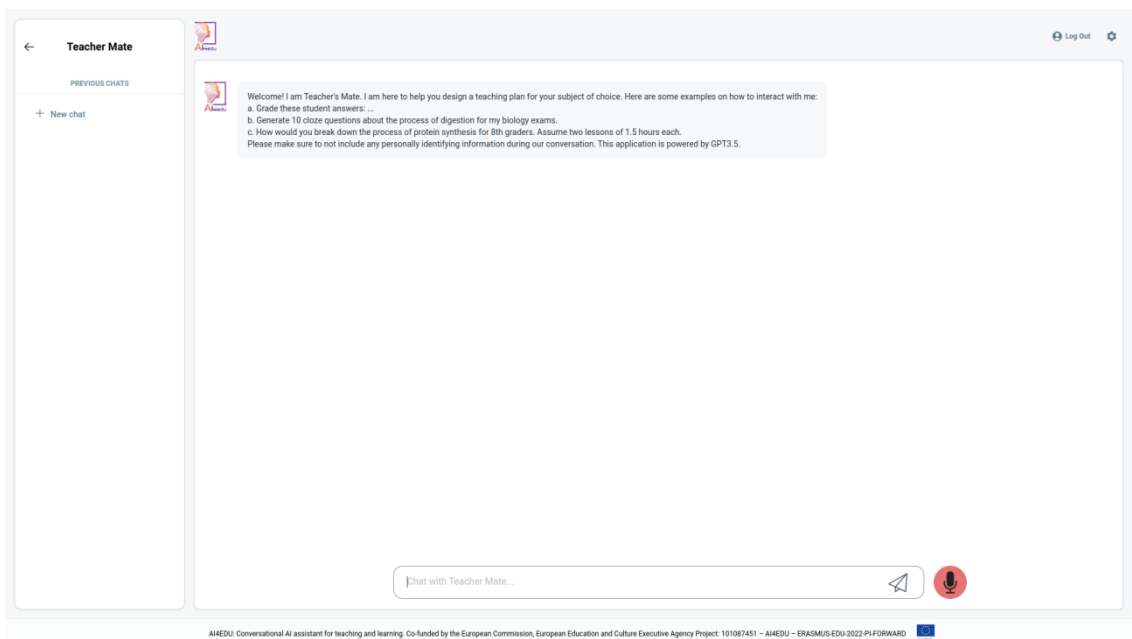


Figure 4: The TM dialogue interface.

TM provides a set of tools to facilitate the fast creation of engaging, and accurate educational content. The tools are implemented via prompting the LLM that powers the application. These tools are presented to the teacher in an intuitive interface (Fig. 5).

