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Personalized digital tools in the function of improving the learning of mathematics

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Abstract

This paper analyzes the role of personalized digital tools in modern mathematics teaching. The focus of the research was on determining how high school students use digital tools for learning, how much they help them understand the material and what attitudes they have towards their use in class. The research was conducted by surveying a sample of 225 students from different grades of high school. The results showed that digital tools are most often used outside the classroom that the use of simple tools such as YouTube and PhotoMath dominates, while tools that enable deeper understanding and interactive learning are less represented. Students showed a moderate level of motivation and recognition of certain advantages of digital tools, but also pointed out important disadvantages, such as misunderstanding of procedures and technical limitations. Based on the results and analysis, the paper offers guidelines for improving the teaching of mathematics through purposeful, personalized and digitally supported teaching.

Keywords:

Digital tools, Personalization, Mathematics, Teaching, Motivation.

INTRODUCTION

In the modern educational context, where digital technologies occupy an increasingly important place, the question arises of how to effectively integrate them into the teaching and learning process, especially in teaching subjects that are traditionally perceived as demanding, such as mathematics (Weigand et al., 2024). The development of information and communication technologies has enabled the emergence of various digital tools that, if properly applied, can significantly contribute to the individualization of teaching and the increase of learning efficiency (Gkoutis et al., 2025). This need for harmonizing educational methods with the modern technological environment was the starting point for the research presented in this paper.

In practice, we observe differences in learning approaches among students every day, as well as the increasingly pronounced need to adapt teaching methods to different learning styles.

In this context, special attention is drawn to personalized digital tools that can respond to the individual needs of students in learning mathematics, a subject that often causes fear, insecurity or a sense of distance in high school students (Ayeni et al., 2024).

It is necessary to keep in mind that today's students of the 21st century grew up with phones, tablets, computers, social networks and various applications that they use every day. School, and especially the teaching of mathematics, often seems abstract and boring to them because it does not correspond to the world in which they move and communicate. This is precisely why there is a real need to bring the contents and teaching methods closer to their digital language. Based on the research carried out, the authors (Engelbrecht & Borba, 2024) conclude that by enabling students to solve mathematical problems using technologies known to them, watch video explanations, use interactive applications and participate in digital quizzes and simulations, mathematics becomes not only more understandable, but also more interesting and motivating.

In the previous period, the application of artificial intelligence in education was present. It aims to improve the quality of learning through faster access to information, easier individualization of teaching and more effective monitoring of achievements. Teachers gain the ability to monitor student progress in real time, while students have the opportunity to learn at their own pace and through assignments that are consistent with their prior knowledge. However, with numerous advantages, there are also certain challenges. The most frequently asked questions are related to the reliability and accuracy of the information that artificial intelligence provides, to the ethical aspects of its use, as well as to the preservation of the pedagogical role of teachers in the digital environment (Akgun & Greenhow, 2022). Digital tools can increase student motivation and enable more active participation in the teaching process. Although technology can help in the transfer of knowledge, it cannot completely replace the teacher, whose role in interpretation, explanation and motivation of students is irreplaceable.

The aim of this paper is to examine, through the analysis of a survey conducted among high school students, how students perceive the application of digital tools in learning mathematics, to what extent they use them, how much they help them in understanding the material, what problems they perceive and how they imagine the ideal teaching of mathematics with digital tools. A special focus is placed on personalization the ability to adapt the content and way of working to each student individually, which enables more efficient and motivated acquisition of knowledge.

THEORETICAL FRAMEWORK OF THE RESEARCH

Digital tools are resources and technologies used to enhance the teaching process, enabling interactive, visual, personalized and flexible learning (Parveen & Ramzan, 2024). In the context of education, these tools aim to make it easier for students to understand the material, to further motivate and engage them, as well as to provide support to teachers in the organization and evaluation of teaching. The growing importance of modern technologies in education is evident (Ilyas et al., 2023).

The development of digital technology has led to the availability of a large number of educational tools, such as: interactive applications and software (e.g. GeoGebra, Desmos, Cabri), platforms for practicing and checking knowledge (e.g. Kahoot!, Quizizz, Edmodo, Microsoft

Forms), video lessons and tutorials (e.g.YouTube, Khan Academy, educational channels with animations), applications for automatic problem solving (e.g. PhotoMath, Microsoft Math Solver, Symbolab), virtual classrooms and LMS systems (e.g. Google Classroom, Moodle, Microsoft Teams).

The introduction of digital tools in teaching changes the traditional role of teachers and students. The teacher is no longer the exclusive source of knowledge, but a guide through the learning process. In modern education, the teacher has the role of a leader in the learning process, influencing student motivation, knowledge creation, communication and the ability to work in a team as well as the ability to work independently (Zhai, 2025). Students actively participate in creating their own knowledge in lessons and independently at home. Digital tools allow for faster and more efficient communication between students and teachers, automatic feedback, easier checking of knowledge, as well as better organization of teaching materials (Carević, 2025).

