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Advantages and Opportunities of Integrating Educational Programmes for Teaching Rational Numbers in 6th-Grade Mathematics

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Abstract

Aim/Purpose	The aim of this study was to identify the advantages and disadvantages of using interactive technologies in teaching mathematics to 6th-grade students.
Background	This paper addresses the problem of low student engagement and difficulty understanding complex mathematical concepts by evaluating how interactive educational programmes can enhance the teaching and learning of rational numbers in 6th grade.
Methodology	The methodology included research methods, such as surveys of teachers and students, as well as a SWOT analysis to identify the strengths and weaknesses of using these programmes. The study involved 45 mathematics teachers and 60

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6th-grade students from three secondary schools in the Issyk-Kul region of Kyrgyzstan, selected through random sampling.

Contribution This paper shows how interactive programmes enhance 6th-grade students' learning of rational numbers, improving engagement and understanding.

Findings The results showed that teachers consider interactive programmes useful for facilitating learning complex mathematical concepts. It was found that teachers regard the use of educational programmes as an effective tool for improving their teaching quality. It was determined that educational programmes significantly increase students' interest in the learning process, contribute to the development of critical thinking, and improve mathematical problem-solving skills. The use of such programmes enables teachers to more effectively monitor students' progress, identify individual needs, and adjust the learning process.

Recommendations for Practitioners Practitioners should integrate interactive programmes to personalise instruction, enhance visual learning, and effectively monitor students' mathematics progress.

Recommendations for Researchers Researchers should explore how interactive programming influences sustained mathematical understanding and supports inclusive, differentiated learning.

Impact on Society The study supports improved maths education through digital tools, fostering critical thinking and digital literacy among students.

Future Research Future research should examine the long-term effectiveness of interactive educational programmes, their impact on various student populations, and their integration in inclusive and adaptive learning environments.

Keywords digital resources, learning platform, critical thinking, personalised learning, educational technologies

INTRODUCTION

In modern education, the integration of information technologies into the educational process offers wide opportunities for enhancing the effectiveness of teaching and the quality of learning. Mathematics, as one of the core disciplines, requires modern approaches to teaching, especially when addressing topics that are fundamental for the further mastery of the subject. One such topic in the 6th-grade mathematics curriculum is rational numbers, which require students to develop a profound understanding of mathematical patterns, as well as the ability to perform calculations, make comparisons, and apply numbers in real-life situations. In this study, the term "curricula" refers specifically to the structured content or set of courses and learning experiences designed to achieve specific educational goals. It encompasses the subjects, materials, and methods used in instruction within an educational system. On the other hand, the term "educational programmes" refers to broader, organised educational offerings that may include curricula, along with the teaching methods, assessments, and extracurricular activities aimed at achieving particular educational outcomes. The use of educational programmes in the study of rational numbers can significantly facilitate the assimilation of complex materials, increase students' interest, and encourage active engagement in the learning process. Interactive learning tools enable the creation of a more visual, accessible, and engaging environment for working with rational numbers (Nurgaliyeva et al., 2025). Furthermore, such programmes allow for the individualisation of learning, taking into account each student's unique needs and helping them progress at their own pace. This approach contributes to the development of strong mathematical skills, the enhancement of logical thinking, and greater confidence in problem-solving. Through the integration of innovative technologies, the learning process becomes not only more effective but also more engaging and motivating for modern students (Matviienko et al., 2023).

A significant number of researchers have studied this topic and presented diverse perspectives on it. For example, Bobyliev and Vihrova (2021) analysed the prospects for distance learning in fundamental disciplines, emphasising that the integration of digital technologies improves the understanding of mathematical topics and allows for the adaptation of the learning process to students' needs. Research has demonstrated that interactive teaching methods, like digital games, enhance cognitive skills and facilitate more efficient mastery of rational numbers.

McMullen et al. (2024) demonstrated that the use of games for learning, especially adaptive learning approaches, supports better mastery of rational numbers and increases students' interest in mathematics. Their results imply that digital games actively promote conceptual development by helping students internalise important numerical relationships through individualised scaffolding mechanisms in addition to increasing engagement. Bouzid et al. (2021) investigated the impact of digital games on teaching mathematics in primary schools. Specifically, they identified learning operations with fractions, a foundational skill for working with rational numbers, as a crucial element of mathematics education. In their study, students exposed to game-based learning environments demonstrated improved problem-solving accuracy and increased motivation compared to those taught using traditional methods. The development of digital games for learning rational numbers has proven effective in school practice. Kärki et al. (2022) demonstrated that the NanoRoboMath game helped students strengthen their knowledge of rational numbers while also increasing their motivation to learn and engagement in the learning process. The use of information and communication technologies (ICT) in mathematics education plays a key role in creating an accessible and interactive learning environment.