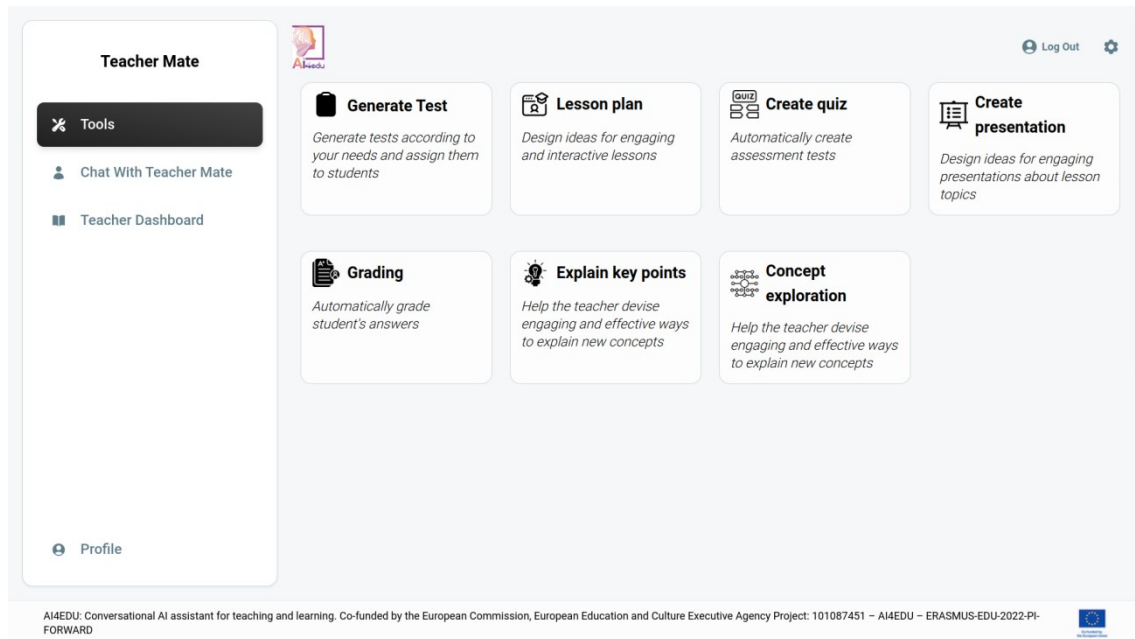
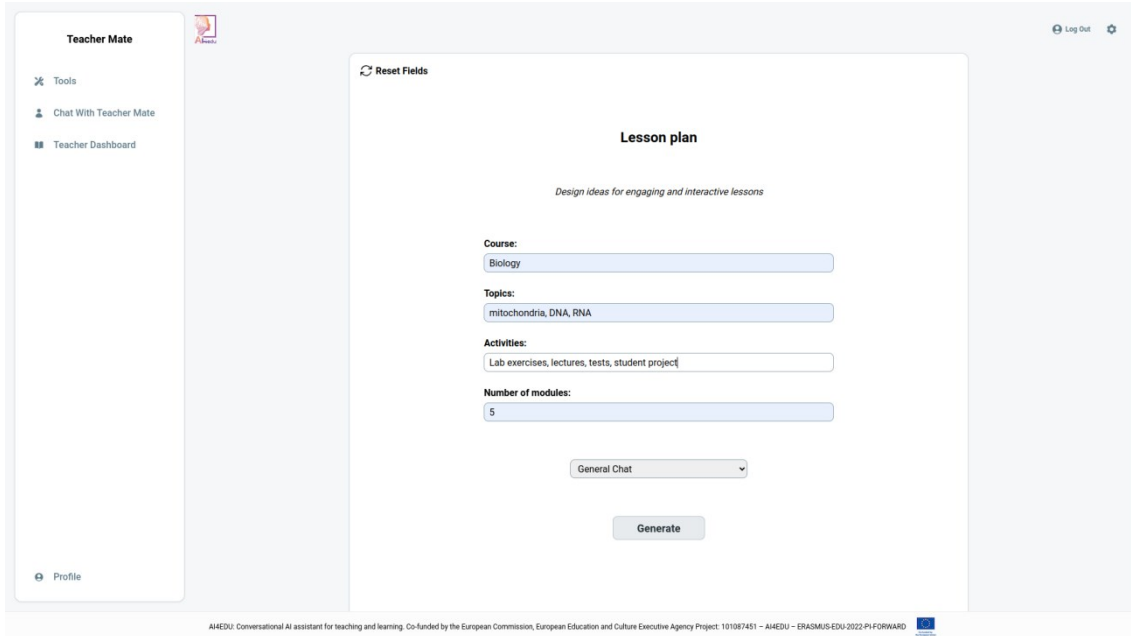


Figure 5: The teacher tools dashboard.

When the teacher selects one of the tools, they can configure the prompt visually, via a form. The forms are generated dynamically based on the input fields required by each prompt, allowing for easy extensibility. As an example, the teacher may select to create a “Lesson Plan” for the next lectures in the “Biology” class, covering the topics of mitochondria, DNA, and RNA. The teacher can specify the activities they want to include and the number of modules that should be allocated to this lesson plan. Finally for all tools, the teacher can decide whether to use the General Chat (LLM without custom context), or if they want to use one of the registered textbooks to ground the LLM response. For this example, we showcase the General Chat. The configuration form is shown in Fig. 6.



