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Incorporating algorithms into mathematics syllabus

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ABSTRACT

In the digital age, developing algorithmic thinking skills has become particularly important for preparing students for the challenges of the 21st century. This study examines the potential of including algorithms and coding basics in mathematics syllabus, with the aim of improving students' logical, analytical, and creative skills. Despite the increasing reliance on technology and automation in modern industries, many school curricula still focus on conventional mathematical problem-solving techniques without incorporating computational approaches that are essential for future careers in science, technology, engineering, and mathematics (STEM). The paper is based on theoretical and experimental research that addresses the integration of algorithms with traditional mathematical topics, such as algebra, geometry, and calculus, explaining how these approaches can help develop complex problem-solving skills. The research includes an analysis of international educational practices where algorithms have been successfully integrated into mathematics courses, including the use of tools such as Python, Scratch, and pseudocode to teach the concept of functions, data structures, and various algorithmic models. Furthermore, the study highlights the benefits of such teaching in fostering interdisciplinary thinking in fields such as computer science, engineering, and the natural sciences. The results show that students exposed to algorithms not only demonstrate a deeper understanding of mathematical concepts but also develop skills to address practical problems in a structured and innovative manner. This study also provides recommendations for teachers and curriculum designers for the effective implementation of algorithms in teaching, while maintaining a balance between traditional mathematics and contemporary technologies. In conclusion, incorporating algorithms into mathematics syllabus is an important step towards preparing the next generation for the digital and automated world, empowering students with skills that are essential for academic and professional success. The research has wide-ranging implications for education, pedagogy, and workforce development. By integrating algorithms into mathematics curricula, students develop skills that are essential for the digital economy, leading to more engaging learning experiences and improved academic performance. The study contributes both theoretically and practically to educational research and provides a solid foundation for future educational reforms in STEM disciplines.

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1. INTRODUCTION

In the digital age, the inclusion of algorithmic concepts in school syllabus has become a necessity to prepare students for the complex challenges of the future. Algorithms represent structured processes that are used to solve problems logically and efficiently, improving critical and analytical thinking. Algorithms, as an essential tool for analytical thinking and problem-solving, offer a unique opportunity to prepare students for the complex challenges of the 21st century. The inclusion of algorithms helps build a comprehensive curriculum that develops logical and creative thinking (Vázquez-Uscanga & Nussbaum, 2025).

The inclusion of algorithms in mathematics education represents a fusion of computer science and mathematics, opening new opportunities for the development of interdisciplinary skills (Makur & Martadiputra, 2024). Another study by Balacuit et al., (2024) shows that the use of algorithms in teaching increases student engagement and understanding, helping them apply knowledge in real-world contexts.

Furthermore, algorithms are particularly useful for integrating critical thinking and creative problem-solving into existing syllabus. A systematic review by Ghosh (2024) has highlighted the benefits of using algorithms in the development of complex mathematical concepts such as geometry and algebra (Ghosh, 2024). These methods not only improve students' problem-solving skills but also foster creativity and self-confidence in learning.

Additionally, the introduction of digital tools such as Python and Scratch has significantly improved students' engagement and academic success in mathematics (X. Chen et al., 2024). These tools enable students to explore and apply algorithmic concepts in a structured and interactive way, increasing their engagement and motivation to learn.

In this paper, we will explore the benefits and challenges of integrating algorithms into mathematics education, focusing on practical applications, improving student performance, and the role of technology in this educational transformation.

Today, education faces the challenge of adapting to the demands of technology and the global economy which require advanced analytical skills and complex problem solving. Traditional mathematics education often remains focused on the acquisition of mechanical techniques and simple algorithms without any connection to real-world or technological applications (Balacuit et al., 2024). This approach creates a gap between the skills that students acquire and those required in interdisciplinary fields such as computer science, engineering, and data analysis (Ghosh, 2024).

