Interactive platforms for developing mathematical thinking in fifth grade

Vera SHOPOVA, Vilislav RADEV

Paisii Hilendarski University, Faculty of Pedagogy, Plovdiv, Bulgaria

shopova.v@uni-plovdiv.bg, vradev@uni-plovdiv.bg

Abstract: *This article presents pedagogical experience related to the integration of three popular digital platforms – Science Buddies, Quizizz and Scratch – in fifth grade mathematics education. The main goal is to promote mathematical thinking by combining an experimental-research approach, gamification and visual programming. Science Buddies provides access to rich resources for science projects and experiments that motivate students to explore real-world problems and apply mathematical concepts in a practical context. Quizizz is used as an interactive tool for testing knowledge and for introducing an element of competition and fun, which stimulates active participation and deepens understanding. Scratch allows students to create animated projects and games, thus applying mathematical operations and algorithmic thinking in a creative environment. The presented practice shows that the combined use of these resources leads to higher motivation, better understanding of mathematical relationships and development of problem-solving skills. The article offers examples from the classroom and outlines opportunities for applying the model in different educational contexts*.

Keywords: Science Buddies, Quizizz, Scratch, Mathematical literacy, Learning, Students.

1. Introduction

Mathematical thinking can be viewed as a set of skills that include logical sequence, abstraction, algorithmic thinking, and working with dependencies. Modern pedagogical research emphasizes that these skills are most effectively developed in conditions of active learning, problem-oriented tasks, and application of knowledge in a real context (Stoitsov & Garov, 2013). In this regard, digital educational platforms offer new opportunities for enriching the learning process in mathematics.

Science Buddies places mathematical concepts in the context of real-world engineering and scientific problems, Quizizz introduces elements of gamification and immediate feedback, and Scratch creates conditions for visualizing abstract relationships through programming. The combined use of these platforms forms the theoretical and practical framework of the present study.

In recent years, there has been an increased interest in the use of digital platforms to develop mathematical literacy and thinking in lower secondary

https://doi.org/10.58503/icvl-v21y202612

schools. Research emphasizes project-based learning, STEM/STEAM approaches, and gamification as effective tools for increasing motivation and academic achievement (Garov & Dobrev, 2024). The teacher - innovator "provides students with the tools they need to meet modern challenges" (Angelova & Nikolova, 2024). Platforms such as Gauthmath, Photomath, EducaPlay, Gamma, Prezi and others, working with artificial intelligence, are widely used for visualization of mathematical relationships, formative assessment and development of algorithmic thinking (Velcheva & Kartleva, 2025).

Projects under the name "Little Engineers" are found in various educational contexts, most often as STEM initiatives aimed at integrating science, technology and mathematics. In this article, the "Little Engineers" project is used as an author's pedagogical framework for systematically integrating mathematics with engineering and digital activities in fifth grade, rather than as a reproduction of a specific external program.

Against this background, this study contributes with a model for purposefully combining Science Buddies, Quizizz, and Scratch specifically in mathematics education, with a focus on mathematical thinking, not solely on cross-curricular integration.

2. Exhibition

2.1 Methodology

The subject of the research in the article is the integration of digital educational platforms (Science Buddies, Quizizz and Scratch) into the fifth-grade mathematics learning process, with an emphasis on their use to stimulate mathematical thinking and increase learning motivation.

The object of the study is the learning activities in mathematics in the fifth grade, organized through the application of an experimental-research approach, gamification and visual programming.

The study was conducted during the school year with students (29 in number) from the fifth grade, aged between 11 and 12 years old, from a class with intensive study of information technologies and natural sciences at the "Knyaz Alexander I" Primary School, Plovdiv.

The main goal of the study is to develop, implement and analyze a pedagogical practice for integrating the digital platforms Science Buddies, Quizizz and Scratch into mathematics education, with a view to increasing interest, motivation and effectiveness of the learning process.

The research tasks in this article include: exploring the possibilities of the Science Buddies, Quizizz and Scratch platforms for application in mathematics teaching; building a model for the integrated use of the three platforms in mathematics classes (compulsory and optional) in fifth grade; analyzing the impact of the model on students' motivation, activity and achievements.

2.2 Description of the pedagogical practice - project "Little Engineers"

Within the framework of fifth-grade mathematics education, a pedagogical practice has been implemented - the "Little Engineers" project, based on the integrated use of three digital platforms - Science Buddies, Quizizz and Scratch. The practice is aimed at developing mathematical thinking by combining experimental-research approaches, gamification and visual programming.

