mISLec4EDU: AI-enabled platform for asynchronous and personalized learning

Grega Vrbančič*, Lucija Brezočnik, Tadej Lahovnik, Zala Lahovnik and Vili Podgorelec

Intelligent Systems Laboratory, Faculty of Electrical Engineering and Computer Science, University of Maribor, Slovenia

Abstract

The rapid development of generative artificial intelligence is reshaping educational practices by enabling new forms of adaptive, scalable, and personalized learning. However, many existing AI-based learning systems remain fragmented, insufficiently integrated, and often detached from pedagogical frameworks. This paper presents the *mISLec4EDU*, an AI-enabled platform designed to support asynchronous and personalized learning for students while assisting educators in the design and delivering instructional content. The platform integrates a conversational tutor, adaptive formative assessments, and human-in-the-loop support for quiz creation. It also supports deployment flexibility through both cloud-based and locally hosted large language models, addressing institutional needs for privacy, cost control, and flexibility. We describe the system architecture and key functionalities, and illustrate their use through a real-world case study. The unified architecture enables context-aware prompting, learner-specific feedback, and lecturer-controlled content creation. The platform's design emphasizes pedagogical alignment, educator control, and responsible AI integration. This contribution aims to initiate discussion on practical, flexible, and ethically grounded uses of generative AI in education.

Keywords

Personalized learning, Asynchronous learning, Generative AI, Educational technology

1. Introduction

Artificial intelligence (AI) has emerged as a transformative technology, reshaping industries, economies, and societies, irreversibly changing the way we live, work, and learn [1]. In education, for example, AI-driven systems now support tutoring, feedback, and assessment at scale, with early studies reporting improvements in learner engagement and personalization outcomes [2, 3]. AI is not a single entity or consciousness, but rather a collection of techniques and algorithms designed to process information and generate results based on data. Although AI can simulate certain cognitive functions, it lacks awareness, emotions, or understanding, and, unlike humans, it does not possess the ability to comprehend the meaning or context of the information it processes. For educators, understanding AI as a powerful yet non-sentient system highlights its role as a resource for supporting teaching and learning rather than replacing human insight, creativity, or ethical judgment.

Generative AI (GenAI) is a specialized form of artificial intelligence designed to create new content by learning patterns and structures from existing data. Unlike traditional AI systems, which focus on classification or prediction, GenAI employs advanced models, such as neural networks, to generate text, images, audio, or video that mimic human creativity. These systems, including well-known tools such as ChatGPT and DALL·E, are trained on extensive datasets and produce outputs by identifying and combining patterns from the data they have been exposed to during training. For example, a generative AI model trained on natural language texts can compose coherent essays or dialogues, while another trained on visual data can generate realistic images or artistic works. Despite its impressive results, GenAI does not "understand" the content it produces; it relies solely on probabilistic associations derived from its training data. This means that its creations are not original in the human sense, but

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*Corresponding author.
grega.vrbancic@um.si (G. Vrbančič); lucija.brezocnik@um.si (L. Brezočnik); tadej.lahovnik1@um.si (T. Lahovnik); zala.lahovnik1@um.si (Z. Lahovnik); vili.podgorelec@um.si (V. Podgorelec)
0000-0003-0723-3889 (G. Vrbančič); 0000-0002-3622-428X (L. Brezočnik); 0009-0005-9689-2991 (T. Lahovnik); 0009-0003-9807-4242 (Z. Lahovnik); 0000-0001-6955-7868 (V. Podgorelec)

are mathematical reconstructions of learned patterns. For educators, GenAI presents opportunities to enhance learning experiences through creative tools. Yet it also demands careful consideration of its limitations, including potential inaccuracies, biases, and ethical concerns regarding originality and ownership of generated content.

