Artificial Intelligence in E-Assessment: Tools and Action Research in Mathematics

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Abstract: The rapid advancement of artificial intelligence (AI) has led to significant transformations in educational assessment practices. AI-supported electronic testing (e-assessment) is gaining attention for its potential to enhance automation, adaptivity, and efficiency in both formative and summative evaluation processes. This study combines a comparative analysis of selected online platforms that utilize AI for e-assessment with the outcomes of action research implemented in real-life school settings. In the first phase, we conducted a functional and pedagogical analysis of various AI-based e-testing tools, focusing on their capabilities for automatic question generation, adaptive item sequencing, and real-time feedback. Special attention was given to the field of mathematics education at the primary level, where accurate knowledge verification and differentiation are essential. In the second phase, we carried out action research at the lower secondary level (ISCED 2) of a primary school, investigating the implementation of AI-generated e-tests in regular mathematics instruction. The study examined not only the cognitive and motivational responses of students to AI-driven assessment but also teachers' reflections on the practical integration of such tools in their instructional routines. The results indicate that AI-enhanced e-testing offers multiple pedagogical benefits, including increased student engagement, personalization of learning, and more efficient data-driven feedback. However, several limitations were identified, such as technological constraints, challenges in interpreting open-ended responses, and the need for teacher mediation in adapting AI outputs to classroom realities. This research contributes to the ongoing discourse on educational technology by providing empirical evidence and critical reflection on the meaningful integration of AI in assessment. It underscores the importance of equipping educators with both digital and pedagogical competencies to ensure responsible and effective use of AI tools in primary and lower secondary education.

Keywords: Artificial Intelligence, E-Assessment, Mathematics Education, Primary School

1. Introduction

Over the past ten years, the landscape of teaching and student assessment has undergone profound transformation across all educational levels. The widespread adoption of digital technologies has fundamentally changed not only how instruction is delivered, but also how learners are assessed. A growing number of electronic tools are now being incorporated into classroom practice, enabling more interactive, engaging, and adaptive forms of teaching and providing teachers with faster, data-informed feedback. Among these tools, electronic testing (e-testing) has emerged as a particularly promising method. E-testing brings numerous advantages—not only in terms of efficiency and time-saving capabilities, but also in its potential to support individualized learning pathways, offering tailored questions and differentiated levels of difficulty (Andriaputra, Resmana, Marzuki, & Rangkuti 2022). In parallel with the evolution of e-testing tools, significant strides have also been made in the field of artificial intelligence (AI), which is increasingly being harnessed to enhance educational processes. Within the context of primary and secondary education, AI technologies are now being used for tasks that were previously difficult or highly time-consuming. These include the automatic generation of test questions, adaptive sequencing based on student responses, automated evaluation of open-ended items, and the provision of real-time, personalized feedback (Luckin et al. 2016; Abdelmagid et al. 2024). Such innovations not only support more dynamic assessment practices, but also open new possibilities for addressing individual student needs. In the specific context of mathematics education at the lower secondary level, the integration of AI into e-assessment has the potential to deliver significant benefits. Mathematics is a discipline that demands precision, systematic problem-solving, and repeated practice. Teachers often face challenges such as preparing exercises that suit different ability levels, adapting instruction for diverse learners, and spending large amounts of time manually grading assignments. AI-powered e-testing tools can help automate many of these processes while maintaining assessment quality and increasing student motivation through interactivity and instant results (Vilček 2024). The purpose of this article is to present and critically examine several selected online platforms that incorporate artificial intelligence into the design and delivery of electronic tests, with a particular emphasis on their application in lower secondary mathematics education. In addition to conducting a comparative analysis of these AI-enhanced platforms, the study also includes an action research component, carried out in real classroom settings at the ISCED 2 level. This practical phase explored how AI-generated e-tests function in regular instruction, focusing on students' cognitive performance and

motivational engagement, as well as on teachers' reflections regarding the feasibility and value of integrating AI tools into their everyday teaching practice.

2. Research Design

This study addresses the insufficient empirical evidence on the use of AI-generated e-tests in primary school mathematics education. The research aims to investigate their impact on students' cognitive performance, motivation, and teachers' practical experiences with the implementation of these tools compared to traditional assessment methods.

The research design is based on a mixed-method approach combining a comparative analysis of selected AI-supported e-assessment tools with an action research component conducted in authentic classroom settings. This design enabled linking theoretical knowledge of AI functionalities in e-testing with practical experiences in real-life school environments.