Innovative approaches to teaching rational numbers have also proven effective when combined with ethnomathematics. Mania and Alam (2021) examined teachers' perceptions of incorporating ethnomathematics in teaching, noting that game-based technologies positively impact students' adaptability to new knowledge. Researchers discovered that combining game-based technologies with culturally relevant content increases students' flexibility and interest in learning new information. Moreover, Kaplan et al. (2025) analysed the role of artificial intelligence (AI) – specifically, ChatGPT – in teaching rational numbers, observing that AI-based tools can help personalise learning by offering students tasks adapted to their level of knowledge. Additionally, based on each student's unique input, they can function as dynamic instructional agents that produce adaptive tasks, immediate explanations, and responsive feedback. According to their research, students who used ChatGPT improved their problem-solving techniques and gained more self-assurance when handling challenging mathematical tasks.

Flores et al. (2024) described specific methods for teaching rational number concepts to 5th-grade students with mathematical difficulties. Their research confirms that specialised educational programmes contribute to a better understanding of the topic and increase students' confidence in learning mathematics. The authors also emphasised how focused interventions increase students' perseverance and engagement with challenging numerical tasks in addition to their academic progress. Kramarenko et al. (2021) investigated the impact of ICT on teaching mathematics to students with special educational needs, finding that curricula designed with ICT help to reduce learning barriers and enable adaptation to individual student needs. In addition, digital tools serve to develop critical thinking within mathematics education. According to their findings, technology-enhanced learning environments facilitate multisensory engagement, differentiated content delivery, and alternative representations of mathematical problems – all of which are critical for assisting diverse learners.

Copur-Gencturk (2021) examined how the depth of teachers' understanding of fractions affects the effectiveness of teaching. The researcher found that teachers with a solid conceptual understanding of fractions were better able to identify misconceptions in their students, offer a variety of solutions, and foster a deeper understanding of rational numbers. The scholar also demonstrated that programmes offering clarity and interactivity significantly facilitate teaching these topics, especially for students who struggle with mathematics. Fried (2024) explored the relationship between teachers' knowledge and the mathematical concepts taught in schools, emphasising the importance of using well-designed curricula to expand teachers' horizontal knowledge and thereby enable them to provide a deeper understanding of the topic of rational numbers.

Research gaps remain regarding the long-term impact of curricula on the development of sustainable skills in working with rational numbers. Most existing studies focus on short-term outcomes, without examining how interactive technologies influence students' subsequent mathematical performance. The role of curricula within the framework of inclusive education, particularly for students with diverse cognitive characteristics, also remains insufficiently explored. Furthermore, the integration of ethnomathematics and adaptive digital games for teaching rational numbers across different cultural and educational contexts requires further investigation.

The aim of this study was to identify the strengths and weaknesses of using interactive technologies in teaching mathematics to 6th-grade students. The objectives of the study were to analyse the capabilities of modern curricula in the process of teaching rational numbers, to determine the advantages of using interactive technologies in mathematics education for 6th-grade students, and to propose recommendations for improving the implementation of curricula in the educational process, ensuring their effectiveness and alignment with the needs of modern students.

MATERIALS AND METHODS

The study was conducted during the 2023-2024 academic year to examine the impact of educational programmes, such as Khan Academy, GeoGebra, and MathWay, on mathematics teaching and to identify the challenges faced by students. These programmes were selected due to their effectiveness in visualising, individualising learning, and developing students' analytical thinking skills. The study analysed a sample of mathematics teachers and 6th-grade students from three secondary schools in the Issyk-Kul region, Kyrgyzstan. Table 1 presents the main characteristics of the study participants.