The educational use of GenAI is rapidly expanding. Several national education ministries, such as Spain and Australia, have issued guidelines promoting the pedagogically responsible and inclusive use of GenAI [4, 5]. At the same time, systematic reviews have noted that many existing applications remain fragmented—focusing either on chatbots or assessments without cohesive integration or educator oversight [6, 7].Research and development in GenAI focus on improving these models' speed, capabilities, and efficiency. However, many fundamental questions about its principles, applications, and socio-economic impact remain unexplored. This poses a challenge, as a clear understanding and framework for GenAI in education is still evolving. While GenAI offers numerous opportunities for innovation and improvement across various industries, it is equally important to acknowledge its challenges and strive for its responsible and ethical use.

The need for AI regulation is particularly pressing in education due to the field's inherent vulnerabilities. These include handling sensitive student data, the risk of algorithmic bias affecting educational outcomes, and concerns about academic integrity arising from the misuse of GenAI tools, such as essay generators. Unlike other advanced AI systems, GenAI strives to replicate a broad range and complexity of human cognitive abilities, enabling machines to perform various intellectual tasks [8]. In this way, GenAI holds exceptional potential in education, particularly in building adaptive learning environments tailored to the diverse needs of students. It facilitates dynamic adjustments to students' abilities and learning needs comparable to human interaction.

However, GenAI solutions' high capabilities, combined with their lack of awareness and understanding of broader contexts, as well as their uncritical use, pose several potential challenges. These include academic dishonesty, over-reliance on automated tools, the spread of biased or inaccurate information, and a decline in critical thinking and creativity among students and educators. Moreover, many platforms lack transparency, do not involve educators in the content-generation loop, and may reinforce existing inequalities [9]. By establishing clear frameworks and guidelines, appropriate regulations can mitigate these risks while promoting the ethical and effective use of AI technologies throughout the educational system.

2. Generative AI for personalized learning

GenAI holds significant potential to personalize education and scale the learning by dynamically adjusting to to individual learners' needs, pace, and preferences [10]. It extends the boundaries of creativity and innovation through interactive, innovative, and often highly authentic learning experiences. These technologies can close achievement gaps, open access to high-quality education to everyone, and provide new tools to those who seek to transform pedagogic methods.

Recently, there has been a trend of emerging studies and publications covering GenAI in different educational contexts. North Carolina Department of Public Instruction report [11] points out GenAI's vast aid to educators in carrying out teaching-related tasks, particularly those targeting improved teaching efficiency and effectiveness. Similarly, the Spanish Ministry of Education [4] pointed out that GenAI facilitates adaptive, personalized learning by tailoring lessons, exercises, and the pace of content progression to the individual learner.

Even though GenAI can be beneficial to learners and educators, let's focus on the latter first. GenAI can be a helpful tool for them when creating content, such as developing lesson plans, quizzes, or multimedia materials, and constructing interactive learning materials. The other important use could be task automation [4]. GenAI can automate routine or repetitive tasks, such as rapid large-scale feedback generation, report writing, and communication with parents [12]. This support reduces the administrative burden on educators, allowing them to devote more time and energy to their core pedagogical responsibilities.

On the other hand, learners may also benefit from GenAI. It has the potential to make learning more scalable by tailoring various tools and features to meet diverse students' requirements and make the learning process easier. It functions as a learning assistant, providing real-time support to learners across multiple tasks, from answering questions to explaining complex or difficult-to-understand concepts [11]. Moreover, GenAI can increase student engagement through game-based learning, interactive tools, and real-time feedback, making the learning experience more motivating and dynamic [3, 7, 4].

When used appropriately, GenAI improves accessibility by helping to overcome linguistic barriers and other limitations (e.g., those faced by students with special needs) [13]. This includes features such as translation, adaptive interfaces, and assistive technologies like text-to-speech and speech-to-text [5]. It can thus provide stronger support for diversity and equity, fostering the inclusion of culturally and linguistically diverse learners.