Research questions:

1. What is the impact of AI-generated e-tests on students' cognitive performance in mathematics?
2. How do AI-supported e-assessment tools influence students' motivation and engagement in solving mathematical tasks?
3. What are teachers' experiences and perceptions of the benefits and limitations of implementing AI-based e-testing tools?

Participants: The study involved 37 students from grades 6 and 7 (ISCED 2) and two mathematics teachers. The tools tested were Quizizz and Edpuzzle, selected for their AI-driven features such as automatic question generation, instant feedback, and result tracking.

Data collection methods included:

- Observation of classroom interactions and engagement levels.
- Analysis of test results (success rates, types of errors, time to solve tasks).
- Short post-lesson questionnaires for students focusing on motivation and perceived usefulness.
- Semi-structured interviews with teachers to gather their reflections on the implementation process.

Data analysis combined quantitative indicators (test scores, error distribution) with qualitative coding of student and teacher comments. This allowed a multi-faceted understanding of how AI tools influence both cognitive and affective aspects of learning, as well as their practical applicability in mathematics education.

The research design of this study combines comparative analysis with elements of action research. The aim was not only to describe and compare the functions of selected online tools using artificial intelligence in e-testing, but also to verify their practical use in teaching mathematics at the second level of primary school. This mixed approach allows to link theoretical knowledge about the possibilities of AI tools with concrete experiences from real school environments. The research was conducted in two follow-up phases. The first phase focused on a systematic analysis of the features of the three selected applications, with an emphasis on their applicability to the development of e-tests in mathematics. The second phase took the form of an action research in which these tools were tested in regular classrooms, and students' reactions and teachers' reflections were observed. The following subsections describe in detail the procedure and methods used in both parts of the research.

2.1 Phase 1 - Comparative Analysis of Educational Applications

In the first phase of the research, a comparative analysis of three online educational tools that combine traditional e-testing environments with elements of artificial intelligence was conducted. Kahoot!, Edpuzzle and Quizizz were included in the selection process and were chosen based on several criteria: availability of a free version, degree of integration of AI features, intuitiveness of the interface for teachers, feedback options and ability to work with mathematical content. For each of the apps, specific AI-powered features were looked at, the automatic generation of questions based on a given topic, text, link or PDF document, the adaptive nature of the testing, and the options for scoring answers, including open-ended tasks. The analysis also focused on the practical applicability of the tools in the development of tests in mathematics at the second level of primary school, noting their advantages and limitations in terms of pedagogical use. For example, Kahoot! offers the generation of test problems from text-based materials or web pages and high student motivation due to its game-like format. Edpuzzle enables interactive video work and uses AI to generate questions and automatically score open-ended answers. Quizizz features a wide range of question generation options and clear result

scoring. The output of this phase was a systematic characterisation of each tool and its suitability for use in mathematics education.

2.1.1 Rationale for Excluding Kahoot! from the Action Research

Although Kahoot! scored highly in terms of student motivation thanks to its game-based design, its limited capacity to support more complex mathematical problems and reliance predominantly on multiple-choice formats made it less suitable for the objectives of this research. In contrast, Quizizz and Edpuzzle provided more flexible options for generating and assessing mathematics tasks, including open-ended responses and adaptive question formats. These features better aligned with the study's aim to examine not only engagement but also deeper cognitive understanding in mathematics education.

Table 1 Comparison of AI-supported e-testing tools (Kahoot!, Edpuzzle, Quizizz).

Criterion	Kahoot!	Edpuzzle	Quizizz
AI Question Generation	From text, PDF, or website	From video content	From topic, text, or website
Mathematical Suitability	Less suitable for complex problems	Supports conceptual understanding	Strong support incl. math notation
Feedback Quality	Immediate, mostly multiple-choice	Detailed, incl. open-ended answers	Provides instant feedback with detailed tracking
Motivation/Engagement	High (game-based)	Moderate to high (video-based)	High (gamified quizzes)
Teacher Workload	Requires review/editing	Saves time via auto-grading	Reduces workload with AI-assisted customization
Free Version Limitations	Some advanced features restricted	Some features limited	Limited access to certain features

2.2 Phase 2 - Action research in school environment

In the second phase of the research, action research was carried out to test the possibilities of using electronic tests generated by artificial intelligence in regular mathematics teaching. Action research, first conceptualized by German American psychologist Kurt Lewin in the 1940s, is a cyclical and reflective process in which researchers and practitioners collaboratively identify a problem, plan and implement interventions, observe the outcomes, and reflect on the results to improve practice. In educational contexts, this methodology is widely used to enhance teaching and learning in authentic classroom settings, as it allows for a dynamic interplay between research and practice.