Table 1. Characteristics of study participants

Parameter	Description
Number of teachers	45 (31 women, 14 men)
Age of teachers	From 25 to 55 years old
Number of students	60 (32 girls, 28 boys)
Grade of students	Grade 6
Geography of the study	Issyk-Kul region, Kyrgyzstan
Participating schools	3 secondary schools
Distribution of participants by school	Secondary school No. 11 named after M. Gorky, Karakol city – 20 students, 15 teachers Secondary school named after B. Mambetov, Tort-Kul village – 18 students, 12 teachers Secondary school named after S. Sydykov, Saruu village - 22 students, 18 teachers
School selection criteria	Secondary schools in the region
Participant selection criteria	Random selection among mathematics teachers and 6th-grade students

The survey was conducted using Google Forms from September to May of the respective academic year. Questions for the teacher questionnaire:

1. What methods do you consider the most effective for engaging students in the process of learning mathematics?

2. How do you adapt the teaching process for students with different levels of preparation?
3. What types of tasks, in your opinion, contribute to students' better assimilation of mathematical material?
4. What tools or programmes would you like to use to teach mathematics?
5. Do you have previous experience using such programmes?
6. How do you identify and take into account the individual characteristics of students during the teaching process?
7. What, in your opinion, is the greatest challenge in creating active student engagement during mathematics lessons?
8. How often do you receive feedback from students regarding teaching methods?
9. Do you conduct interactive or group-based tasks in lessons? If so, how often?

Questions for the student questionnaire:

10. Do you enjoy interactive or group tasks in mathematics lessons?
11. What teaching methods help you understand the material most effectively?
12. How would you assess the complexity of the tasks given during lessons?
13. Would you like to use more educational programmes or other modern tools for mathematics lessons?
14. What do you like most about mathematics lessons?
15. What difficulties do you most often experience when solving mathematical problems?
16. Is enough time allocated for explaining new material during lessons?
17. What would you change in the way mathematics is taught to make lessons more interesting and engaging for you?

The study was conducted in accordance with the Code of Ethics of the American Sociological Association (2018). In particular, the anonymity of study participants was ensured. Informed consent for the processing of personal data was obtained from all participants (or their legal representatives, in the case of students), and the data were used exclusively for scientific and analytical purposes. Based on the survey responses from students and teachers, a SWOT analysis was carried out, allowing for the identification of strengths, weaknesses, opportunities, and threats associated with the use of interactive educational programmes in teaching mathematics.

In addition to the survey data, other complementary sources were used to gather information about the efficacy of platforms like Khan Academy, GeoGebra, and MathWay. Previous empirical research on the effects of these platforms on mathematical learning, as well as an exploratory analysis of the platform functionalities carried out by the authors to assess their pedagogical affordances for teaching rational numbers. These sources influenced the assessment of platform potential, especially considering that 80% of the teachers polled had never used these tools before.

The validity of the questionnaire was verified through a multi-stage process. First, pilot testing was conducted among a small group of teachers and students to identify potential issues with question formulation and the logical structure of the questionnaire. Following this stage, necessary adjustments were made to ensure the clarity and comprehensibility of the questions. The questionnaire included various types of questions: closed questions (with fixed answer options), open-ended questions (for more detailed responses), and rating scales (to assess levels of interest or perceived complexity of the material). The survey results were coded and processed using statistical software, specifically the Statistical Package for the Social Sciences (SPSS), for subsequent analysis. To evaluate the impact of interactive programmes, a control group of students who did not use them was formed, which enabled a comparative assessment of their effectiveness. The responses of teachers and students were analysed separately but also compared to identify differences in perceptions of the programmes' effectiveness. Statistical methods applied in the analysis included descriptive statistics, analysis of mean values, and comparison of groups using paired t-tests. A p-value of less than 0.05 was considered statistically significant, indicating meaningful differences between measurements and supporting conclusions about the effectiveness of educational programmes. The study also presents recommendations for the use of interactive curricula in teaching 6th-grade mathematics, with a particular focus on the topics “Rational Numbers,” “Positive and Negative Numbers,” “Simplifying Expressions,” and “Solving Equations.”

The study’s foundation is constructivist learning theory, which emphasises student-centred, active knowledge construction made possible by engagement with relevant tasks and resources. This viewpoint influenced the creation of the survey tools and the standards for assessing digital platforms, especially with regard to their ability to provide scaffolding, personalisation, and feedback. The research sought to evaluate both the existence of technological tools and their pedagogical integration in mathematics education by coordinating methodological choices with constructivist principles.

RESULTS

POSSIBILITIES OF MODERN CURRICULA IN THE STUDY OF RATIONAL NUMBERS USING EDUCATIONAL PROGRAMMES

The use of educational programmes in teaching mathematics, particularly when studying topics such as rational numbers in 6th grade, is becoming increasingly widespread. Interactive technologies enable students not only to better understand complex mathematical concepts but also to significantly increase their engagement and interest in learning. Such engagement is achieved through access to visual materials, interactive exercises, and the possibility of individualising the learning process for each student.