Teacher Mate

- Tools
- Chat With Teacher Mate
- Teacher Dashboard

Lesson plan

Design ideas for engaging and interactive lessons

Course:
Biology

Topics:
mitochondria, DNA, RNA

Activities:
Lab exercises, lectures, tests, student projects

Number of modules:
5

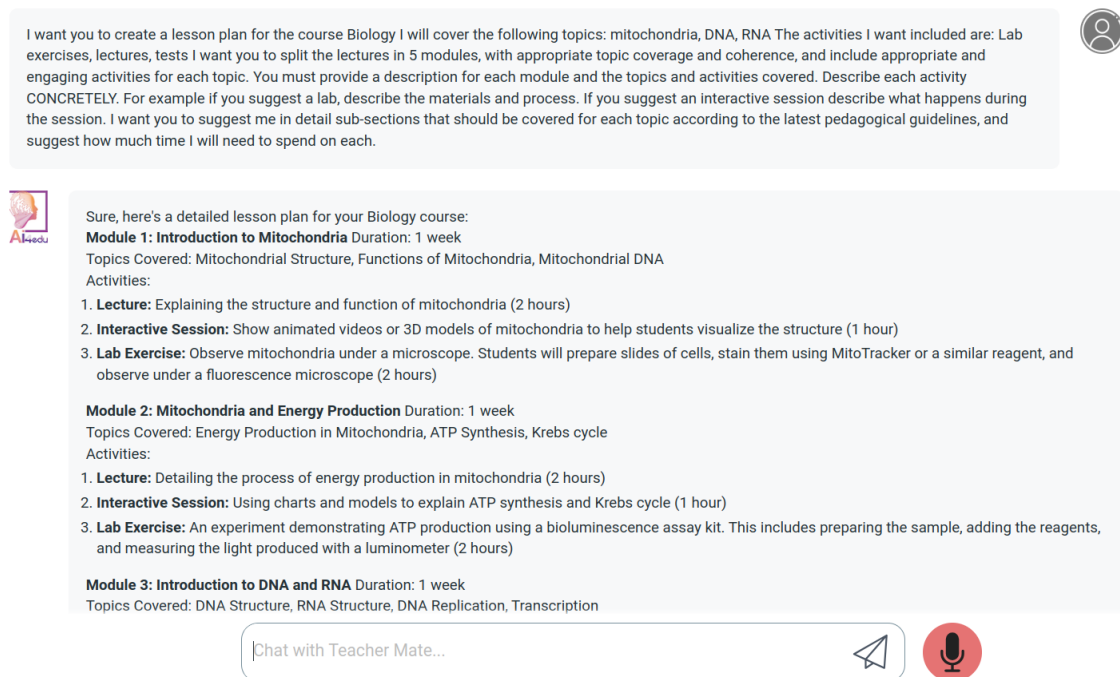
General Chat

Generate

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Figure 6: Lesson plan configuration form.

When the “Generate” button is pressed, the teacher is directed to the chat interface, where the configured prompt is submitted to the LLM and the response is streamed, as shown in Fig. 7.



I want you to create a lesson plan for the course Biology I will cover the following topics: mitochondria, DNA, RNA The activities I want included are: Lab exercises, lectures, tests I want you to split the lectures in 5 modules, with appropriate topic coverage and coherence, and include appropriate and engaging activities for each topic. You must provide a description for each module and the topics and activities covered. Describe each activity CONCRETELY. For example if you suggest a lab, describe the materials and process. If you suggest an interactive session describe what happens during the session. I want you to suggest me in detail sub-sections that should be covered for each topic according to the latest pedagogical guidelines, and suggest how much time I will need to spend on each.

Sure, here's a detailed lesson plan for your Biology course:

Module 1: Introduction to Mitochondria Duration: 1 week
Topics Covered: Mitochondrial Structure, Functions of Mitochondria, Mitochondrial DNA
Activities:

- Lecture:** Explaining the structure and function of mitochondria (2 hours)
- Interactive Session:** Show animated videos or 3D models of mitochondria to help students visualize the structure (1 hour)
- Lab Exercise:** Observe mitochondria under a microscope. Students will prepare slides of cells, stain them using MitoTracker or a similar reagent, and observe under a fluorescence microscope (2 hours)

Module 2: Mitochondria and Energy Production Duration: 1 week
Topics Covered: Energy Production in Mitochondria, ATP Synthesis, Krebs cycle
Activities:

- Lecture:** Detailing the process of energy production in mitochondria (2 hours)
- Interactive Session:** Using charts and models to explain ATP synthesis and Krebs cycle (1 hour)
- Lab Exercise:** An experiment demonstrating ATP production using a bioluminescence assay kit. This includes preparing the sample, adding the reagents, and measuring the light produced with a luminometer (2 hours)

Module 3: Introduction to DNA and RNA Duration: 1 week
Topics Covered: DNA Structure, RNA Structure, DNA Replication, Transcription

Chat with Teacher Mate...

