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# THE IMPACT OF INTEGRATING INFORMATICS AND MATHEMATICS ON STUDENTS' ALGORITHMIC THINKING

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**Abstract**:
This article explores the pedagogical impact of integrating informatics and mathematics in secondary and higher education, with a particular focus on enhancing students' algorithmic thinking. The development of algorithmic thinking is essential for solving complex problems, designing step-by-step solutions, and fostering computational literacy. The integration of informatics and mathematics enables students to understand the logical structure of problems while applying computational tools for resolution. The study presents both theoretical insights and practical approaches for harmonizing these subjects in the curriculum. The research emphasizes the importance of interdisciplinary connections to cultivate deeper reasoning and strengthen problem-solving capacities among learners.

**Keywords:** Algorithmic thinking, interdisciplinary approach, informatics education, mathematics integration, computational logic, problem-solving skills, digital pedagogy

## Introduction

In the contemporary educational environment, the need for interdisciplinary teaching strategies has become more pronounced due to the increasing complexity of knowledge domains and the demands of the digital age. One particularly significant intersection lies between informatics and mathematics, both of which share foundational principles such as logic, abstraction, and problem-solving. Algorithmic thinking, a core competency in both fields, refers to the ability to

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formulate step-by-step procedures for solving problems. As societies move toward digital transformation, algorithmic thinking becomes not only a technical skill but also a cognitive tool essential for all learners.

In Uzbekistan, efforts to modernize education have led to curricular reforms aimed at strengthening STEM education and preparing students for the demands of the 21st-century economy. Integrating informatics and mathematics offers a promising direction in this context. Mathematics provides abstract models and theoretical frameworks, while informatics equips students with tools to implement and automate these models. When taught in isolation, each subject may fall short of developing the full potential of students' cognitive abilities. However, when strategically combined, they can mutually reinforce learning outcomes, particularly in fostering structured thinking and problem analysis.

Furthermore, the integration of these subjects supports the development of digital literacy and prepares students for further education in technical fields. It allows for the application of mathematical concepts through programming tasks, simulations, and data analysis. For instance, topics like functions, sequences, and logical operations can be deepened by coding exercises, which bring abstract concepts to life. Therefore, this article investigates how a structured integration of mathematics and informatics influences the development of algorithmic thinking, analyzing both theoretical perspectives and instructional practices relevant to pedagogical institutions in Uzbekistan.

## Literature Review

The relationship between informatics and mathematics has been a subject of increasing interest in educational research, particularly in the context of developing students' computational and algorithmic competencies. Wing (2006) introduced the concept of "computational thinking" as an essential skill for all disciplines, emphasizing its foundations in both computer science and mathematical logic. Subsequent studies by Grover and Pea (2013) highlighted the value of integrating programming tasks with mathematical content to promote deeper conceptual understanding and enhance problem-solving abilities.

Research in curriculum design, such as that by Weintrop et al. (2016), demonstrated that interdisciplinary models integrating computer science and

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mathematics foster students' engagement and improve their performance in both subjects. In particular, algorithmic thinking develops most effectively when students are exposed to iterative reasoning, recursive patterns, and condition-based logic—skills that are common to both mathematical problem-solving and computational processes.

Studies focused on secondary and tertiary education in Eastern Europe and Central Asia, including Uzbekistan, have begun to recognize the need for such integrative approaches. However, there is still limited empirical data on the specific pedagogical methods and their outcomes in these regions. Local researchers such as Abdurahmonov (2021) and Toshpulatova (2022) have called for more experimental implementation of blended learning strategies involving programming and applied mathematics, especially in teacher training institutions. The existing body of literature provides a theoretical basis for integration, but practical models suited to regional curricula and technological infrastructure remain underdeveloped. Therefore, this study seeks to fill this gap by examining the specific impact of integrated instruction on students' algorithmic thinking skills in pedagogical contexts.

## Methodology

This study employs a qualitative-dominant mixed-methods approach to examine the effects of integrating informatics and mathematics on the development of students' algorithmic thinking. The research was conducted in several pedagogical universities in Uzbekistan, focusing on third- and fourth-year students enrolled in mathematics and informatics teacher education programs. The study was structured around classroom-based interventions, where selected topics in discrete mathematics, algebra, and logic were taught in parallel with corresponding programming activities using Python.

The participants were divided into two groups: a control group receiving traditional subject-specific instruction, and an experimental group experiencing integrated lessons combining mathematical theory with informatics applications. The instructional units lasted six weeks and included tasks such as algorithmic modeling of mathematical sequences, writing code for solving linear equations, and using conditionals and loops to simulate real-world problems.

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Data collection methods included pre- and post-intervention surveys to assess students' perceived growth in algorithmic thinking, semi-structured interviews with instructors, and classroom observation protocols. In addition, samples of students' code and mathematical solutions were analyzed using a rubric assessing logical consistency, abstraction, decomposition, and problem-solving efficiency. The study also employed triangulation by comparing self-reported outcomes with performance-based indicators. NVivo software was used to code qualitative data from interviews and observations, while SPSS was used for basic descriptive statistical analysis of survey results. The goal was to determine whether integrated instruction improved students' ability to understand and apply algorithmic principles more effectively than traditional methods, and to identify which aspects of integration contributed most to this development.