The application of educational programmes in teaching mathematics to 6th-grade students offers numerous advantages and opportunities that considerably enhance the effectiveness of the learning process. This approach enables students not only to comprehend the material more deeply but also to observe how mathematical operations function in real-life contexts. Educational programmes often incorporate graphical interfaces, where students can see a visual representation of numbers on a number line, aiding them in clearly visualising the difference between positive and negative numbers. Such visualisation helps students grasp the concept of direction and relativity of numbers, which is essential for the subsequent successful mastery of more advanced topics, such as solving equations involving both positive and negative numbers (Aliu et al., 2025).

Furthermore, these programmes allow the creation of targeted exercises for practising simplifying expressions and solving equations, which are crucial for developing students’ mathematical competencies. Exercises may include interactive tasks focused on simplifying algebraic expressions, where students learn to apply essential mathematical rules, such as removing brackets, reducing like terms, and performing operations with fractions. Through instant feedback, students can assess the accuracy of their solutions and, in cases of mistakes, receive hints or step-by-step guidance to correct their errors (Ibatov et al., 2021). This feature is essential for the development of independent problem-solving skills and for improving students’ overall understanding of mathematical principles. Another valuable feature of learning applications is the possibility of integration with other tools, such as online journaling platforms, distance learning systems, and resources for sharing learning materials (Wang et al., 2024). This integration allows teachers to efficiently assess student performance, monitor progress, and adapt the learning process. Furthermore, these platforms can facilitate the organisation of group projects, thus helping students develop teamwork and collaboration skills (Dudar et al., 2025).

Another challenging topic for 6th-grade students is solving equations. Educational programmes enable students to explore the problem-solving process interactively, observing step-by-step solutions, receiving prompts for correct mathematical operations, and correcting mistakes at each stage. Multimedia programmes can offer a wide variety of equation types for practice, including simple linear equations and ones involving unknowns in the numerator and denominator (Asanov & Orozmamatova, 2019; Mazakova et al., 2023). This diversity allows students to become more knowledgeable about different equation types and to develop effective problem-solving strategies. These tools support not only the consolidation of previously studied material but also the development of self-directed learning skills. Students learn to organise their own work and monitor their progress independently. In addition, the use of educational programmes fosters the development of critical thinking in students (Nurhikmayati et al., 2025).

Personalised learning is another important advantage of using educational programmes, as platforms such as Khan Academy automatically adapt the difficulty of tasks to the student's level, allowing for a gradual increase in workload as they progress (Traverso-Condori et al., 2024). Through adaptive algorithms, curricula automatically select tasks and exercises based on each student's level of knowledge. This enables every student to work at a comfortable pace, receiving tasks that correspond to their abilities and needs. For example, a student struggling with the material can be provided with additional exercises to reinforce basic concepts, while a student with a higher level of preparation can be challenged with more advanced tasks. Another significant benefit is the accessibility of these programmes, as they allow students to learn at any time and on any device. With these programmes, students can engage with the material not only during lessons but also at any time convenient for them, enabling them to review previously covered material or prepare for assessments. This is particularly valuable for independent learning, as students can access online resources without time constraints, including exercises, tests, and video lessons (Kravchenko & Khyzha, 2023).

Khan Academy is an interactive platform that offers video lessons and mathematics exercises. For example, for the topic "Fractions," Khan Academy offers animated exercises that illustrate how to convert a mixed number into an improper fraction. GeoGebra enables the construction of graphs and the modelling of mathematical objects, which contributes to a deeper understanding of the topic of "Linear Equations". This capability also makes it especially effective for blended learning: the teacher explains the topic, and students then complete exercises within the programme. MathWay assists students in solving equations by providing step-by-step explanations, which is particularly beneficial for understanding "Quadratic Equations". Among their main advantages is the incorporation of graphs, animations, and number lines, which make the learning process more visual and comprehensible. This increases the engagement of students. Thanks to interactive elements, videos, animations, and game-based content, students are better able to understand complex mathematical concepts. This approach helps make lessons more engaging and motivating, encouraging active participation in the learning process. The integration of gamification elements (such as progress tracking, reward systems, and immediate feedback) boosts motivation and strengthens students' cognitive engagement during mathematical problem-solving (Zecri et al., 2021).