In this study, the action research was conducted during two consecutive lessons in the second level of primary school (ISCED 2), specifically in grades 6 and 7, with the participation of a total of 37 pupils. The Quizizz and Edpuzzle applications were used during the lessons, with an emphasis on the use of their AI features for automatic test problem generation, feedback, and result tracking. The research focused on three main areas: (1) students' cognitive response, i.e., level of understanding of the task and success in solving the tasks; (2) motivational aspects, such as engagement in the activity and preference for the tools; and (3) teachers' reflection, including practical experiences with the implementation of the tools in the classroom, their perceived benefits, and limitations. Data were collected through classroom observations, semi-structured interviews with teachers, and analysis of test results (including success rates, types of errors, and solution time).

3. Review of Selected Educational Apps

Given the growing potential of using artificial intelligence (AI) in education, new tools are emerging that can significantly save teacher's time while also making learning more engaging for students. One area where AI is increasingly being applied is in the creation of electronic tests—not only in generating questions but also in evaluating responses and providing feedback. For the purposes of this article, three online tools were selected that combine traditional testing environments with AI elements and have proven effective in teaching mathematics at the lower secondary school level. The selection criteria focused primarily on the availability of a free version, the extent of AI integration, the intuitiveness of the teacher interface, feedback options, and the ability to handle mathematical content. This section will present and compare the following applications in more detail: Kahoot! Edpuz285zle, and Quizizz. The emphasis will be on describing specific AI-powered features, the advantages and limitations of each tool, and their practical application in the creation of e-tests in primary school settings.

3.1 Kahoot!

Kahoot! is a very popular tool among pupils due to its game-based approach to testing and strong visual appeal. Recently, Kahoot! has implemented several AI-powered features that significantly speed up content creation and save teacher's time. One of the key features is the ability to automatically generate questions based on a given topic—for example, by entering the term *"geometry,"* the system creates related questions along with possible answers. This feature supports more than 50 languages, including Czech, and allows users to choose the difficulty level of the questions. Another useful function is the ability to generate a quiz from an uploaded PDF document, such as a worksheet or a teaching text. The AI can extract key information from the document and create relevant questions. Similarly, quizzes can also be generated from a provided website link—for instance, inserting a link to a Wikipedia article prompts the system to automatically create questions based on the page's content. These tools allow for a very efficient transformation of study materials into an interactive format without the need for manual rewriting. However, it's important to note that AI-generated content may not always be accurate or fully appropriate for specific learning objectives. Therefore, teachers should carefully review and, if necessary, edit the AI outputs to ensure they meet the instructional goals and the age level of the pupils.

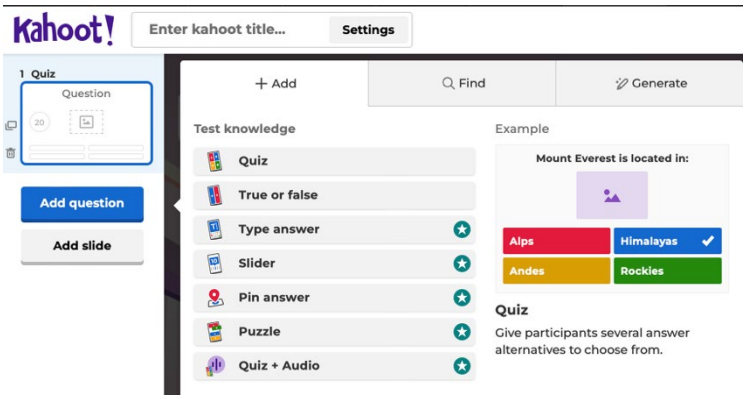

Figure 1 app Kahoot!