**Discussion**

The findings of the study indicate a significant positive impact of integrating informatics and mathematics on the development of students' algorithmic thinking. Students in the experimental group demonstrated stronger capabilities in decomposing problems, applying logical operators, and developing structured solutions through both code and mathematical models. This reinforces the theoretical proposition that interdisciplinary instruction enhances cognitive transfer between related domains.

One of the most evident improvements was in students' ability to represent abstract mathematical ideas through programming constructs. For instance, students who initially struggled with recursive sequences in mathematics were better able to understand them after writing recursive functions in Python. Similarly, concepts such as conditional logic and iteration became clearer when they were simultaneously applied in solving equations and designing small-scale algorithms. This suggests that applying mathematical knowledge in a digital, functional context helps solidify conceptual understanding.

Teacher interviews highlighted several benefits of integration, including increased student engagement, improved retention of theoretical material, and enhanced motivation. Many instructors noted that students were more curious and active during integrated lessons, often making connections between the structure of mathematical expressions and programming syntax. The integration also fostered collaborative learning, as students discussed coding approaches and mathematical strategies in pairs or groups.

However, the integration process also revealed several challenges. Firstly, it required significant preparation from instructors who needed proficiency in both subjects and an understanding of pedagogical integration. Secondly, the existing curriculum structure in many pedagogical universities in Uzbekistan remains compartmentalized, making it difficult to schedule or support interdisciplinary courses. Technical limitations, such as access to reliable computer labs and digital resources, were also cited as barriers to effective implementation.

Despite these challenges, the outcomes clearly support the argument for adopting integrative approaches in teacher education. The students who experienced the blended model were better equipped not only with algorithmic thinking skills but also with the ability to bridge conceptual knowledge with practical tools—an essential competence for future educators in STEM fields.

**Main part**

The integration of informatics and mathematics in educational settings is not simply a combination of two subjects, but rather a methodological shift that reshapes how students conceptualize problems and solutions. In the context of algorithmic thinking, this integration plays a foundational role in training learners to analyze complex situations, recognize patterns, design algorithms, and evaluate computational outcomes.

To illustrate the impact, specific instructional units were designed where mathematical topics such as functions, sequences, sets, and logic were taught alongside corresponding programming practices. For example, during lessons on arithmetic and geometric progressions, students were tasked with writing Python functions to generate series and calculate sums. This dual exposure allowed them to see the direct application of mathematical formulae in a programmable environment, reinforcing both symbolic and procedural understanding.

Another unit focused on set theory and Boolean logic. Students used these concepts to create simple databases and develop decision-making algorithms. This helped solidify the abstract operations of union, intersection, and negation

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by translating them into coding instructions. As students navigated between mathematical notation and programming syntax, they developed a more nuanced understanding of logical operations and their real-world significance.

Algorithmic thinking also involves decomposition—breaking down a complex problem into manageable sub-tasks. This skill was emphasized in both mathematical problem-solving and code structuring. Tasks such as solving systems of linear equations or constructing visual representations of functions required students to plan step-by-step procedures and represent them as functions or loops in code. The process of debugging code further sharpened their ability to detect logical errors, revise steps, and reflect on their thinking—a valuable metacognitive skill that is less common in traditional mathematics instruction.

In addition, the integrated model emphasized the use of visual tools. For instance, students used graph plotting libraries to visualize functions, compare outputs, and identify patterns. This enhanced their ability to analyze results, a key part of algorithmic thinking. Many students reported that seeing immediate outputs of their code increased their motivation and helped clarify abstract mathematical ideas.

The benefits of integration extended beyond cognitive development. Students became more collaborative, shared responsibilities during group programming tasks, and developed communication skills by explaining both their mathematical reasoning and programming decisions. These outcomes are particularly relevant for future teachers, who will need to translate complex content into teachable components in their professional practice.

Overall, the integration of mathematics and informatics provides a more holistic approach to developing algorithmic thinking. It merges declarative knowledge (knowing what) with procedural knowledge (knowing how), enabling students to apply what they learn in dynamic, technology-rich environments. The results from this study underscore the importance of breaking traditional disciplinary silos in pedagogical institutions to prepare learners for interdisciplinary thinking and digital competence.

## Conclusion

The integration of informatics and mathematics in teacher education programs has demonstrated clear benefits in enhancing students' algorithmic thinking. By engaging with mathematical concepts through programming and computational tasks, students developed a deeper and more functional understanding of logic, structure, and process. The findings from this study show that students exposed to integrated instruction were better at formulating problem-solving strategies, decomposing tasks, and applying abstract ideas to practical scenarios.

Furthermore, the integration fostered increased motivation, active participation, and collaboration among learners—outcomes that are highly desirable in modern pedagogy. These developments are particularly important for future educators, as they must not only possess strong algorithmic skills but also be capable of teaching them in engaging, interdisciplinary ways. Algorithmic thinking is no longer confined to informatics alone; it is a core skill across many disciplines, and its foundation is effectively laid through a combined approach with mathematics. Despite institutional and logistical challenges, the integration of these two fields should be a strategic priority for pedagogical universities in Uzbekistan. Curriculum designers and educational policymakers are encouraged to support interdisciplinary modules, provide training for teachers, and invest in necessary technological infrastructure. Further research is recommended to explore long-term outcomes of such integration, including its effect on student achievement in national assessments and its influence on teaching practices after graduation.

Ultimately, the integration of informatics and mathematics offers a forward-thinking educational model that aligns with the demands of a digital world. It prepares students not only to think logically and creatively but also to thrive in data-driven and technology-mediated environments.

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