All of these programmes contribute not only to individualised learning by adapting tasks to each student's level of proficiency, but they also play a critical role in supporting teachers' instructional strategies. Through real-time data collection and automated assessment features, platforms allow educators to monitor students' progress continuously and identify specific areas of difficulty. Specifically, by providing diagnostic tools, customised lesson plans, and performance analytics to support differentiated instruction, Khan Academy has proven successful in fostering the development of fundamental mathematical skills in both elementary and secondary education (Gordon-Hernández et al., 2024). This enables teachers to make timely pedagogical decisions, such as adjusting lesson plans, providing targeted support, or offering enrichment activities for advanced learners. As a result, the learning process becomes more dynamic and responsive. Moreover, the use of such programmes contributes to more efficient lesson organization because part of the work is managed by automated systems, freeing up time for interactive discussion and support. Teachers can store and organise large volumes of educational materials in a convenient and structured format thanks to these programmes. Teachers can create various exercises, tests, interactive tasks, and projects, which significantly reduces preparation time for lessons. Many programmes have built-in templates for different types of tasks, enabling teachers to quickly generate learning materials without requiring significant time and effort.

According to studies, educators and institutions can identify the most pedagogically sound digital tools for teaching mathematics by evaluating e-learning applications using structured multi-criteria methods (Başaran & Haruna, 2017). Interaction with these programmes also gives students the opportunity to solve practical problems using mathematical theories and rules, which fosters the development of critical thinking skills and the ability to apply knowledge in practice. In summary, the use of educational programmes holds enormous potential for improving the quality of mathematics education, engaging students actively in the learning process, and ensuring high levels of achievement when mastering mathematical concepts.

Using Interactive Technologies and Programmes in Teaching Mathematics to 6th-Grade Students

Thanks to the interactivity and accessibility of modern curricula, teachers can also conduct online lessons and implement distance learning, which is particularly relevant under conditions of restrictions or for students who are unable to attend classes in person. To improve one's grasp of the topic, a survey was conducted among mathematics teachers teaching 6th-grade and 6th-grade students. The results of the survey are presented in Tables 2 and 3.

Table 2. Results of the teacher survey

Questions	Answers
1. What methods do you find most effective for engaging students in mathematics learning?	Use of interactive technologies – 50% Application of real examples – 30% Gamification – 20%
2. How do you adapt the teaching process for students with different levels of preparation?	Differentiated tasks – 45% Individual consultations – 35% Use of additional resources – 20%
3. What types of tasks, in your opinion, contribute to better learning outcomes for your students?	Practical real-life tasks – 40% Visualisation and graphics – 30% Project work – 30%
4. What tools or programmes would you like to use when teaching mathematics?	GeoGebra – 40% MathWay – 25% Khan Academy – 20% Other – 15%
5. Do you have any previous experience using such programmes?	Had no experience – 80% Had similar experience – 20%
6. How do you identify and take into account the individual characteristics of students during teaching?	Observation of progress – 50% Student survey – 30% Analysis of errors in tasks – 20%
7. What do you consider the biggest challenge in creating active student engagement in lessons?	Low student motivation – 50% Lack of sufficient resources – 30% High class occupancy – 20%
8. How often do you receive feedback from students about your teaching methods?	Regularly (weekly) – 35% Occasionally (once a month) – 50% Rarely – 15%
9. Do you conduct interactive or group-based tasks during lessons? If so, how frequently?	Constantly – 40% From time to time – 50% Rarely – 10%

Table 3. Student survey results

Questions	Answers
1. Do you enjoy interactive or group tasks in mathematics lessons?	Yes – 70% Sometimes – 25% No – 5%
2. What teaching methods help you understand the material most effectively?	Visualisation (graphs, diagrams) – 40% Explanations with examples – 35% Group work – 15% Other – 10%
3. How would you assess the complexity of the tasks given during lessons?	Easy – 15% Moderate – 65% Difficult – 20%
4. Would you like to use more educational programmes or other modern tools for mathematics lessons?	Yes – 80% Doesn't matter – 15% No – 5%
5. What do you like most about mathematics lessons?	Logical tasks – 45% Practical application – 30% Teamwork – 15% Other – 10%
6. What difficulties do you most often experience when solving mathematical problems?	Understanding the problem condition – 35% Choosing the right method – 40% Calculation – 25%
7. Do you think enough time is allocated to explaining new material?	Yes – 60% Sometimes not enough – 30% No – 10%
8. What would you change in the way mathematics is taught to make lessons more interesting for you?	More interactive tasks – 50% Use of modern technologies – 30% More applied tasks – 20%

The results of the survey of teachers and students highlight the importance of using interactive methods and modern tools in the teaching of mathematics. The fact that both teachers and students strongly favour interactive and visual teaching methods is one of the most notable findings. A majority (70%) of students say they like interactive or group projects, and 80% say they would like to see more educational programmes used in the classroom. This excitement is in line with the increasing body of research showing that technology-enhanced learning environments, particularly those that include multimedia and gamification, promote higher levels of motivation and engagement in mathematics instruction (Zecri et al., 2021).