Despite its promise, GenAI also raises significant concerns. Critical literature points to the risks of generation of inaccurate or fabricated content, embedded algorithmic biases, limited transparency in how outputs are produced, and the risk of diminishing students' autonomy in the learning process. [14, 6, 15]. For instance, AI-generated explanations can sometimes include inaccurate or misleading statements, which may go unnoticed in low-stakes contexts [16]. Over-reliance on GenAI may reduce learners' critical thinking and problem-solving development, especially if AI is treated as a source of unquestioned authority. Furthermore, ethical concerns about intellectual property, academic honesty, and equity must be considered when deploying such technologies in diverse educational settings.

Current GenAI tools are often fragmented, requiring educators and students to use multiple applications to accomplish tasks such as content generation, tutoring, and assessment. This fragmentation increases complexity and can reduce overall effectiveness. While several tools support personalization in isolated areas, few integrate this capability into a unified, pedagogically coherent system. In response to this need, we developed *mISLec4EDU*, a platform designed to support both learners and educators by consolidating core GenAI functionalities into a single environment, guided by principles of responsible use and instructional alignment.

3. Case study: mISLec4EDU

mISLec4EDU is an AI-enabled platform for the deployment of asynchronous and personalized learning in real-world educational settings ranging from higher education to K-12, wherever asynchronous and personalized learning is needed. Although traditional e-learning tools often provide content delivery or limited adaptivity, they do not offer the full spectrum of personalization. Many current implementations are fragmented – for example, one tool might offer an AI tutor chatbot, while another separately provides adaptive quizzes, leaving it to educators or learners to stitch together multiple tools. The contribution of *mISLec4EDU* is to unify these capabilities in one platform with a coherent architecture. The goal of such a unified approach is to enhance user experience (reducing the cognitive load from switching tools) and improve learning outcomes by ensuring that every aspect of the learning process, from content to support to assessment, is personalized and data-informed. *mISLec4EDU* not only focuses on the student but also acts as a supporting system for the lecturer, helping the lecturer to prepare augmented learning materials and different types of student knowledge evaluations, such as practices and exams.

Figure 1 provides a comprehensive overview of the primary *mISLec4EDU* functionalities in the form of a use case diagram. The use case diagram illustrates how students can apply for and view courses, engage with course content, practice and take exams for courses, and obtain AI-generated explanations and augmented materials. They also interact with an AI tutor chatbot capable of conversational support and tailored responses. For lecturers, the platform provides tools to manage course content, including enabling the lecturer to provide additional learning resources in the form of PDFs, create and validate assessments such as practices and exams using AI assistance, and track student progress. Both student and lecturer interactions leverage AI features that are backed by a modular integration with large language models (LLMs).