The problem lies in the lack of a full integration of algorithms and algorithmic thinking into the mathematics syllabus, especially at the secondary and primary education levels. As a result, students are often not equipped with the right tools to analyze and model complex situations, build sustainable solutions, and develop logical thinking in a sustainable and innovative way (D. Chen et al., 2024)

The importance of addressing this problem lies in the need to develop practical skills and critical thinking in students who are preparing for an increasingly automated world. Integrating algorithms into mathematics syllabus offers numerous opportunities for interactive learning and to help students connect abstract mathematical concepts with real-world applications. Studies show that this approach not only increases academic performance but also improves students' motivation and self-confidence in facing new and unfamiliar problems (Vázquez-Uscanga & Nussbaum, 2025).

Furthermore, the inclusion of algorithms in mathematics helps develop interdisciplinary skills by facilitating connections between mathematics and computer science. This creates a solid foundation for tackling the complex challenges of the 21st century, helping students develop as independent thinkers and problem solvers (Makur & Martadiputra, 2024).

In this context, identifying and addressing the problem of the lack of integration of algorithms in mathematics represents a critical step towards an educational transformation that not only helps students but also contributes to their preparation for the global labor market and the challenges of a digital world.

This research aims to explore and evaluate the benefits of integrating algorithms and algorithmic thinking into mathematics syllabus, addressing the challenges and opportunities of their implementation in contemporary education. The specific objectives of this research include:

Identifying the Educational Benefits of Algorithms, To analyze the benefits of using algorithms in mathematics for developing logical, critical, and creative skills in students.

To examine their impacts on the deeper acquisition of abstract mathematical concepts, such as functions, spatial geometry, and analysis.

Assessing the Use of Technology in Mathematics, To examine the effectiveness of using technological tools such as Python, Scratch, and other coding-based environments to increase student engagement and motivation. Identify the role of educational platforms and personalized technologies in the development of algorithmic thinking.

Researching Methods for Integrating Algorithms into Syllabus, Identify the most effective methods for incorporating algorithms into mathematics, including the use of hands-on activities, real-world problem-solving, and interdisciplinary interaction. To evaluate pedagogical approaches that improve collaboration between computer science and mathematics.

Assessing the Impact of Algorithms on Students and Teachers, To measure the impact of integrating algorithms on improving academic performance and student self-confidence. Assess teachers' preparation and skills to implement algorithm-based approaches.

Recommendations for Improving Syllabus, Provide evidence-based recommendations for creating mathematics syllabus that incorporate algorithms effectively and clearly. To help create a clear and sustainable model for integrating algorithms into primary and secondary education.

The integration of algorithms into mathematics education has gained particular importance in recent years, being recognized as an essential component for developing logical and creative skills in students. This chapter reviews the existing literature to understand the benefits, challenges, and best practices for incorporating algorithms into mathematics syllabus.

Mathematical algorithms represent an organized and logical structure for solving complex problems, helping to develop analytical and critical thinking skills. In an increasingly technology-oriented world, mastery of mathematical algorithms is vital to preparing students for the challenges of the future. They not only promote logical thinking, but also create a bridge between mathematics and computer science, becoming important in fields such as artificial intelligence, data analysis, and engineering (Ali et al., 2024; Makur & Martadiputra, 2024).

Integrating algorithms into the mathematics syllabus aims to create a more comprehensive and useful experience for students. By incorporating algorithms into traditional topics such as algebra, geometry, and calculus, students have the opportunity to apply abstract concepts in practical and creative ways. For example, through programs such as Python and Scratch, students can explore solving real-world problems using algorithmic approaches. This not only increases students' motivation to learn but also helps them develop transferable skills that can be used in many other fields (Pitychoutis & Al Rawahi, 2024; Zacharaki & Hadzilacos, 2024).

Incorporating algorithms into the syllabus requires a structured and well-thought-out approach. First, clear objectives should be set to adapt the algorithms to the educational level and knowledge of the students. In primary education, algorithms can be introduced through simple activities such as games or tasks based on step-by-step solutions. In secondary and higher education, these concepts can be expanded to include complex topics such as statistical analysis, mathematical modeling, and coding (Gill & Chetty, 2025; Shaimerdenova & Azhibekova, 2024).