The goals set by the authors of the article when implementing the project are for students to:

- develop skills in applying measurements and calculations of lengths, areas and volumes in a practical context;
- learn basic concepts of proportion and ratio by constructing and modeling a drone, rocket, and greenhouse;
- develop spatial orientation and geometric thinking by working with three-dimensional models and instructions;
- apply logical thinking and consistency when performing technological tasks and instructions;
- use digital resources and platforms for problem solving and team collaboration;
- understand the connection between mathematical concepts and real-world engineering applications.

In the first stage of the training, students work with content and projects provided by the Science Buddies platform. They construct models of a drone, a rocket and a greenhouse, applying mathematical knowledge for measuring, calculating area, volume and proportions in the process. In this way, conditions are created for integrating theoretical knowledge with practical activity and for developing skills for research and experimentation. The activities are implemented in mandatory and optional classes and in interest groups in mathematics, natural sciences and information technology.

The developments in Science Buddies are structured according to the engineering cycle “ask-think-plan-create-improve” and provide clear instructions, materials and data sheets that facilitate the targeted introduction of mathematical practices. In the drone model, students make drawings, calculate mass and weight distribution for stability. In the air rocket, they measure the dependent quantities (height, flight time), recording several repetitions and calculating the average value and percentage deviation. In the “greenhouse” project, they compare the surface area and volume ratio, measure temperature and humidity and argue which parameters have the greatest impact on heat retention. Thus, the platform functions as a model for experimental design, in which mathematics is integrated with real engineering solutions.

Assessment and reflection are organized through an experimental plan (goal, hypothesis, variables), data tables, graphs (linear or bar) and short analytical conclusions. Students present prototypes and defenses in which they compare options with mathematical arguments and plan subsequent models. Rubrics with

criteria for correctness of measurements, quality of data visualization, logicality of the conclusion and contribution of each participant make progress visible, both in mandatory and optional classes and interest groups. This sequence develops skills in modeling, working with data and argumentation, while strengthening motivation by meaningfully connecting mathematics with construction and experiments.

In the second stage, the Quizizz platform is used as an interactive tool for diagnostics and practice. Through game tests, students check their acquired knowledge, compete in teams and individually, which stimulates their activity, concentration and striving to achieve better results.

Quizizz's built-in AI generation capabilities make it easy to quickly build quality fifth grade tasks and tests. The teacher provides learning objectives or key concepts, and the system offers an initial set of questions, distractors, and explanations that can be edited by difficulty. Different types of items are supported (multiple choice, short numerical answer, fill in the blank, ordering), which is important when constructing tasks for algorithmic thinking and modeling. AI tools accelerate differentiation. The teacher generates tasks of varying complexity and type.

Gamification using Quizizz (real-time or asynchronous) supports learning designs like “Little Engineers.” The rounds in the competitive part of the project can be structured as engineering “sprints” with increasing complexity, time limits, and intermediate checkpoints. Adjustable timers, team competition, and instant feedback keep engagement high, and the ability to alternate instructional and question slides allows for “learning through challenges.”

Quizizz diagnostic reports provide detailed analysis in real time and after the lesson - overall success rate, response time, "difficult" tasks and recognition of recurring misconceptions. Based on this data, AI modules support subsequent customization. This makes it easier to track progress between preliminary and final diagnostics, as well as plan subsequent "sprints" within "Little Engineers". Export of results and easy sharing support the consistent building of a repository of validated mathematical thinking tasks in fifth grade.

In the third stage, students work with the visual programming environment Scratch. They create animated projects and educational games in which they use mathematical operations, logical structures and algorithmic models (Velcheva & Dimitrov, 2023). This activity supports the development of creativity, critical thinking and problem-solving skills, while creating positive learning motivation.

Within Little Engineers, Scratch tasks are designed to “spatialize” mathematics—characters navigate a coordinate grid, rotate at specified angles, and scale shapes according to ratios and proportions. Using the Pen extension, students parameterize polygons (e.g., “draw an n-gon of length a”), use variables for perimeter/ area, and create their own blocks for reusing procedures. Lists collect results from random number experiments, allowing for elementary probability simulations.

The organization of the work consists of planning, building, testing, and reflection. Formative assessment is based on rubrics with measures of correctness, algorithm efficiency, code clarity, and mathematical validity.