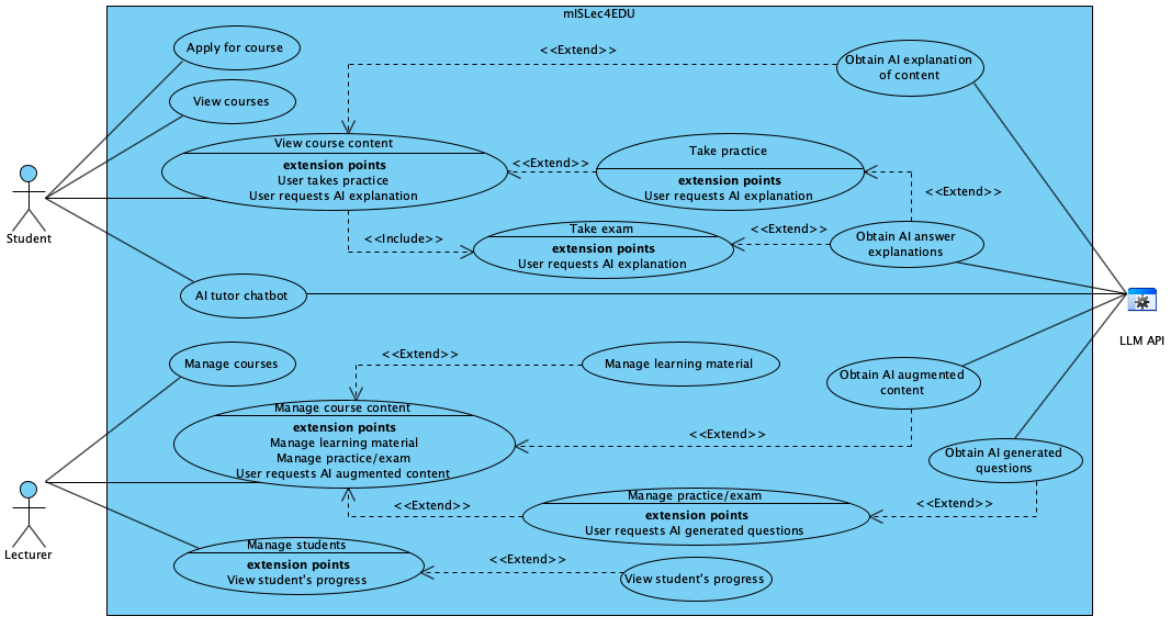

Figure 1: Use case diagram of the *mISLec4EDU* platform.

A distinguishing design principle of *mISLec4EDU* is its capability to utilize both third-party LLM APIs and local LLM deployments. API-based integration allows the platform to take advantage of state-of-the-art models (e.g., OpenAI's GPT-4, Claude, or Gemini). However, dependence on external services can introduce concerns regarding data privacy, network reliability, and cost, particularly in educational institutions with strict data governance policies.

To mitigate these challenges, *mISLec4EDU* supports local deployment of LLMs. Running LLMs on-premise ensures that sensitive student data remains within the institutional infrastructure, avoiding transmission to external servers and reducing exposure to third-party data processing. This configuration allows educational institutions to retain full control over the data flow—from input prompts and learning context to generated outputs—ensuring compliance with data protection regulations and internal governance policies. Local deployment also enables system functionality in offline or bandwidth-constrained environments, ensuring uninterrupted access in regions with limited internet connectivity.

A key advantage of local LLMs lies in their adaptability: models can be fine-tuned or contextualized using institution-specific educational content, which improves relevance, interpretability, and alignment with curricular goals. However, deploying and maintaining LLMs locally presents significant technical and operational demands. It requires access to specialized hardware (e.g., high-memory GPUs), robust infrastructure for inference serving, and skilled personnel to manage updates, scaling, and fault tolerance. Additionally, institutions must ensure that user access and usage data are securely handled and logged in accordance with local privacy policies.

By supporting both cloud-based and local LLM integration, *mISLec4EDU* provides a flexible architecture that allows institutions to choose the deployment model best suited to their privacy requirements, technical capacity, and pedagogical goals—without sacrificing the capabilities of generative AI.

3.1. Personalized learning

The platform is designed to provide personalized learning experiences for students, supporting the construction of individualized learning paths that adapt in real time to student input and performance. The *"Find out more"* feature allows students to select a specific subsection of the course content they want to explore further, thus enabling them to delve deeper into topics of interest or difficulty in the

form of a text conversation. This type of targeted just-in-time support has been shown to foster learner engagement and improve content retention [17]. The feature is showcased in Figure 2. When the feature is triggered, the AI tutor is invoked with a prompt requesting the LLM to provide an additional explanation regarding the topic of the current subsection. In order to ensure a relevant and accurate response, the LLM is provided with a contextual prompt including the subsection content and the most appropriate excerpts from relevant learning resources. This form of context-aware augmentation aligns with findings in [18, 19], which emphasize the importance of timely, context-sensitive AI feedback in educational systems.