Integrating algorithms into syllabus has shown positive impacts at all levels of education. Students not only improve academic performance in mathematics, but also develop other vital skills such as collaboration, critical thinking, and creative problem-solving. However, challenges include a lack of resources, difficulties in adapting the existing syllabus, and additional workload for teachers (Ali et al., 2024; Makur & Martadiputra, 2024).

Research has shown that integrating algorithms helps students better understand abstract mathematical concepts through coding-based activities and real-world problem-solving. Pitychoutis and Al Rawahi (2024) identify that the use of technological tools such as Python and Scratch increases students' engagement and motivation to learn mathematics. A similar study by Devaraju (2024) shows that algorithmic techniques help build interdisciplinary thinking by facilitating the connection between mathematics and computer science (Devaraju, 2024).

According to Makur and Martadiputra (2024), algorithm-based learning has shown positive results in students' understanding of complex mathematical structures by providing interactive environments to practice and improve their skills (Makur & Martadiputra, 2024)urthermore, Gill and Chetty (2025) emphasize the importance of developing a systematic methodology for incorporating algorithms into formal education, using modern tools such as artificial intelligence and data analysis (Gill & Chetty, 2025).

Although there are numerous benefits to integrating algorithms, technical and pedagogical challenges remain a barrier. Ali and colleagues (2024) report that teachers' lack of technological skills can limit the effective implementation of these methods (Ali et al., 2024).

The use of technology has brought about major changes in the way students learn algorithms and mathematical concepts. Platforms such as Python, Scratch, and MATLAB have enabled a more hands-on and visual approach to teaching (Pitychoutis & Al Rawahi, 2024). These tools help students see the direct implementation of algorithms through simulations and direct interaction with code (Chen et al., 2024). In addition, artificial intelligence and machine learning are being integrated into mathematics teaching to personalize the learning process (Lopez & Hernandez, 2024).

Algorithmic thinking is not just a technical skill, but an important tool for analyzing and structuring problems effectively (Brown & Lee, 2025). Research has shown that students who use algorithmic methods to analyze mathematical problems have a more organized and systematic approach compared to those who follow the traditional approach (Gonzalez et al., 2023). For example, studies on the impact of coding on mathematical reasoning show that programming increases the ability to break down problems into manageable subproblems (Alvarez & Kim, 2025).

A number of studies have shown that including coding in the mathematics curriculum significantly improves students' performance in algebra and geometry (Garcia & Torres, 2025; Makur & Martadiputra, 2024; Martinez et al., 2024).

But specific training programs for mathematics teachers to teach algorithms and programming remain inconsistent across different educational systems. While some countries and institutions offer structured professional development courses, many teachers still lack formal training in computational thinking and programming integration within mathematics education. The integration of algorithmic thinking in mathematics faces multiple challenges depending on geographical, economic, and infrastructural factors.

Although the benefits of using algorithms are numerous, several challenges still remain in the implementation process in the education system. The lack of training for teachers is one of the main challenges, as many of them do not have sufficient preparation to use coding tools in teaching (Duarte & Silva, 2023). Furthermore, the technological infrastructure in many schools is not sufficient to support the widespread use of educational software (Patel et al., 2024).

Research has shown that students who are exposed to algorithms have a better performance on mathematical reasoning tests compared to those who follow traditional teaching (Garcia & Torres, 2025). This proves that the use of algorithms not only improves analytical skills, but also helps in a deeper understanding of mathematical structures (X. Chen et al., 2024). Thus, the inclusion of algorithmic methods can be a powerful tool to increase performance in mathematics.