Table 1. Detailed description of the “little engineers” project

Stage	Platform used	Specific activities	Applied mathematical knowledge and skills
Experimental research approach	Science Buddies	Drone construction (balance, center of gravity). Building a rocket model and observing its flight. Creating a greenhouse and analyzing plant growth conditions.	Proportions and symmetry. Calculating height, speed, working with area and volume, applying mathematical concepts in real-world situations.
Gamification and assessment	Quizizz	Solving interactive tests and tasks. Teamwork and competition between students.	Fast and accurate calculation. Checking and correcting errors.
Visual programming and creativity	Scratch	Programming an animated maze with movement along a coordinate system. Simulation of a rocket launch along a parabola. Creating a "smart greenhouse" with algorithms for regulating temperature and humidity.	Use of mathemati-cal operations and algorithms. Applying knowledge of angles, coordinates and relation-ships. Development of logical and creative thinking, problem-solving skills.

2.3 Practical results and effects on the students

The analysis of the results was conducted by combining qualitative and quantitative methods: observation, analysis of student products, diagnostic tests in Quizizz, and a study motivation survey.

At the beginning and end of the project, a diagnostic of mathematical knowledge was conducted using an identically structured test. The average score of the class increased from 62% at the beginning to 78% after the project was completed. The most significant improvement was observed in tasks requiring work with proportions, coordinate systems, and data interpretation.

The survey shows that 83% of students describe math classes as “more interesting” compared to the traditional format, and 76% say they understand better “what math is for in real life.” Teacher observations report increased activity, more frequent teamwork, and a greater willingness to argue for solutions.

These results are indicative and do not claim statistical generalizability, but they confirm the positive effect of implementing the integrated model.

It is observed that students are more evenly involved in group work and that roles are more clearly defined when solving problems. Oral defenses of solutions and presentation of prototypes show better argumentation and more accurate use of mathematical concepts when explaining choices.

3. Conclusion

The presented pedagogical practice shows that the integration of Science Buddies, Quizizz and Scratch into fifth grade mathematics education creates conditions for a deeper understanding of mathematical concepts and for the development of key skills – logical and algorithmic thinking, working with data and problem solving. Despite the limitations of the research design, the results show a sustainable positive trend in terms of motivation and academic achievement.

Future research could expand the presented model by forming an experimental and control group for the purpose of statistical comparison of the results. It is recommended that the model be tested in more than one grade and in different school contexts to check the sustainability of the effect with different student profiles. Scaling up could include developing a set of ready-made scenarios and assessment rubrics to facilitate implementation and ensure comparability of the results. Of additional interest is the long-term follow-up of the effects on mathematical literacy and interest in STEM subjects.

Acknowledgments

This study is financed by the European Union-NextGenerationEU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, project DUECOS BG-RRP-2.004-0001-C01.

REFERENCES

Angelova, V. & Nikolova, A. (2024) The Digital Competence of Students Preparing to become Primary School Teachers - Perspectives for Development. *TEM Journal*. 13 (1), 377 – 385. https://doi.org/10.18421/TEM131-39.

Educational platform and visual programming environment - *Scratch* - https://scratch.mit.edu/ [Accessed: 8th November 2025].

Educational platform for creating, administering, and participating in interactive quizzes, tests, and lessons - *Quizizz* - https://quizizz.com/ [Accessed: 8th November 2025].

Educational platform with free STEM resources - *Science Buddies* - https://www.sciencebuddies.org/ [Accessed: 8th November 2025].

Garov, K. & Dobrev, I. (2024) The use of artificial intelligence in information technology classes – applications and benefits. *Education and Technology*. 15(2), 402 – 406. https://www.doi.org/10.26883/2010.242.6204.

Primary School "Knyaz Alexander I", Plovdiv (n.a.) - *Facebook page* - https://www.facebook.com/61558002928470/videos/1273967643750418?locale=bg_BG [Accessed: 8th November 2025].

Stoitsov, G. & Garov, K. (2013) Use of dynamic and interactive models for presenting educational content in the discipline "Computer Networks and Communications". *Mathematics and Informatics Journal.* 1, 73-83. https://pedagogy.azbuki.bg/en/matematics/matharticles/matematika-i-informatika-knizhka-1-godina-lvi-2013-2/ [Accessed: 8th November 2025].

Velcheva, I. & Dimitrov, I. (2023) The Scratch educational game related to the subject of man and nature for 4th grade. *Write-off of "Education and Technology"*. 14, 222-228. https://doi.org/10.26883/2010.231.5099.

Velcheva, I. & Kartaleva, I. (2025) An exemplary approach for the application of artificial intelligence and project work in mathematics education. *Mathematics and Informatics Journal.* 68(3), 284-301. https://doi.org/10.53656/math2025-3-3.