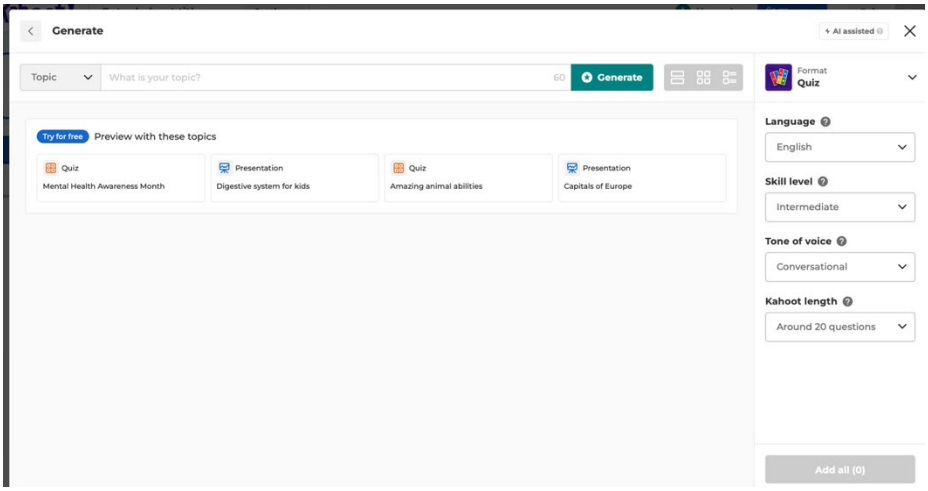

Figure 2 app Kahoot! - AI generator

Advantages of Kahoot!:

- High pupil motivation thanks to the game-based format
- Fast question creation using AI
- Ability to generate quizzes from PDFs or websites
- Support for the Czech language
- Clear evaluation of responses

Disadvantages of Kahoot!:

- AI-generated content is not always accurate – teacher review and correction is necessary
- Limited options for more complex math problems
- More suitable for review than for deeper assessment of understanding
- Some advanced features are only available in the paid version

3.2 Edpuzzle

Edpuzzle is an interactive learning platform that allows teachers to take any video from the internet (such as YouTube, Khan Academy, or their own recordings) and enhance it with interactive elements—specifically questions, notes, or comments. This transforms ordinary passive video watching into an active learning experience that increases student engagement and allows teachers to monitor understanding throughout the video.

As students watch the video, they are prompted to respond to embedded questions (such as multiple choice, short answer, or fill-in-the-blank). This enables the teacher to see exactly who answered what and when, and to adjust instruction accordingly. For example, if most students struggled with a particular section, the teacher can revisit it during class.

Newer versions of Edpuzzle include tools powered by artificial intelligence (AI), grouped under the Teacher Assist feature set. These AI tools are designed to save teachers time and support more efficient lesson planning and assessment:

- Autograde: This feature automatically evaluates open-ended responses by comparing student answers to an ideal response provided by the teacher. It saves time on manual grading and delivers prompt feedback to students.
- Question Generator: AI analyses the content of the selected video and automatically suggests relevant questions that can be embedded directly into the video. Teachers can either use these questions as-is or modify them to better suit their instructional goals. This greatly simplifies the preparation of interactive lessons.

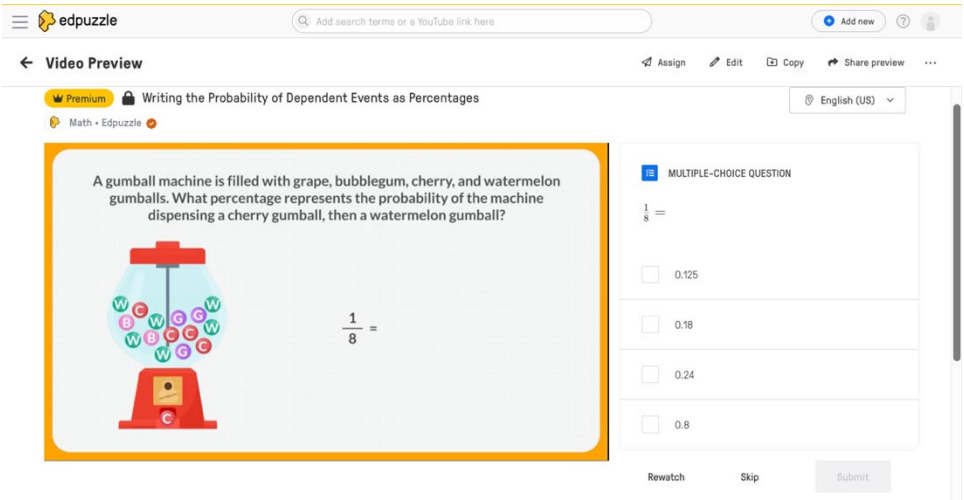

Figure 3 app Edpuzzle

Advantages of Edpuzzle:

- Automated grading of open-ended questions using AI
- Question generation based on video content
- Ability to customize questions to meet specific instructional needs

Disadvantages of Edpuzzle:

- Automatic grading may be less accurate for complex answers
- Generated questions may not always match the desired difficulty level
- Some features may be limited in the free version

3.3 Quizizz

Quizizz is a modern platform for creating quizzes and e-tests, popular among both teachers and pupils for its interactive and playful environment. Compared to traditional quiz tools, it has taken a step further thanks to the integration of artificial intelligence (AI), which enables fast and efficient generation of test questions. The Quizizz AI feature offers several ways to automatically generate questions based on the teacher's needs.

The most used function is Generate with AI, where the user simply enters a topic (e.g., *fractions*, *equations*, *probability*), and the AI automatically creates a set of questions with answer options. The teacher can choose the language (Czech is supported), the number of questions, and their difficulty level. Alternatively, the Generate from Text function allows the creation of questions based on an inserted text (e.g., a textbook excerpt or explanation), generating questions that match the content precisely. Quizizz also enables question generation from a website or by entering key terms.

In mathematics education, Quizizz is highly applicable—it supports not only multiple-choice questions but also fill-in-the-blank answers and working with mathematical expressions. The platform allows teachers to easily track pupil results, assign homework, or create competitions that motivate pupils to review the material.

Advantages of Quizizz:

- Quick question generation using AI
- Generation from a topic, text, or website
- Support for Czech and various difficulty levels
- Engaging environment for pupils, including game elements
- Ability to track results and repeat tests

Disadvantages of Quizizz:

- AI-generated questions need review—they are sometimes too general or too simple
- Open-ended or multi-step math problems are limited
- Some features and advanced analytics are only available in the paid version

4. Research Findings

This section presents the main outcomes of the conducted action research on the use of AI-supported e-assessment tools in mathematics education. The findings are based on data collected from two classes (6th and 7th grade), where Quizizz and Edpuzzle were implemented during regular lessons. The results highlight both cognitive aspects of student performance and the motivational impact of using these tools. The following subsections provide a detailed overview of the quantitative results and students' feedback on their learning experience.

4.1 Quantitative Findings

The quantitative analysis of the collected data revealed high success rates among students when using AI-generated e-tests. In Grade 6, where the focus was on the properties of triangles, the average success rate reached 97%. Despite this overall high performance, several recurring mistakes were identified. The most frequent errors included confusion between equilateral and isosceles triangles, incorrect identification of obtuse angles within triangle contexts, and difficulties in determining the type of triangle based on given side lengths. In Grade 7, where the topic of percentages was addressed, the average success rate was slightly lower, at 94%. Commonly observed mistakes included confusion about identifying the correct base value in percentage calculations, mixing up decimal and percentage forms (for example, interpreting 0.25 as 25% or vice versa), and omitting essential steps when solving word problems. These findings suggest that, while students generally performed well using AI-supported e-assessment tools, specific conceptual misunderstandings persist in both geometry and percentage calculations.

4.2 Qualitative Findings

The findings indicate that the use of AI-based assessment tools had a positive effect on student motivation and overall engagement during mathematics lessons. Many students reported that completing tasks through these digital platforms was significantly more enjoyable than traditional paper-based tests. In particular, the game-like format of Quizizz was highlighted as highly engaging, fostering a sense of competition and encouraging students to perform better. They appreciated the opportunity to receive immediate feedback on their answers, which allowed them to correct mistakes and improve their understanding on the spot. The feedback on Edpuzzle was more varied. While some students valued the use of instructional videos and considered them helpful for

understanding the topic, others expressed a preference for the faster-paced, interactive quizzes provided by Quizizz. This suggests that different students may respond differently to various AI-supported tools, with gamified approaches generally perceived as more appealing. Selected student comments illustrate these perceptions:

- “This was way better than a regular test.”
- “I scored higher than last time—happy about that!”
- “The video was okay, but I like quizzes more.”

Overall, the integration of AI tools appeared to enhance student motivation, making the learning process more dynamic, interactive, and enjoyable compared to traditional testing methods.