Figure 7: The lesson plan generated using the LLM and the teacher tool.

As a second example, “Concept exploration” tool is demonstrated. Here the teacher wants to brainstorm how to present the “Lifecycle Analysis” concept, which is part of the “Sustainable development: Marine plastic waste” class, and they want to explain this concept to students

with ADHD and learning difficulties. Note that in contrast to the previous example, the teacher opts to use the class textbook for concept exploration. The configuration is shown in Fig. 8.

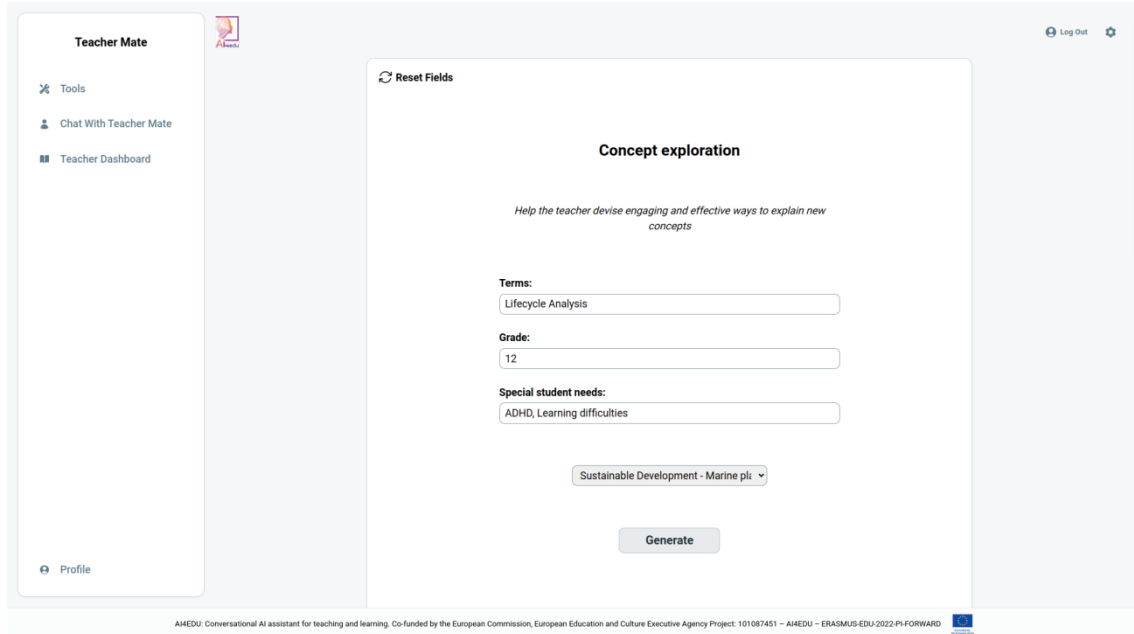
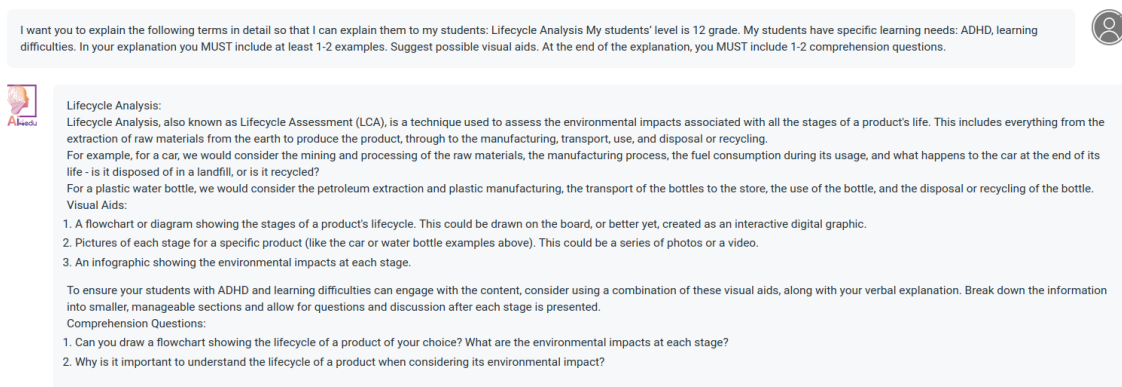


Figure 8: Concept exploration configuration.