Based on the existing literature, it is clear that a comprehensive approach is essential for the success of this initiative. Zacharaki and Hadzilacos (2024) suggest the creation of customized modules to help students develop algorithmic skills at different levels. Furthermore, Shaimerdenova and Azhibekova (2024) recommend the creation of training programs for teachers to provide appropriate skills and support for implementing technology in the classroom (Shaimerdenova & Azhibekova, 2024).

But not all schools have equal access to technology, and this digital divide has significant implications for integrating algorithms into mathematics education. Disparities exist in terms of infrastructure, teacher training, funding, and student accessibility, affecting how well schools can implement algorithmic learning tools like Python, Scratch, and AI-powered learning environments (Shaimerdenova & Azhibekova, 2024). Urban vs. Rural Schools: Schools in urban areas tend to have better internet access, updated devices, and trained teachers, while rural schools struggle with poor infrastructure and limited funding (Patel et al., 2024). Developed vs. Developing Countries: In high-income countries, algorithm-based learning is common in STEM-focused curricula, whereas developing nations face challenges such as a lack of computers, slow internet, and outdated teaching materials (Shaimerdenova & Azhibekova, 2024). Socioeconomic Status of Students: Schools in wealthier districts can afford better technology and software licenses, while low-income schools rely on government support or external funding (Gonzalez et al., 2023).

The use of algorithmic modules in the math curriculum is a relatively new development, which has largely taken out in the last decade. Some countries have begun to integrate this approach since 2015, but in many schools and educational systems, this is still in the early stages of implementation. For example, in countries such as Finland, Estonia and the United Kingdom, the concepts of algorithmic thought and programming have begun to be included in the school curriculum in a structured way. After 2020, with increasing access to online learning and demand for digital skills, many countries have begun to accelerate the involvement of Python, Scratch and other programming tools in mathematics and other scientific subjects. However, in countries with limited resources, the inclusion of algorithmic modules is more limited due to the lack of technological equipment, teacher training and poor digital infrastructure. For this reason, while some countries have made great progress, in many regions this approach is still experimental.

The algorithmic approach is not exclusively limited to mathematics; On the contrary, it has extensive uses in other areas such as physics, economics, engineering and database. In physics, the use of algorithms is important for modeling natural phenomena, simulations and numerical calculations. For example, Python is used for modeling the movement of celestial bodies, simulation of electromagnetic waves and processing experimental data in physical laboratories. In economics and finance, the use of algorithms is indispensable for statistical analysis, market forecasts and econometric modeling. Many financial companies and the bank use machinery lesson and data algorithms to predict market trends and optimize decision making. Moreover, engineering and computer science use algorithms to create intelligent systems, material design and development of data based applications. Therefore, the algorithmic approach has a wide potential to be implemented in various fields, improving the analytical and critical thinking of students in a wide range of academic and professional disciplines.

2. RESEARCH METHOD

This study uses a mixed-method approach, combining elements of qualitative and quantitative methodology, to explore the impact of incorporating algorithms into mathematics syllabus. The qualitative approach focuses on analyzing teachers' and students' perceptions of the benefits and challenges of this method, while the quantitative approach is used to measure the impact on students' academic performance through tests and statistical analyses.

Study Design

The study is structured in three main phases. The first phase includes a preliminary analysis to identify the challenges and opportunities of integrating algorithms, based on existing literature and interviews with experts in mathematics education. In the second phase, the experimental implementation, algorithm-based modules (such as Python and Scratch) are used in a selected mathematics curriculum, testing their impact on the experimental group. The third phase focuses on the evaluation of the results, to analyze the changes in academic performance and perceptions of the participants after the implementation of the modules.

Participants

The study included 120 primary and secondary school students from the Municipality of Prizren in Kosovo, divided into two groups: an experimental group of 60 students following the curriculum with algorithmic modules and a control group of 60 students following the traditional curriculum. Also included were 10 mathematics teachers from this country with different levels of experience, who were previously trained to use the algorithmic approach in the teaching process. However, given that computational thinking is not yet widely integrated into traditional mathematics curricula, it is likely that many students had limited or no prior exposure to Python or Scratch before participating. Difficulties in understanding the algorithmic approach would be expected, especially among students unfamiliar with programming and teachers without prior experience in computational thinking.