Figure 4 Children making Quizizz

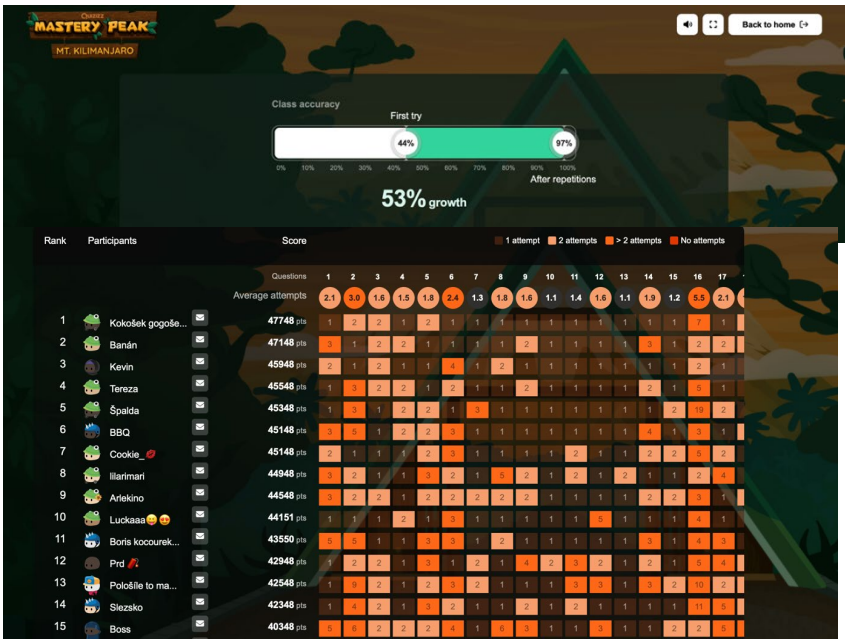

Figure 5 Quizizz results

5. Conclusion

This research confirmed that AI-supported e-assessment tools can significantly enhance formative assessment practices in mathematics education at both the primary and lower secondary levels. The tested applications, Quizizz and Edpuzzle, enabled teachers to quickly generate tests using AI features, provided students with instant feedback, and increased their motivation through interactive and game-like elements. The action

research conducted in two classes (6th and 7th grade) demonstrated that students responded positively to this type of assessment, actively engaged in learning activities, and generally achieved high success rates. Despite these benefits, some challenges were observed. The study highlighted the need for teacher oversight to ensure the accuracy, appropriateness, and difficulty level of AI-generated questions. While AI tools effectively support content review and quick diagnostics of student understanding, their ability to handle complex, multi-step problems remains limited. Additionally, successful implementation depends on adequate technical infrastructure and teachers' digital literacy, as well as their ability to pedagogically adapt the generated content to students' needs. Feedback on Edpuzzle showed that while video-based questions can support understanding, many students preferred the more dynamic quiz format. From a practical perspective, AI-driven e-assessment tools have strong potential to complement traditional evaluation methods by making the learning process more engaging, adaptive, and efficient. Teachers who wish to integrate these tools should critically review AI-generated content for accuracy, tailor it to individual learners, and ensure equitable access to technology. Future research should investigate the long-term effects of AI-supported assessment on learning outcomes, its potential to create personalized learning pathways, and its applicability across broader mathematical topics and other school subjects. With proper implementation and teacher guidance, AI-driven e-assessment can significantly enrich mathematics education and contribute to more dynamic, data-informed, and student-centered learning environments.

Ethics declaration

This study did not require formal ethical clearance, as it was conducted within the standard framework of regular classroom instruction and involved no collection of sensitive personal data. Participation was entirely voluntary, and the students' responses and results were anonymized. The research was carried out with the informed consent of the participating teachers. No identifiable information about students was recorded or reported.

Declaration on the Use of AI Tools

In the preparation of this work, the authors made use of the ChatGPT language model developed by OpenAI, primarily for academic language editing and refinement of the English text. All content generated with the assistance of this tool has been carefully reviewed, revised, and edited by the authors, who assume full responsibility for the final version and overall content of the article.

Acknowledgement:

This paper is supported by grant KEGA 077UK-4/2025 "Edu-Steam laboratory in primary education teaching"

Erasmus+ 2023-1-CZ01-KA220-HED-000160664: "Accelerating STEAM-related Knowledge and Skills via 3D Modelling and 3D Printing"

SGS06/PdF/2025: " Integration of e-learning, e-testing and GeoGebra software in mathematics education"

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