According to 50% of teachers, interactive technologies are the best way to retain students' interest, followed by gamification (20%) and real-world examples (30%). This lends credence to the idea that although educators are aware of the educational benefits of digital tools, they might not have the institutional support or real-world experience necessary to fully adopt them. Interestingly, 80% of educators said they had never used sites like Khan Academy or GeoGebra before, indicating a big disconnect between digital competency and pedagogical intent. According to Gordon-Hernández et al. (2024), when used with proper training and curriculum alignment, platforms such as Khan Academy can be effective tools for developing mathematical competencies. This emphasises how crucially focused professional development is on assisting educators in successfully integrating these technologies. In light of this, teachers also mention a lack of resources (30%) and low motivation (50%) as major obstacles to student engagement, indicating that although educational technologies have pedagogical potential, systemic constraints frequently prevent their full use.

The responses from the students reaffirm how crucial visual aids are to the learning process. A significant number of students (40%) said that visual aids like graphs and diagrams were the most beneficial for comprehending mathematics, and another 35% said that explanations based on real-world examples were the most useful. Additionally, 65% of students believe that the current tasks are moderately difficult, and their most significant difficulties are choosing the best approach to solving problems (40%) and comprehending the instructions (35%). More frequent use of platforms that provide scaffolded problem sets and step-by-step explanations (features that both Khan Academy and MathWay offer) could help to lessen these challenges (Başaran & Haruna, 2017; Gordon-Hernández et al., 2024).

In conclusion, given the favourable attitudes of students and the pedagogical alignment recognised by teachers, the survey results show a great potential for increasing the use of digital learning tools in 6th-grade mathematics instruction. However, the results also highlight the necessity of curriculum integration, resource investment, and structured training to guarantee that programmes like Khan Academy, GeoGebra, and MathWay are used as essential elements of inclusive and successful mathematics education rather than merely as supplemental tools.

Based on the survey of students and teachers, a SWOT analysis was also conducted, which identified the strengths, weaknesses, opportunities, and threats associated with the use of interactive curricula in education. Table 4 presents the results of this analysis.

Table 4. SWOT analysis of the use of curricula in teaching mathematics

Strengths	Weaknesses
Increasing student engagement*	Lack of proper technical equipment in some schools*
Increasing access to visual materials and examples*	Insufficient training of individual teachers to work with digital platforms*
Possibility of an individualised approach to learning**	Students overloaded with information due to excessive number of interactive tasks**
Use of modern digital resources to deepen understanding of the topic**	Loss of student interest due to technical glitches or incorrect programme operation*
Distance learning option if necessary**	Dependence on stable Internet access*
Improving mathematical competence through interactive practical tasks**	Risk of reduced social interaction between students and teacher*

Note: Items marked with a single asterisk (*) are based on survey data; double asterisk (**) items are inferred by the authors.

The SWOT analysis demonstrated that the use of educational programmes in teaching the topic “Rational Numbers” in 6th grade has significant potential to enhance the learning process. Among the identified strengths are increased student engagement, access to visual materials, and the possibility of an individualised approach. However, there are also notable weaknesses, including technical difficulties in schools and the need for additional teacher training. The analysis highlighted opportunities such as the use of modern digital resources and distance learning, while threats include technical failures and limited internet access (Oldenburg & Miethlich, 2020). To achieve maximum learning outcomes, it is crucial to overcome these barriers.