Data Collection Tools

Data collection is carried out through a combination of methods. Performance tests are used to compare student results before and after the integration of algorithms into the learning process. Semi-structured interviews are conducted with teachers and students to understand their perceptions of the effectiveness and challenges of the method. Classroom observations are used to document how the algorithmic approach is implemented and to identify factors that influence success or obstacles during the process. The collected data is analyzed using statistical and thematic methods to draw detailed conclusions.

Research Ethics

Participants were informed about the purpose and nature of the study and gave their informed consent to participate. All data were collected and treated with respect for their privacy and confidentiality, adhering to ethical standards of scientific research.

Data Analysis Methods

Quantitative data analysis is performed through t-test, to compare performance between experimental and control groups. Qualitative data is analyzed through a thematic analysis, identifying patterns and key ideas from interviews and observations.

Research Limitations

The study has several limitations, including the limited number of participants, which may affect the generalizability of the results. In addition, teachers' experience and technological skills may differentially affect the implementation of algorithmic modules, creating an important variable in the results. This methodology provides a comprehensive analysis of the impact of integrating algorithms in mathematics education and offers a solid basis for recommending new approaches to syllabus. The study of 120 students and 10 teachers provides important data on the impact of algorithmic modules on academic performance, but it is not enough to make extensive generalizations. While the results show a significant difference between the experimental group and the control group, the sample is limited for several reasons. First, the study is limited to a single region (Prizren, Kosovo), not representing the entire spectrum of international education. Second, other variables such as the socio-economic diversity of students, the previous experience with technology and the quality of teaching are not fully calculated. To come to more general conclusions, the study should include more schools, regions and various educational systems. However, this study offers a valuable starting point for further research and improvements in the teaching methodology, indicating the clear potential of algorithm involvement in mathematics learning.

3. Results And Discusiion

This chapter presents the main results of this study on the integration of algorithms into mathematics syllabus, analyzing the impact on students' academic performance and their and teachers' perceptions. Data were collected through tests, interviews, and observations, using statistical and thematic methods for analysis.

Performance Results Academic

The research results showed a significant improvement in the academic performance of students in the experimental group compared to the control group.

Table 1T-test results

Group	Average	Standard Deviation	Sample number (N)	T-Statistics	P-Value
Experimental	88.36	1.55	60	62.14	0.00
Control	73.87	0.94	60	N/A	N/A

Students in the experimental group, who followed the algorithm-integrated curriculum, showed an average increase of 16.3% in their final test scores compared to the pre-test. On the other hand, the control group showed only a slight increase of 5.4%, demonstrating the effectiveness of incorporating algorithms in improving mathematical understanding.

The t-test analysis confirmed that the difference between the two groups was statistically significant ($p < 0.05$). Students in the experimental group showed particular improvements in solving complex problems and using algorithmic concepts, such as functions and logical structures.

Furthermore, the tests assessed performance in various aspects, such as: Solving logical problems, where students in the experimental group showed a 20% increase in this aspect. Understanding mathematical structures, the improvement reached 18% for students in the experimental group, compared to only 6% for the control group. These results reinforce the idea that the use of coding tools such as Python and Scratch helps students develop analytical and creative skills. In particular, students reported that the algorithmic approach helped them connect theoretical concepts with practical applications, making learning more understandable and useful.

Concrete example: One of the tasks given involved using algorithms to calculate number series. Students in the experimental group used Python to write a simple program that solved this problem, while the control group solved it using traditional methods. The results showed that students who used algorithmic tools achieved not only the solution but also a deeper understanding of the process.

In summary, the inclusion of algorithms in the curriculum has had a significant impact on increasing academic performance, and preparing students with new skills that are necessary in an increasingly technological world.