The LLM response is shown in Fig. 9.



I want you to explain the following terms in detail so that I can explain them to my students: Lifecycle Analysis My students' level is 12 grade. My students have specific learning needs: ADHD, learning difficulties. In your explanation you MUST include at least 1-2 examples. Suggest possible visual aids. At the end of the explanation, you MUST include 1-2 comprehension questions.

Lifecycle Analysis:
 Lifecycle Analysis, also known as Lifecycle Assessment (LCA), is a technique used to assess the environmental impacts associated with all the stages of a product's life. This includes everything from the extraction of raw materials from the earth to produce the product, through to the manufacturing, transport, use, and disposal or recycling.
 For example, for a car, we would consider the mining and processing of the raw materials, the manufacturing process, the fuel consumption during its usage, and what happens to the car at the end of its life - is it disposed of in a landfill, or is it recycled?
 For a plastic water bottle, we would consider the petroleum extraction and plastic manufacturing, the transport of the bottles to the store, the use of the bottle, and the disposal or recycling of the bottle.

Visual Aids:

1. A flowchart or diagram showing the stages of a product's lifecycle. This could be drawn on the board, or better yet, created as an interactive digital graphic.
2. Pictures of each stage for a specific product (like the car or water bottle examples above). This could be a series of photos or a video.
3. An infographic showing the environmental impacts at each stage.

To ensure your students with ADHD and learning difficulties can engage with the content, consider using a combination of these visual aids, along with your verbal explanation. Break down the information into smaller, manageable sections and allow for questions and discussion after each stage is presented.

Comprehension Questions:

1. Can you draw a flowchart showing the lifecycle of a product of your choice? What are the environmental impacts at each stage?
2. Why is it important to understand the lifecycle of a product when considering its environmental impact?

Figure 9: Concept exploration response.

The teacher then can opt to refine the answer by focusing on their ADHD students via the interactive chat session, and the refined response is shown in Fig. 10.



Sure, breaking down complex concepts into smaller parts, and explaining it step-by-step can be very helpful for students with ADHD. Here is a simplified version of Lifecycle Analysis:

1. Introduction to the Term:

"Lifecycle Analysis is like a story of a product from beginning to end. It's how we can learn about everything that happens to something, like a toy, from the time its parts are just materials in the ground, until it's thrown away or recycled."

Visual Aid: Show a picture of a toy at various stages: as raw material, being made, being used, and being thrown away or recycled.

2. Stages of Lifecycle Analysis:

"Let's break down this story into four main parts:

- First, we have 'Material Extraction.' This is when the raw materials are taken from the earth.
- Second, we have 'Manufacturing.' This is when the raw materials are used to make the product.
- Third, we have 'Usage.' This is when we use the product.
- Last, we have 'Disposal or Recycling.' This is what happens to the product when we are done with it."

Visual Aid: Draw a simple flowchart on the board with these four stages.

3. Examples:

"Let's think about a toy car. First, we get the plastic and metal from the ground. Then, these materials are made into a toy car in a factory. Then, someone plays with the toy car. Finally, when they don't want it anymore, it gets thrown away or recycled."

Visual Aid: Show pictures or a video of each stage of a toy car's life.

4. Importance:

"Understanding how a product's life goes can help us see how it affects the world around us. For example, if lots of toy cars are thrown away, they can end up in landfills and cause pollution."

Comprehension Questions:

1. "Can you think of another product and tell its story from beginning to end?"
2. "Why do you think it's important to know the story of a product's life?"

Remember to give students ample time to process each stage and the opportunity to ask questions. You may also want to consider incorporating movement or physical activity into the lesson, such as having students act out the stages of the lifecycle. This can be particularly helpful for students with ADHD.

Figure 10: Interactive refinement of the response provided by the “Concept Exploration” tool.

As a final example, we show the test creation tool. The teacher can describe the test's subject, the total marks allocated to the test and the desired test time. Furthermore, they input the desired number of questions, per question type (multiple choice, cloze, matching, open).