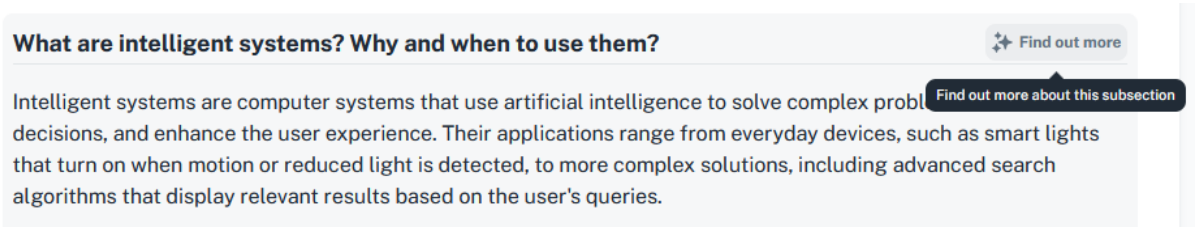

Figure 2: The *"Find out more"* functionality of the mISLec4AI platform.

Upon the initial explanation, students can continue conversing with the AI tutor. This feature, demonstrated in Figure 3, is particularly beneficial for supporting self-regulated learning, as students can request elaborations, ask clarifying questions, and explore related content in a conversational interface. It is important to note that the quality of the AI tutor's answers depends on the underlying LLM used. The responses are not curated by the lecturer, and therefore, misinterpretations may occasionally occur. However, the use of tailored prompts with high-quality contextual information has been shown to reduce hallucinations in LLM outputs [16].