The topic “Positive and Negative Numbers” also requires visualisation tools to enable students to clearly conceptualise the position of numbers on a number line. The use of graphs and animations helps demonstrate how numbers change when adding or subtracting negative values, as well as how positive and negative numbers interact during mathematical operations. Interactive exercises for simplifying expressions and solving equations are essential tools for developing students’ ability to work with algebraic expressions (Järvis et al., 2022). Through educational programmes, students can complete practice exercises, check their solutions' accuracy, and receive immediate feedback. This system not only automatically assesses results but also allows for corrections to errors during the task, thereby supporting deeper assimilation of the material. In the context of equation solving, it is important that educational programmes include a variety of equation types, enabling students to explore different methods of solution. Programmes offering step-by-step guidance in solving equations help students understand the sequence of mathematical operations, thereby improving their logical thinking. Additionally, it is beneficial to incorporate creative problem-solving tasks, such as real-life scenarios, in which students apply their mathematical knowledge to address practical challenges. Another key aspect is the monitoring of student progress. Automated assessment tools within educational programmes enable teachers to promptly receive data on students' mastery of the material, allowing them to adjust the learning process as needed. This type of feedback helps students recognise their strengths and weaknesses and provides teachers with the means to organise additional support for those who require further assistance. In general, the integration of educational programmes in teaching mathematics in the 6th grade facilitates a deeper understanding of complex mathematical concepts, fosters analytical and critical thinking, and enhances problem-solving skills. Simultaneously, these programmes allow teachers to effectively monitor student progress and offer personalised instruction, contributing positively to the overall quality of education.

DISCUSSION

The results of the study indicate the significant potential of using curricula in the process of teaching rational numbers in Grade 6. Interactive technologies help to enhance students' understanding of the material, develop analytical skills, and increase motivation and engagement in learning. These findings are important, as they demonstrate how digital tools can transform traditional teaching approaches, creating a more adaptive and effective learning environment.

The study's results confirm the conclusions of Papadakis et al. (2021), who found that the use of mobile devices in education contributes to a better understanding of mathematical concepts through visualisation and interactivity. In particular, their approach to using Realistic Mathematics Education (RME) was shown to be effective not only in primary school but also at the secondary level. The current study observed similar outcomes, demonstrating the beneficial use of curricula for teaching rational numbers. Research also confirms that interactive teaching tools play a crucial role in individualised learning. Pouta et al. (2021) and Ay Emanet and Kezer (2021) found that educational programmes help students better understand how rational numbers are perceived. Additionally, these tools enable teachers to adapt the learning process to the individual needs of students, which is consistent with the data obtained in this study regarding the effectiveness of such approaches in classrooms with students of varying levels of preparation. Interactive platforms have also proven to be effective in increasing student motivation. As noted by Putra et al. (2023), the use of online formative assessment not only enhances understanding of rational numbers but also actively engages students in the learning process. The study revealed that tasks provided through such platforms stimulate students to explore, develop experimental thinking, and identify new strategies for problem-solving.

The results of the study clearly highlight the importance of cognitive flexibility as a critical element in learning complex mathematical concepts such as rational numbers. Cognitive flexibility enables students to adapt their thinking strategies and problem-solving approaches in response to new challenges and contexts that arise during the learning process (Nurakenova & Nagymzhanova, 2024). This is particularly important because mastering rational numbers requires students to manipulate multiple forms of numerical representation, such as fractions, decimals, and percentages, as well as to understand the relationships among these forms (Cherniha et al., 2016). A study by Scheibling-Sève et al. (2022) supports this perspective, demonstrating that specially designed programmes aimed at developing proportional thinking significantly improve students' abilities to analyse and solve mathematical problems. Such programmes are designed to create learning environments where students engage with various mathematical concepts, including fractions and percentages, to help them recognise connections and apply their understanding across different contexts. One of the most significant findings of the present study is that interactive platforms assist students in understanding the interrelations between fractions, decimals, and percentages, which form the foundation for successful mastery of rational numbers.

The findings of this study are consistent with those of Thompson et al. (2021) and Tashtoush et al. (2022), who emphasise the importance of reducing cognitive biases in mathematics learning. The use of interactive applications contributes to the clearer and more consistent formulation of mathematical concepts, thereby minimising the impact of cognitive biases that can hinder understanding and problem-solving. Moreover, Uyen et al. (2021) demonstrate that integrating a realistic mathematical approach can significantly enhance students' mathematical abilities. In the context of learning rational numbers, the application of real-life problem-solving scenarios has proven particularly effective in developing applied thinking and the capacity to solve practical problems (Dahan et al., 2025).