Nevertheless, the application of digital tools in education does not mean the exclusion of the teacher, but rather his transformation into a guide and mentor (Celik et al., 2022). The role of the teacher remains crucial in the selection and adaptation of tools to the specific context of teaching and the developmental needs of students.

Personalization of learning is a modern pedagogical approach that adapts the educational process to the individual needs, interests, prior knowledge, pace of work and learning style of each student (Walkington & Bernacki, 2020). In contrast to traditional teaching, which is usually aimed at the whole class as a homogeneous group, personalized learning recognizes the differences between students and strives to enable everyone to make maximum progress based on their specificities. In the 21st century, thanks to digital technologies, this approach becomes not only possible, but also increasingly present (Mikić et al., 2022). Digital tools allow the content to be automatically adapted to the user: tasks are offered to the student according to his previous answers, automatic feedback is obtained, additional explanations or easier/harder examples are accessed, and progress is monitored through real-time analytics (Huang et al., 2023). This kind of approach is especially useful in learning mathematics, where students often come with very different prior knowledge and different levels of self-confidence. Personalization allows each student to work at their own pace and build understanding without pressure or comparison to others.

Mathematics is considered one of the most important, but also the most challenging school subjects. Its abstract nature, the demanding nature of the material and the gradual upgrading of knowledge often represent an obstacle for students who fail to master the basic concepts in time. Because of this, mathematics is often perceived as a "difficult subject", which can cause resistance, fear, and even loss of self-confidence in students. Also, students with different work paces and learning styles are easily left behind. Interactive content, visualizations, animations, customized tasks and automatic feedback can contribute to students gaining a deeper understanding of the material and developing a more positive attitude towards learning mathematics (Saat et al., 2024).

Numerous international studies in recent years indicate the significant potential that digital tools have in improving mathematics teaching, especially when used in the context of personalized learning. Different authors emphasize the positive effects of the application of

digital technologies on the understanding of the material, the engagement of students, as well as on the improvement of their achievements (Salami & Spangenberg, 2025). Students who use digital resources as a supplement to traditional mathematics lessons achieve statistically significantly better results than those who learn exclusively through classical methods. A study (Joshi et al., 2025) within the PISA research shows that students who have regular and meaningful access to digital tools develop higher levels of functional mathematical literacy. It has also been observed that digital teaching helps students connect abstract mathematical concepts with real life, which contributes to their motivation.

In the context of teaching practice, research shows that the key factor in the successful application of digital tools is precisely the teacher — his digital literacy, openness to new methods and ability to use technology purposefully (Kadluba et al., 2025). Without adequate training and pedagogical reflection, even the most modern tools can remain unused or be used superficially.

In Serbia, this area is still under development, but within the framework of education reforms, the need for the introduction of digital resources, as well as for the professional training of teachers in the direction of their effective use, is increasingly pointed out. Various projects, such as "Digital Classroom" and platforms such as e-classroom and My Classroom, indicate progress in this direction, but practice shows that these processes are still insufficiently implemented and uneven in different environments.

RESEARCH METHODOLOGY

In this research, a quantitative approach was applied through an anonymous survey, with the aim of investigating the attitudes of high school students about the use of digital tools in learning mathematics, especially in the context of the personalization of the teaching process. The research was conducted during the year 2025, through an online questionnaire created in the Google Forms tool, and the link for the survey was distributed to students of different grades in high schools.

The survey was anonymous and voluntary, and students could answer at a time that was most convenient for them, using a mobile phone or computer. The questionnaire contained a combination of closed and open questions, designed to cover the following areas: basic data about the student (class), frequency and type of digital tools used, perception of the usefulness of tools for understanding the material, motivation for learning mathematics when using digital tools, problems using tools, students' ideas about what an ideal mathematics classroom would look like with digital tools.

In total, 225 students from all grades of high school participated in the research, and the answers were processed by statistical analysis at the level of percentage representation, with additional thematic grouping of open questions. The collected data were processed using tables and graphs, with additional thematic coding of answers to open questions.

SURVEY RESULTS AND INTERPRETATION

Basic sample information

The survey included students from all grades of high school in order to get a broader insight into their attitudes and experiences regarding the use of digital tools in learning mathematics.

When asked "Which type are you?" the following responses were received:

Grade 1: 75 students (33.3%), Grade 2: 64 students (28.4%), Grade 3: 39 students (17.3%), Grade 4: 47 students (20.9%).

This distribution shows that all grades are represented, with a slightly higher participation of first and second grade students. This ensures diversity in the sample, which enables the observation of possible differences in the perception and use of digital tools depending on the school age.