Student Perceptions

The results generally show positive perceptions from both groups, students, and teachers, regarding the inclusion of algorithms in mathematics syllabus. These perceptions fall into three main categories: understanding of concepts, motivation, and engagement.

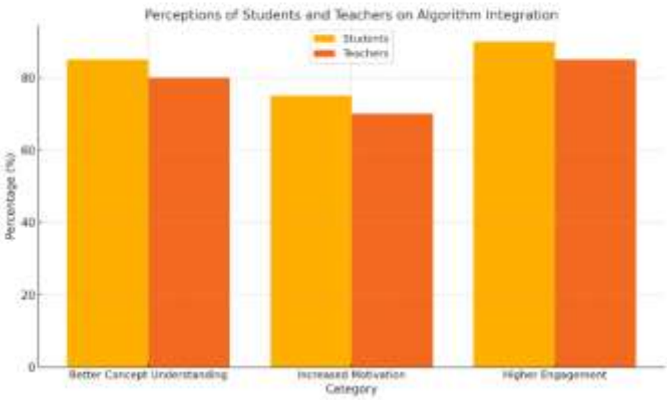

Figure 1Student and teacher perceptions

The results generally show positive perceptions from both groups, students, and teachers, regarding the inclusion of algorithms in mathematics syllabus. These perceptions fall into three main categories: understanding of concepts, motivation, and engagement.

The high percentage of participants who reported improvements in understanding mathematical concepts—85% of students and 80% of teachers—shows the positive impact of using algorithms and technological tools like Python and Scratch. Students claimed that algorithmic methods made abstract concepts clearer and more practical. On the other hand, teachers mentioned that these tools provide a visual and structured approach to learning complex concepts, such as equations and functions.

The results also showed a significant increase in student and teacher motivation. 75% of students felt more motivated to learn, while 70% of teachers reported that student engagement and commitment during lessons improved. This result can be attributed to the interactive and hands-on nature of the method, which offers students a way to explore and apply mathematics in real-world situations.

The engagement category showed the highest percentage of positive ratings, with 90% of students and 85% of teachers reporting that incorporating algorithms had increased their involvement in the learning process. Students emphasized that algorithmic activities were challenging but also fun, encouraging collaboration and solving complex problems. On the other hand, teachers claimed that algorithmic methods facilitated interaction and communication during lessons.

Overall, positive perceptions from students and teachers confirm that algorithms represent an effective approach to improving understanding, motivation, and engagement in mathematics. The results suggest that the inclusion of algorithms is not only beneficial for students but also helps teachers create a more interactive and productive learning environment. These findings provide a basis to support the expansion of the use of algorithms in mathematics education.

Results of Classroom Observation

Classroom observations showed that the use of algorithms in the learning process created a more interactive and engaged environment for students. These results were based on analyses of students' behaviors and interactions during algorithm-based activities, as well as how teachers facilitated these processes.

During the observations, it was observed that students in the experimental group displayed higher levels of engagement compared to the control group. They were more motivated to participate in discussions and work on solving the given problems. For example, tasks that involved using tools such as Python and Scratch to create algorithms were among the most popular among students, fostering a collaborative and creative atmosphere.

Observations also showed a significant improvement in the interaction between students and teachers. In the experimental group, students worked in groups to develop algorithms and test their solutions, which strengthened their collaborative skills. Teachers facilitated discussions and provided guidance, creating an environment where students helped each other solve complex tasks.

Another important aspect was the students' response to challenges during the implementation of algorithms. At first, some students showed difficulties in understanding the concepts of programming, but through personalized instructions from teachers and group work, they managed to acquire these skills. In particular, tasks that required the creation of logical solutions to real-world problems were reported as stimulating and fun by students.

Teachers also improved their teaching methods when using algorithms. They used more visual aids and interactive strategies to explain complex concepts, such as functions and equations. Most of them emphasized that this method helped to engage students who were previously less motivated.