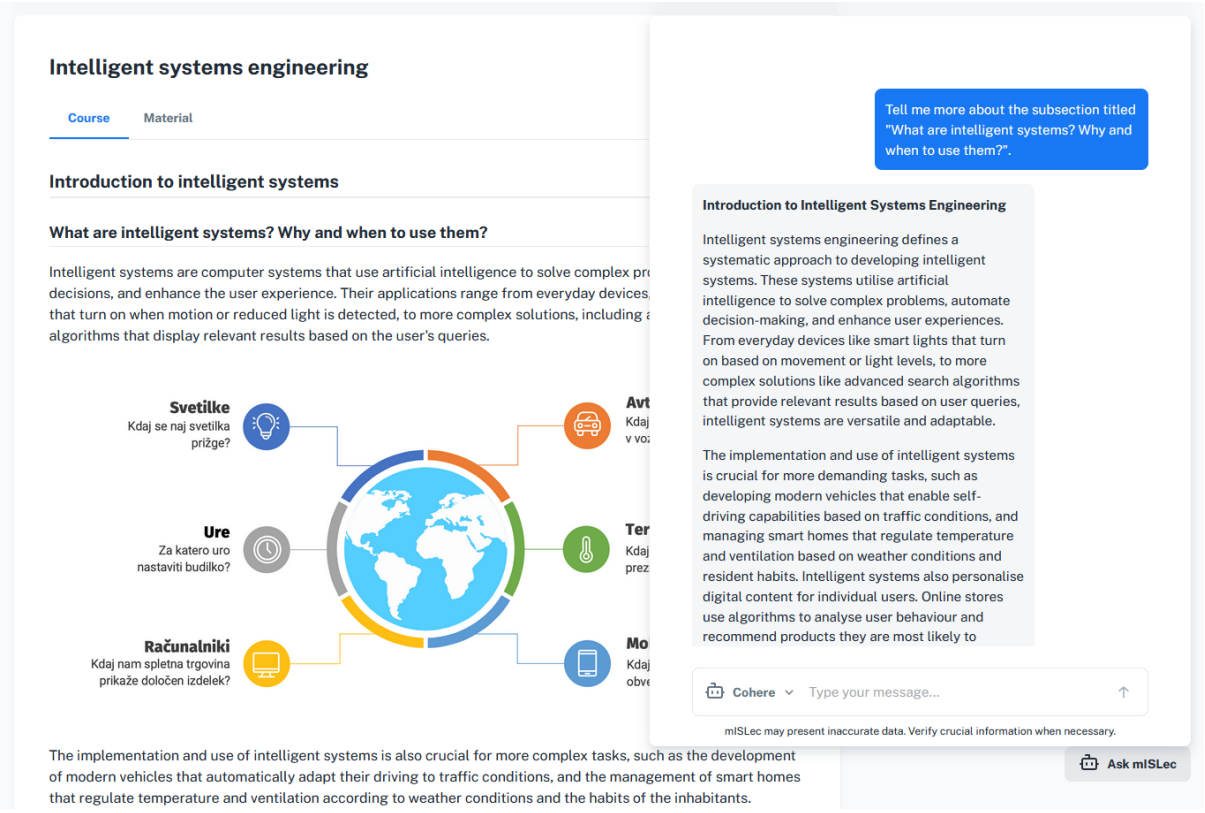

Figure 3: In-depth explanation of the selected subsection of the course through the invocation of an AI tutor chatbot.

In addition to personalized content exploration, *mISLec4EDU* allows students to reinforce their

knowledge through embedded practice quizzes, as presented in Figure 4. These quizzes are authored by the lecturer and can be inserted at any point within the learning content. The strategic placement of such assessments has been shown to enhance retention and meta-cognitive awareness [20]. Each question is accompanied by detailed feedback, automatically generated and aligned with the student's selected response. When a student selects an incorrect answer, they are presented with a personalized explanation that targets misconceptions and reinforces correct reasoning, following evidence-based principles of formative assessment.