Frequency and type of digital tools used

To the question: "How often do you use digital tools for learning mathematics (GeoGebra, YouTube, Khan Academy...)?" , we got the responses shown in Table 1.

Table 1. Frequency of use of digital tools for learning mathematics

Responses	Number of students	Percentage
Sometimes (1-2 times a month)	118	52.4%
Never	56	24.9%
Often (1–2 times a week):	32	14.2%
Very often (almost daily)	19	8.4%

These results show that the largest number of students use digital tools occasionally, while daily use is still not significantly represented. About 25% of students do not use digital tools at all, which indicates exigency for improvement in teaching organization and student motivation for digital work.

In the next question, the students declared which specific tools they use most often. Multiple choice was offered, and the most common responses are shown in Table 2.

Table 2. The most commonly used digital tools in learning mathematics

Responses	Number of students	Percentage
YouTube tutorials	128	56.9%
Applications for solving tasks (PhotoMath, Mathway...)	107	47.6%
Microsoft Math Solver	9	4%
GeoGebra	6	2.7%
ChatGPT and similar tools	15	6.6%

Other responses (e.g. "I don't use", "AI", "notebook and textbook", etc.) accounted for a negligibly small number.

It is noticeable that YouTube stands out as the main source of additional learning, which speaks to the need of students to receive visual and clearly structured explanations. Automatic problem-solving apps are very popular, but they raise the question of whether students understand the solution or just copy it. Tools such as GeoGebra and Math Solver are still poorly represented, which indicates the need for additional training and promotion of these resources by teachers. It is also interesting that some students declared that they use AI tools and ChatGPT, which shows that a new generation of students, is already experimenting with modern technologies — although still in small numbers.

Perception of utility and motivation

In order to examine how much students actually see the benefits of digital tools, the question was asked: "On a scale of 1 to 5, how much do digital tools help you understand math material better?" (1 = not helpful at all, 5 = very helpful). The answers obtained are shown in Table 3.

Table 3. Evaluation of the usefulness of digital tools for understanding mathematical material

Responses	Number of students	Percentage
1	27	12%
2	38	16.9%
3	73	32.4%
4	57	25.3%
5	30	13.3%

We observe that the majority of students give a medium score (3), which suggests that they are aware of certain benefits, but at the same time they also see the limitations of the tool. Only 13.3% of students think that digital tools help them a lot, which indicates the need for a better selection and integration of tools in the teaching process. Almost 30% of students think that digital tools help them little or not at all, which may indicate a lack of knowledge about their use or a bad previous experience.

The students were also asked the question: "How do you rate the motivation to learn mathematics when using digital tools?" The following responses were received:

• Greater motivation than usual - 87 students (38.7%)

• Less motivation than usual - 24 students (10.7%)

• No difference - 114 students (50.7%)

Almost 40% of students feel more motivated when using digital tools, which confirms their potential as a motivating factor. However, for more than half of students (50.7%), the

motivation remains the same, which may mean that the tools are not personalized or engaging enough. The negative impact of digital tools on motivation is reported by only 10% of students, which is a relatively small percentage.

The obtained results show that digital tools, although they have potential, are still not sufficiently directed towards the individual needs of students, and that their greater efficiency could be achieved through a personalized approach and a clear pedagogical purpose.

Problems in using digital tools

One of the key questions in the survey was: "What problems do you have when using digital tools to learn mathematics?" The question was open-ended, which allowed students to freely express their experiences and difficulties.

Based on the thematic analysis of the responses, the problems were grouped into the following categories as shown in Table 4.

Table 4. Problems in using digital tools in teaching mathematics

Problem category	Number of students	Typical answers
Without problems.	98	"None", "No problem"
They don't use digital tools.	14	"I don't use", "That's not how we work", "The professor doesn't use digital tools"
Misunderstanding / unclear procedure	16	"I don't understand how they came up with the solution", "Lack of detailed explanation"
Technical problems	7	"App not working", "No Internet", "PhotoMath does not recognize handwriting"
A different procedure from the school one	4	"He explains differently than the professor", "It's not the same procedure as in school"
Difficult to find content	3	"I have to be too specific", "I can't find what I need"
Lack of motivation / superficiality	2	"I don't make an effort when using apps", "Excessive use of technology"
Other / uncategorized	81	Very varied answers: personal comments, vague or humorous, specific situations

Based on the answers received, we can see that more than 40% of students have no difficulty using the tool, which is a good indicator of their intuitiveness. However, a significant number of students report that they do not use the tools at all, which indicates insufficient integration of digital technology into teaching, which is often the result of a lack of teacher initiative. Not understanding how to solve tasks and differences in procedures are a serious challenge because students often do not get enough explanations, which reduces the effectiveness

of the tool. Technical obstacles are also not negligible, especially in environments with weaker digital infrastructure. The students expressed the need for a tool that would provide step-by-step explanations, be aligned with the school's working methods and enable additional clarifications when in doubt. Also, it was emphasized that the combination of digital tools and the "living word" of the teacher would be the most effective.