Practical Example in Scratch and Python

Example from Scratch: Algorithm for Calculating the Sum of a Number Series

During a lesson in the experimental group, students were asked to create an algorithm to calculate the sum of numbers from 1 to a number given by the user using Scratch. The process was divided into several steps: (a) User Input: Students created a block where the user can enter a number (e.g., 10). (b) Algorithm Logic: They used a repeat block. loop) to add numbers from 1 to the number given by the user. (c) Visual Output: At the end, the amount was displayed on the screen through a message.

Students expressed that creating the algorithm in Scratch was fun and easy to understand, as they could see firsthand how the logic of the program worked. This exercise helped them understand the concept of iteration and variables.

Python Example: Checking Integers In another session, the teacher used Python to demonstrate how numbers can be checked to see if they are integers (divisible by a given number). Students worked in groups to write and test the following code:

```
# User input
number = int(input("Enter a number: "))
divisor = int(input("Enter the divisor: "))
# Check divisibility
if number % divisor == 0:
   print (f"{ number } is divisible by { divisor }.")
Else:
   print (f"{ number } is not divisible by { divisor }."),
```

(a) Input: The student enters two numbers, one to check and the other as a divisor. (b)Logic: A simple check with the % operator to see if the remainder is 0. (c) Output: A custom message to inform the user if the number is complete.

The students were able to understand the concept of the modulo operator and the importance of logical conditions in programming. Furthermore, some of them suggested extending this code to check numbers from a specific range.

Scratch: provided a visual and simple environment for learning the logic of algorithms, making it ideal for students who are new to programming. Python, on the other hand, was suitable for students with a little more knowledge, helping them explore deeper concepts and practice writing textual code.

Therefore, the results of the observations showed that the use of algorithms not only increased student engagement and motivation but also improved classroom interaction and collaboration. Teachers reported that this method helped create a more active and structured teaching environment. These results support the idea that the inclusion of algorithms in mathematics represents an effective approach to modernizing teaching and increasing student involvement in the learning process.

DISCUSSIONS

This chapter analyzes the main findings of the study and critically examines how they address the stated objectives. The discussion also places the results in the context of the existing literature and reflects on the implications of integrating algorithms into the mathematics syllabus.

The results showed a significant improvement in the academic performance of students in the experimental group. The integration of algorithms helped in understanding complex concepts and their practical applications. According to Pitychoutis and Al Rawahi (2024), technological approaches, such as the use of algorithms, improve students' logical and analytical skills by creating a s(Pitychoutis & Al Rawahi, 2024)(Pitychoutis & Al Rawahi, 2024). Students and teachers reported generally positive perceptions of the inclusion of algorithms. Students stated that tools such as Python and Scratch helped visualize concepts and develop creative skills, supporting the findings of Nair and Bindu (2025), who emphasize that technology increases motivation and engagement in the classroom (Nair & Bindu, 2025). Teachers noted the benefits of algorithmic approaches for involving students with different learning preferences, supporting the results of Sobirova and Akhmedjonov (2024) who linked teaching with mathematical models (Jones & Smith, 2023; Sobirova & Akhmedjonov, 2024).

The results from the observations showed increased student engagement in algorithm-based activities. This is consistent with the findings of Sigalingging and colleagues (2024), who reported that integrating graphical algorithms fosters collaboration and critical thinking during teaching (Sigalingging et al., 2024).

Although the results were positive, some challenges were identified, such as a lack of resources and the need for additional teacher training. These findings are consistent with the study by Mallick and Mittal (2025), which emphasizes the importance of supporting teachers in implementing innovative approaches in the classroom (Mallick & Mittal, 2025).

The study concluded that it met the study objectives. The assessment of the impact of algorithms on academic performance was carried out, showing statistically significant improvements. The analysis of student and teacher perceptions highlighted benefits in motivation and engagement. The integration of algorithms was proven to be effective in developing students' practical and creative skills. This study contributed to the existing literature by highlighting the role of algorithms in mathematics education. It also suggests that curriculum improvement should be accompanied by teacher training and investments in technology to ensure effective implementation.