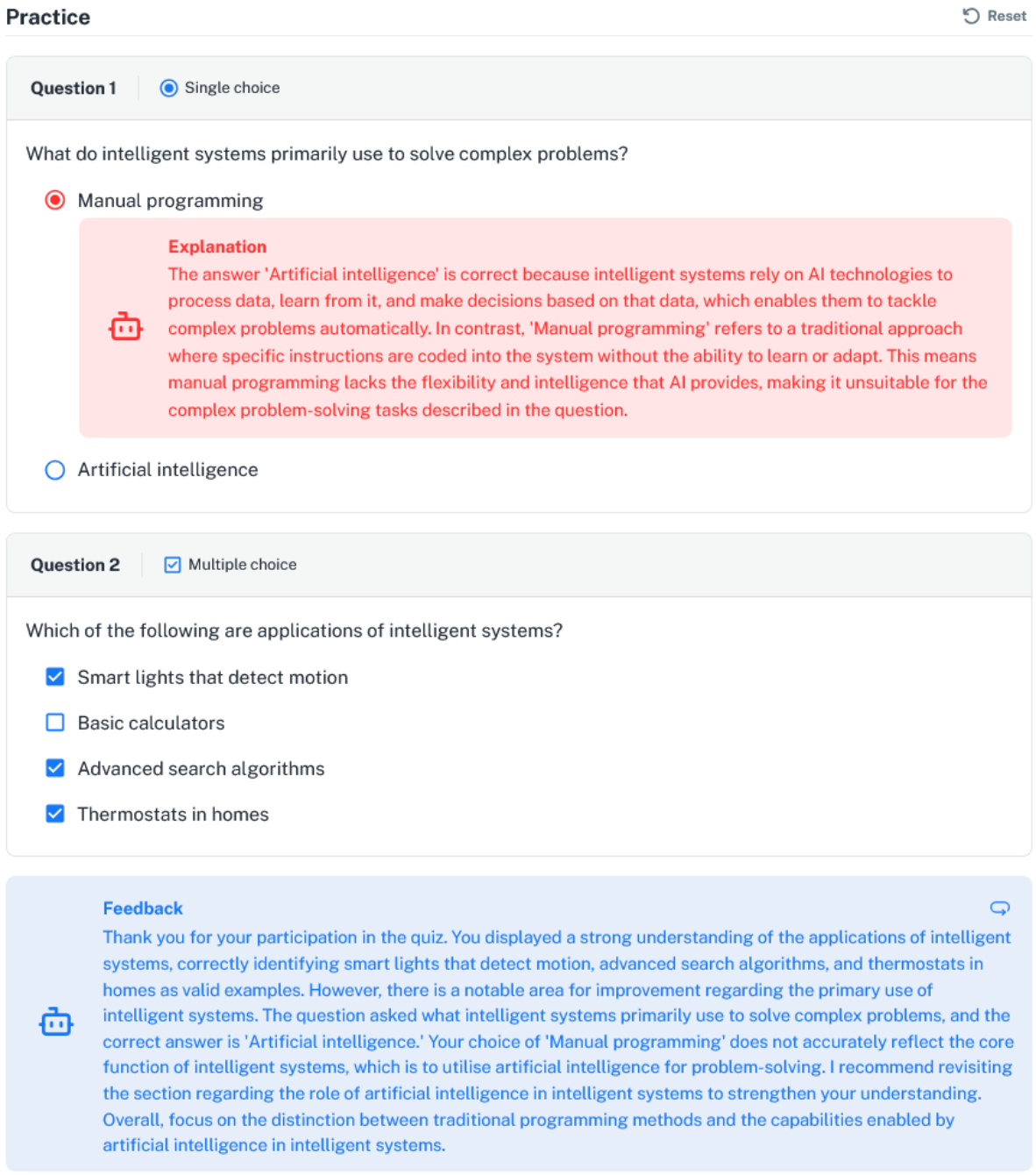

Figure 4: Wrong answer explanation and full quiz feedback.

3.2. Lecturer support

Upon completion of a quiz, students receive an overall feedback summary, which highlights their strengths and weaknesses and provides recommendations for revisiting specific topics. This tailored feedback loop supports mastery learning and encourages reflective learning behavior, which is closely associated with improved academic outcomes [21].

mISLec4EDU is designed not only with the learner in mind but also as a productivity and pedagogical aid for educators, responding to the increasing demand for scalable authoring tools in digital learning environments. One of its core features is the human-in-the-loop approach to assessment creation. Rather than fully automating question generation, which risks producing irrelevant or misaligned assessments, *mISLec4EDU* enables lecturers to co-create quiz content with AI support, preserving pedagogical integrity while accelerating the design process [2], as presented in Figure 5.

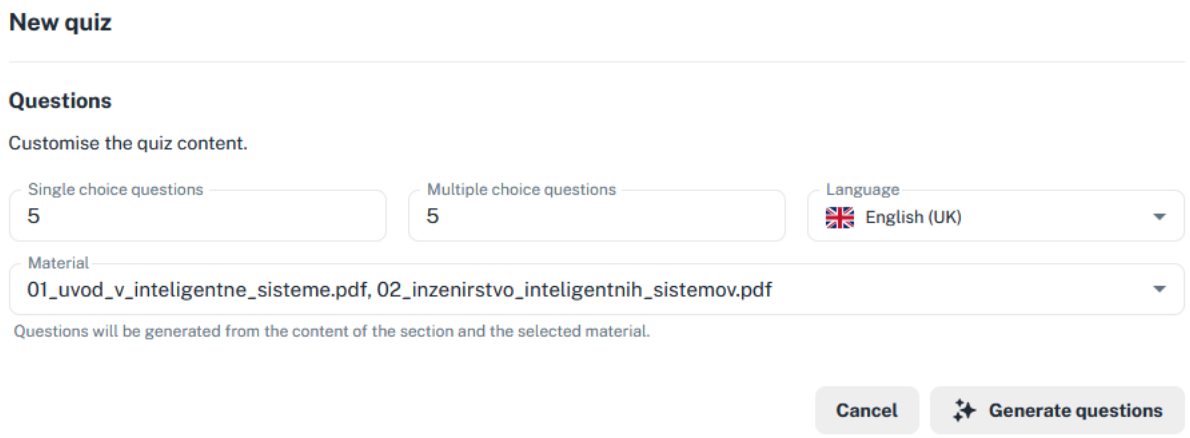

Figure 5: An example of Aan I-powered quiz question generation form.

The lecturer has the option to define the number of single-choice and multiple-choice questions for each practice or exam quiz. Additionally, they can specify which additional learning materials should be used as contextual input for the LLM when preparing suggested questions and answers. Based on this input, the LLM is invoked with a customized prompt that combines pedagogical objectives, curriculum alignment, and instructional design principles. The prompt includes relevant content excerpts and explicit instructions for generating well-structured questions and answers.