Furthermore, the study by Rolfe et al. (2022) confirms the importance of integrating digital technologies in teaching rational numbers, with particular emphasis on the effectiveness of digital games as learning tools. Interactive, game-based tasks provide students not only with opportunities to quickly grasp new material but also to consolidate knowledge for long-term retention (Zabiiaka et al., 2023). This approach contributes to the development of both immediate understanding and sustainable mathematical knowledge and skills, which are essential for further learning and practical application in real-life situations. The study's findings demonstrate that digital games enable students to integrate mathematical concepts in an engaging and motivating way, supporting deeper learning. However, Rolfe et al. (2022) noted that while the short-term benefits of digital games are evident, further research is necessary to assess the long-term effects of these tools. It remains an open question whether digital games can not only facilitate initial understanding but also help students to retain and deepen their knowledge throughout the learning process. Therefore, additional studies are required to examine the sustained impact of such educational tools over time. In conclusion, the results of this research emphasise the importance of interactive platforms and digital games for teaching rational numbers. Research has demonstrated that these tools significantly improve students' comprehension of mathematical concepts and promote the growth of cognitive flexibility and durable knowledge. However, more research is necessary to fully realise their potential, with a specific focus on the long-term effectiveness of interactive approaches.

Adapting curricula for inclusive environments has become an increasingly important area of analysis. As noted by Rojo et al. (2022) and Thomson et al. (2022), interactive programmes are effective for supporting students with learning difficulties. The adaptation of materials and the flexibility to choose an individual pace of learning have contributed to creating equal opportunities for mastering complex mathematical concepts, including rational numbers. The findings of this study also confirm the importance of reflection in the learning process. According to Richit and Tomkelski (2022), McMullen and Van Hoof (2020), and Melhuish et al. (2022), interactive platforms contribute to the development of reflective skills in mathematics education. Such platforms enable students to analyse their mistakes and identify optimal strategies for correction, thereby enhancing their learning outcomes. This approach has shown significant improvements in student performance, particularly when tackling challenging tasks.

However, not all aspects of the present study are fully consistent with the findings of other researchers. For instance, Rach and Schukajlow (2024) argue that professionally directed tasks increase student motivation, although this was not confirmed in all cases in the current research. For students with a lower level of preparation, such tasks were found to be less effective, indicating the need for further analysis and adaptation of learning materials to meet the diverse needs of learners. Furthermore, other researchers, including Werler and Tahirsylaj (2022), emphasise that the effectiveness of digital technologies in education largely depends on the quality of teacher training. The findings of this study also highlight that interactive programmes are effective only when teachers possess the knowledge and skills necessary to implement them effectively. This underscores the critical importance of professional development for teachers in the context of the ongoing digitalisation of education.

The results of the study also emphasise that teachers need to consider students' cultural backgrounds. As noted by Taylor (2021) and Yao et al. (2021), the cultural context significantly influences the effectiveness of mathematical teaching methods, including the use of digital applications. Therefore, curriculum development should be grounded in a profound understanding of local needs and characteristics, ensuring that educational content is relevant and accessible to diverse student populations. Thus, the results of this study confirm the significant potential of curricula in teaching rational numbers. At the same time, the findings indicate a clear need for further research, particularly regarding the long-term impact of these programmes, their adaptation to students with varying levels of preparation, and the enhancement of teacher training for the effective use of digital tools. All these areas present promising prospects for developing more effective educational methods, which will contribute to the formation of sustainable mathematical competencies.

CONCLUSIONS

The study examined the impact of educational software on mathematical teaching and learning, finding that interactive programs significantly increased student engagement and interest in the subject. Teachers noted improvements in students' understanding of rational and negative numbers, and the use of visualisation tools played a crucial role in enhancing comprehension. Interactive exercises helped students identify and correct mistakes early, contributing to better learning outcomes. SWOT analysis revealed strengths such as increased engagement and individualised tasks, but highlighted weaknesses, including the need for substantial resources and adequate teacher training.

The findings have practical implications for classroom practice and curriculum development, emphasising the integration of culturally sensitive content and adaptive digital platforms to improve teaching rational numbers. The results can guide teacher training programmes and support the creation of inclusive mathematics curricula. Despite positive outcomes, challenges such as technical difficulties and insufficient teacher training persist. Future research should focus on developing targeted interactive tasks and examining the long-term effects of these technologies on student motivation and academic performance.

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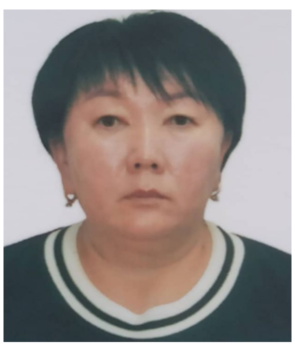

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