Student suggestions for ideal mathematics teaching with digital tools

To the last question in the survey: "In your opinion, what would the ideal mathematics teaching in which digital tools are used look like?" the students gave a large number of open and varied answers, which shows how close and current the topic is. Based on the thematic analysis, the responses were grouped into the following dominant categories as shown in Table 5 .

Table 5. Student suggestions for ideal mathematics teaching

Topic / Proposal	Number of students	Description
Using YouTube tutorials	13	They suggest that lessons are explained using YouTube videos and additional video content
Use of computers and telephones in class	18	They want to use the device for assignments, learning and testing
Presentations and visual explanations	3	They suggest using PowerPoint and graphics for a better understanding of the material
Personalization and work at your own pace	1	They emphasize the need for adapted tasks according to the level of knowledge
Independent and combined work	3	They want to learn more independently with the support of technology and teachers
Quizzes and games	2	Suggestions include math quizzes and competitions for learning through play
No digital tools / negative attitude	4	A few students do not see the benefit of digital tools and prefer "classical teaching"
I don't know / Unspecified	60+	A very large number of students did not know how to answer or left a blank comment
Other (broad and personal suggestions)	100+	From detailed proposals for combined teaching, to humorous, unrelated or emotional statements

Although most students do not have a fully formed image of the "ideal" digital teaching, a significant number recognize YouTube, phones and computers as tools that would make mathematics teaching more interesting and understandable. Students want visual and clear explanations, more freedom in the pace of work and an easier connection of the material with everyday life. Very few students mention personalization explicitly. Although there is a need for individualization, the terminology and awareness about it is still not present enough. Criticisms of digitization of teaching are in the minority, but they are significant. Part of the students think that digital tools are superfluous, especially if the teacher explains the material live. These student suggestions represent a valuable basis for improving teaching and a clear signal that students want greater application of technology in a way that is close and understandable to them, but with teacher guidance and clearly structured content.

When all these findings are considered together, it is clear that there is a great potential for improving the teaching of mathematics through digital, but primarily personalized tools. In order to realize this potential, it is necessary to ensure:

• Education and training of teachers for digital-pedagogical integration of tools,

• Selection of quality, educationally oriented tools,

• Constant feedback on student progress, and most importantly a pedagogical framework in which the tool does not replace teachers, but supports them.

Today's students deserve an education that matches their abilities, interests and digital skills. Mathematics teaching, although demanding and specific, can become more accessible, interesting and effective if it is approached in a modern, thoughtful way and with respect for individual differences.

CONCLUSION

This paper analyzes the importance of the application of personalized digital tools in the function of improving mathematics learning among high school students. Starting from the modern educational needs of the 21st century and the digital habits of students, the paper pointed out the importance of adapting the teaching process to the new generations who use technology every day, primarily mobile phones and social networks.

Research conducted through a survey in secondary schools showed that students use digital tools to learn mathematics to a large extent, but that their application in the teaching process is still not systematized. Simple tools such as YouTube and PhotoMath are most often used, while the use of more sophisticated tools such as GeoGebra or Microsoft Math Solver is much less common. Students show a certain degree of motivation and interest when using digital tools, but at the same time point to numerous challenges — from lack of clear explanation, technical problems, to mismatch between what they see in the tools and what teachers require.

By analyzing the open questions, a number of useful suggestions from the students about what the ideal teaching of mathematics could look like were highlighted. Most of the respondents express the need for greater use of digital tools in the classroom, but in combination with a clear explanation by the professor and interactive work. However, very few students mention personalization as a concept, which indicates that this aspect of teaching is not sufficiently recognized and applied in current school practice.

The work shows that the effective integration of digital tools in mathematics teaching cannot be reduced only to the availability of technology, but requires careful pedagogical planning, teacher training, quality resources and consistent guidance of students towards understanding, and not simply copying results.

Therefore, it is necessary to further develop personalized learning models, which allow the pace, content and access to the material to be adapted to each student. Such models should combine the most effective digital tools with classic pedagogical methods, with the active involvement of students in the learning process.

Based on all the findings, it can be concluded that the successful integration of modern technologies in the teaching of mathematics requires triple support: pedagogically thought-out application by teachers, openness and engagement of students, and institutional and systemic support in the form of training, resources and equipment. Only in this way can digital tools realize their full potential - not as a substitute for teaching, but as its empowerment and modernization, which enables students to experience mathematics as an accessible, understandable and useful subject.

This work contributes to the understanding of how students perceive digital tools and provides a basis for further research and practical initiatives that would improve the quality of education. In a time when technology is becoming ubiquitous, its purposeful and thoughtful use can be the key to education that is motivating, inclusive and adapted to each student.

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