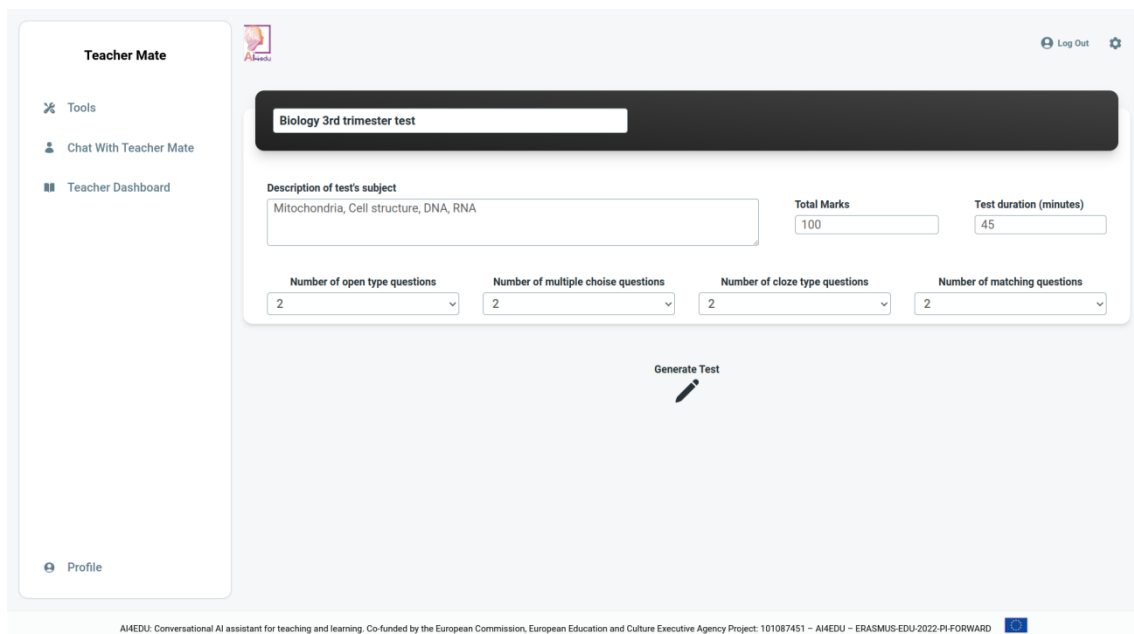


Figure 11: Test creation configuration.

The questions are then rendered in a user-friendly interface, along with the suggested “gold” answer. The teacher can modify them, remove or add questions, and modify the points allocated to each question. In the end, the teacher can assign a due date and assign the test to their students.