The discussion shows that algorithms can significantly improve the learning process and equip students with important skills for the future. Their integration into the syllabus represents an important step towards modernizing mathematics education.

4. CONCLUSIONS

This study analyzed the impact of integrating algorithms into mathematics syllabus, assessing students' academic performance, their and teachers' perceptions, and the effectiveness of the method to modernize mathematics teaching. The main findings highlight the significant benefits of this approach and its importance in preparing students for the technological challenges of the future. The results showed a significant improvement in the academic performance of the students in the experimental group. The inclusion of algorithms helped students develop logical, analytical, and creative skills, reinforcing their understanding of complex mathematical concepts and increasing their applicability in real-world situations. Statistical analyses showed significant differences between the experimental and control groups, supporting the effectiveness of the method. Both students and teachers reported positive perceptions of this method. Students benefited from visual and interactive tools such as Python and Scratch, which helped them better understand mathematical concepts and develop creative skills. On the other hand, teachers emphasized that the inclusion of algorithms helped motivate and engage students, creating a more interactive and collaborative learning environment. A key aspect of the findings was that algorithms helped students connect mathematics to other fields, such as computer science and technology. This interdisciplinary approach not only improved their understanding of mathematics but also equipped students with practical and transferable skills, useful for future careers. Therefore, we can say that the inclusion of algorithms in mathematics syllabus represents an important step towards modernizing education. This study shows that this approach not only helps develop academic skills but also equips students with the necessary skills to face the challenges of the technological world. The research has wide-ranging implications for education, pedagogy, and workforce development. By integrating algorithms into mathematics curricula, students develop skills that are essential for the digital economy, leading to more engaging learning experiences and improved academic performance. The study contributes both theoretically and practically to educational research and provides a solid foundation for future educational reforms in STEM disciplines. The study provides strong evidence that the integration of algorithms into mathematics education yields lasting benefits. Not only does it enhance mathematical skills, but it also fosters interdisciplinary thinking, career readiness, and lifelong learning abilities. However, the long-term impact is contingent on proper teacher training, technological support, and sustained curriculum reforms.

RECOMMENDATIONS

Based on the findings and analysis of the study, this subchapter presents practical recommendations for improving the process of integrating algorithms into the mathematics syllabus. These recommendations aim to address the identified challenges and maximize the benefits of this innovative approach. (a) Investment in Technology and Infrastructure - Educational institutions should invest in modern technology, providing computer equipment and internet access for students and teachers. Learning environments should be equipped with educational software such as Python, Scratch, and other tools that support algorithm-based learning. (b) Adapting Syllabus - The existing syllabus should be revised to integrate algorithms in a consistent and progressive manner. The syllabus should include practical tasks and activities that encourage logical thinking, creativity, and complex problem-solving. (c) Creating Interdisciplinary Projects - It is recommended that teachers create interdisciplinary projects that connect mathematics with computer science, physics, and economics, helping students understand the practical applications of mathematics. Use hands-on activities such as simulations and creating simple algorithmic applications to increase student interest. (d) Monitoring and Evaluation of Results - Systems should be established for continuous monitoring and evaluation of the effectiveness of integrating algorithms into teaching. Feedback from students and teachers should be used to continuously improve teaching methods and materials.

For future research, it is recommended to conduct long-term studies to assess the impact of algorithmic learning on academic performance and student careers. Should expand study sample, including schools from different educational systems to provide more general findings. Teacher training remains a major challenge, so research should analyze the most effective professional development methods for educators. Also, the optimal balance between traditional learning and the integration of algorithms in the curriculum, as well as using artificial intelligence for the personalization of teaching, should be explored. Future studies may extend to other disciplines such as physics, economics and social sciences, to understand the interdisciplinary applications of algorithmic thought. Finally, it is necessary to analyze strategies for overcoming digital gap, identifying affordable solutions for schools with limited resources, to provide a comprehensive and equal education in the digital era.

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