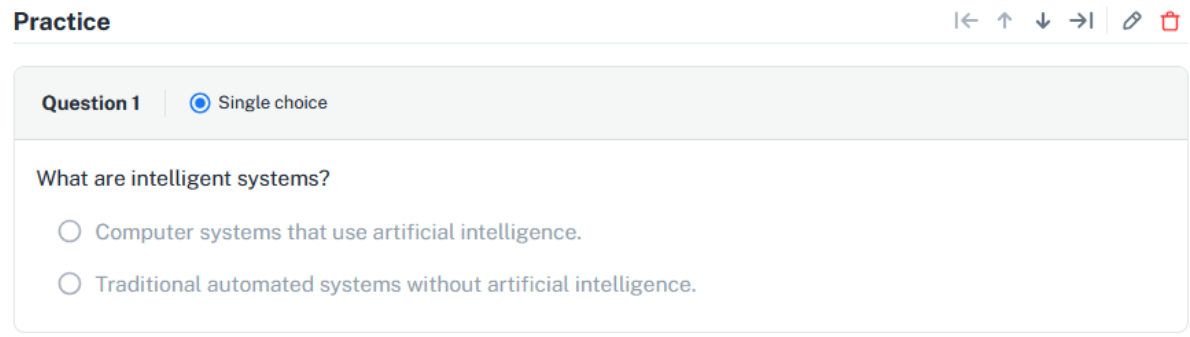

Figure 6: An example of a generated quiz question.

Prompt engineering in this context ensures alignment with educational goals and reduces the cognitive burden on teachers. As a result, as shown in Figure 6, the lecturer receives draft questions tailored to the course objectives. It is important to emphasize that these are merely suggested items. Therefore, the final responsibility for validation and adaptation remains with the educator, reinforcing academic control and safeguarding quality [22]. This approach ensures instructional rigor while significantly

reducing the time and effort typically required in manual assessment design.

4. Conclusions

This paper presented *mISLec4EDU*, an AI-enabled platform that unifies asynchronous and personalized learning with pedagogical control and educator support. Unlike fragmented tools, it combines conversational tutoring, formative assessments, and AI-assisted content generation in a single environment. With supports both third-party and locally hosted large language models, offers institutions flexibility in addressing infrastructure, cost, and data governance requirements. The platform emphasizes context-aware prompting, learner-specific feedback, and a human-in-the-loop workflow that enables educators to validate and adapt AI-generated materials to maintain instructional integrity.

While the system's capabilities have been demonstrated through a detailed case study, we recognize that the current work does not include empirical validation. Claims about improved student engagement or reduced educator workload are grounded in design goals and system functionalities rather than experimental evidence. Future work will therefore focus on conducting systematic empirical studies to evaluate the platform's educational impact. These will include comparative studies between traditional and AI-supported learning, usability testing with both students and educators, and longitudinal assessments of learning outcomes, retention, and engagement across diverse learner demographics.

In addition, we plan to engage more deeply with critical issues surrounding generative AI in education, including transparency of AI decisions, fairness across user groups, explainability of content, and the mitigation of hallucinations or misinformation. Enhancements to the platform will explore mechanisms to increase user trust and awareness of the limitations of AI-generated content while reinforcing the educator's role in maintaining pedagogical rigor.

In conclusion, *mISLec4EDU* represents a step toward practical, flexible, and ethically grounded integration of generative AI in educational contexts. While not a substitute for traditional pedagogy, the platform supports the design of learner-centered experiences that can be scaled and adapted to institutional needs.

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Declaration on Generative AI

During the preparation of this work, the author(s) used Grammarly in order to: Grammar and spelling check. After using these tool(s)/service(s), the author(s) reviewed and edited the content as needed and take(s) full responsibility for the publication's content.

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