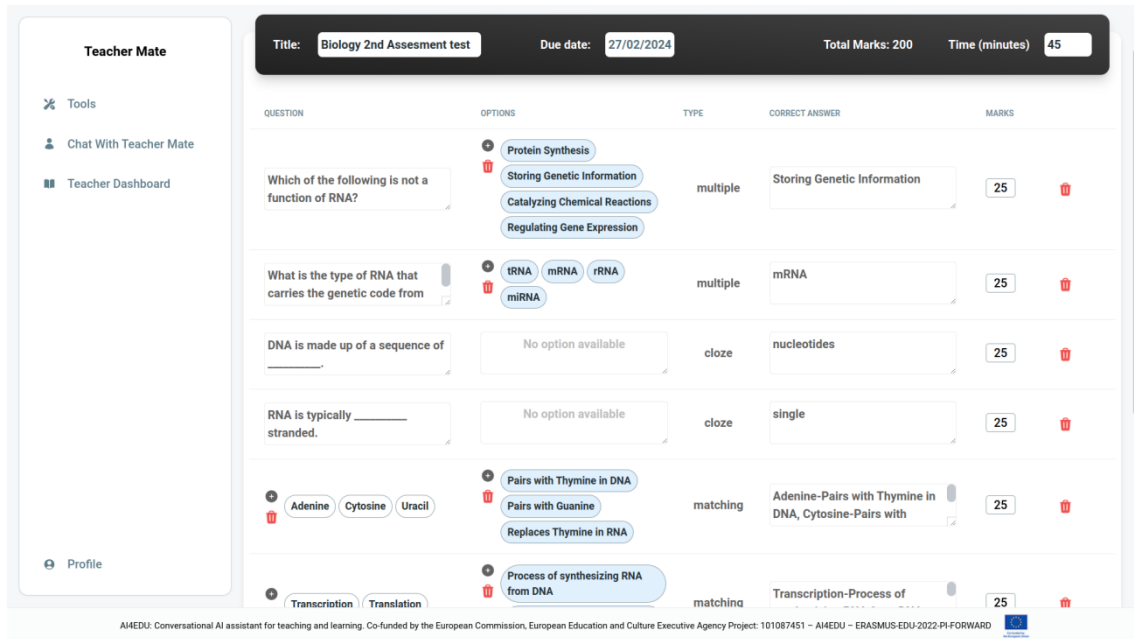


Figure 12: Test creation - Teacher review.

5. Technical details

The Teacher Mate 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 TM 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 Teacher Mate prototype development repository, please visit our GitLab repository at <https://gitlab.com/ilsp-spm-d-all/dialogue/chatbot-ui>.

The Teacher Mate prototype is accessible at the address <https://apps.ilsp.gr/ai4edu/> for users who register as teachers. 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 Teacher Mate prototype, developed as part of Work Package 3 (WP3): "First version of the AI assistant for teachers' prototype." The platform integrates functionalities such as the Teacher Dashboard, chat interface for educators, the ability to interact with course textbooks through RAG, and an expanding list of prompt-based tools targeted towards educators, all of which were designed to enhance the teaching and learning experience. These features have been developed using the specifications outlined in D2.2.

The First Version of the Teacher Mate prototype will be piloted at secondary schools of the four participating countries by teachers at selected school subjects, as part of the WP4: “Evaluation of Usability and Technology Acceptance” activities. The teachers will be demonstrated the Teacher Mate’s tools and functionalities and will be using the prototype in hands-on sessions, to evaluate it for usability and technology acceptance of the interface, educational tools and features of the AI assistant. The feedback gathered during pilots through questionnaires, observations and analysis of teachers’ interactions will be assessed, analysed and integrated into the final version of the Teacher Mate prototype, as part of the WP5: “WP5 Revision of the AI4EDU applications” activities.

7. Appendix A: Prompts used for the Teacher Mate educational tools

7.1. Lesson plan

Prompt: I want you to create a lesson plan for the course {course}

I will cover the following topics: {topic_list}

The activities I want included are: {activities_list}

I want you to split the lectures in {num_modules} modules, with appropriate topic coverage and coherence, and include appropriate and engaging activities for each topic.

You must provide a description for each module and the topics and activities covered.

Describe each activity CONCRETELY. For example, if you suggest a lab, describe the materials and process. If you suggest an interactive session describe what happens during the session.

I want you to suggest me in detail sub-sections that should be covered for each topic according to the latest pedagogical guidelines and suggest how much time I will need to spend on each.

7.2. Create quiz

Prompt: I want you to create a test for the following course: {course}.

You must cover the following subjects: {topic_list}

The test must contain:

- {num_multiple} multiple choice questions
- {num_matching} matching questions
- {num_cloze} questions where I have to fill in the missing word
- {num_open} open-ended question

You MUST include the answers to the questions in your answer.

7.3. Create presentation

Prompt: I want you to create a presentation outline for the course {course}

I will cover the following topics: {topic_list}

The presentation will refresh previous knowledge on: {previous_topic_list}.

I want the presentation to be {num_minutes} minutes long.

I want you to suggest some visual aids to be included in the presentation.

I want you to include possible check-points to interact with students.

I want you to add content to each point of the outline.

7.4. Grading

Prompt: I want you to grade the following exercise

Utterance: {question}

ANSWER: {answer}

You MUST give a score from 0 to 20.

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

7.5. Explain key points

Prompt: I want you to extract key information (e.g., concepts, definitions, examples) on the following topic: {topic} to help my students study.

My students have specific learning needs: {special_needs_list}

Previous knowledge on {previous_topic} needs to be refreshed.

Indicate other resources that could help students better understand this topic.

Suggest possible visual aids.

7.6. Concept exploration

Prompt: = I want you to explain the following terms in detail so that I can explain them to my students: {terms_list}

My students' level is {grade} grade.

My students have specific learning needs: {special_needs_list}.

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

Suggest possible visual aids.

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

