



# Creating Digital Learning Resources Using Scratch for Learning 4th Grade Mathematics

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## Abstract

*The article is dedicated to the creation and use of digital resources created on Scratch when teaching mathematics in the fourth grade. An animated Scratch module from the educational content of the mathematics textbook with authors Prof. Dr. Vladimira Angelova and Zhana Koleva, Prosveta Plus Publishing House, Sofia, 2019 is described in detail. Presented in this way, it offers an opportunity to integrate information technologies into mathematics classes in order to better master the educational material.*

*The purpose of the publication is to present the proposed methodological tools for the application of information technologies in mathematics teaching in the fourth grade, namely - animated Scratch modules, based on the educational content, would help to more effectively master knowledge, skills and attitudes related to mathematical literacy and modern key competencies of students. This would lead to a more effective implementation of the learning goals, to increasing students' interest in mathematics as an academic discipline and building a positive emotional attitude towards it. The expectations are also to create a better transition to the future professional and life realization of the students. The specifics of the developed learning content, the electronic environment, the animated scenarios and the teaching method are related to the 9 key competencies for the development of students set out in the curriculum and program, but the main emphasis is on "Mathematical Competence" and "Digital Competence".*

**Keywords:** Scratch, mathematics, information technology, digital resources, educational content

## 1. Introduction

The dynamics of the last few years and the changes that have occurred in the life of the planet, dictated by global crises that have an impact in various areas - health, social, economic, political, etc., have imposed new requirements on education, namely that the environment be more flexible, open, social, healthy, interactive and digital. It is of key importance to implement various innovations in the educational process in a timely manner, to make modifications in the training trajectories that are adapted to the pace of learning and skills by learners. The UNESCO Global Education Monitoring Report for 2023, which focuses on technology and education, explicitly emphasizes that the opportunities and challenges posed by technology are the main construct for achieving quality education and sustainable development. In more and more areas of life, societies are moving towards digitalization, or in other words, this is the structuring of social life around digital communication and media infrastructure. Digital literacy should “respond to the current and future needs of learners and the community” and “provide students with the tools they need to address contemporary challenges” [7]. The increasing use and presence of digital solutions in people’s daily lives creates a need for systemic change based on digital transformation as a whole. It is important to note that *technologies and Media are effective tools when used as intended* . When we talk about digital learning, we mean any type of learning that is supported by technology or through pedagogical practices and techniques that make the use of a given technology effective.

The integration of digital educational tools into the learning process is inevitable, especially in subjects that usually have difficulty going hand in hand with imagination and fun. It is extremely difficult for students to connect reality with mathematical concepts. This problem is clearly highlighted in the results of the PISA tests - nearly 45% of Bulgarian children are able to cope with only the most elementary tasks [8] .

Primary school students perceive knowledge more effectively in an interactive environment. That is why the use of block-based programming, as an environment for creating visual models and interactive tasks, is emerging as a promising approach in mathematics education. It allows for the combination of logical thinking, creativity and practical application of mathematical knowledge. In this way, one of the most favorite teaching methods of students is applied, namely - gamification ("use of



game elements in a non-game context") [4] , which not only attracts attention for a longer time, but also increases the motivation and self-confidence of students.

## 2. Designing a Prototype of an Educational Animated Module in "Mathematics " for Fourth Grade

### 2.1. Pedagogical Characteristics of an Animated Module "Geometric Friends". Scenario and Technological Implementation

The created game "Geometric Friends" is from the educational content of the topic "Geometric Figures" on page 11 of the textbook "Mathematics" for 4th grade, authors V. Angelova, Zh. Atanasova of the publishing house Prosveta Plus [1] . The game is aimed at systematizing and summarizing the knowledge and skills of students about the studied geometric figures. With the help of the task, students will consolidate their competencies:

- Recognizes geometric shapes: square and triangle;
- Recognizes the types of triangles according to their sides;
- Defines a square as a type of rectangle;
- Defines a square as a rectangle;
- Solves geometric problems.

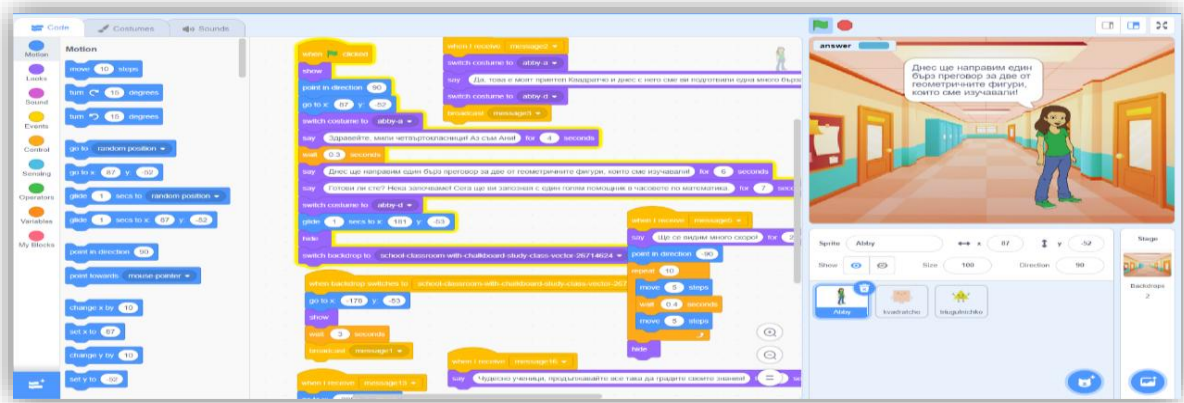
The proposed module includes a text problem that illustrates a square and an equilateral triangle. In the problem, we know the perimeter of the square and how much longer its side is than the side of an equilateral triangle. We are looking for the perimeter of the triangle in centimeters. Students consolidate their knowledge of geometric figures - a square and an isosceles triangle - by making the connection between the four sides of the square, and then use the condition and the data in it to be able to find the perimeter. When they find the side of the square, they can find the side of the triangle, and from there its perimeter.

The plot of the module is developed in three scenes, two of which are repetitive, but in each subsequent scene there is a different animation. The whole game proceeds sequentially step by step in accordance with the educational content. In order for the student to move forward in his solutions, he must successfully solve, record and calculate the problems, which consist of three numerical expressions.

The game is intended for all fourth grade students, and since they do not experience any difficulty in reading, the module is made like a comic book in which the students can read the characters' lines themselves. Although some of the students read more slowly and others faster, the time for reading the speech is sufficient and tailored to the needs of all fourth graders.

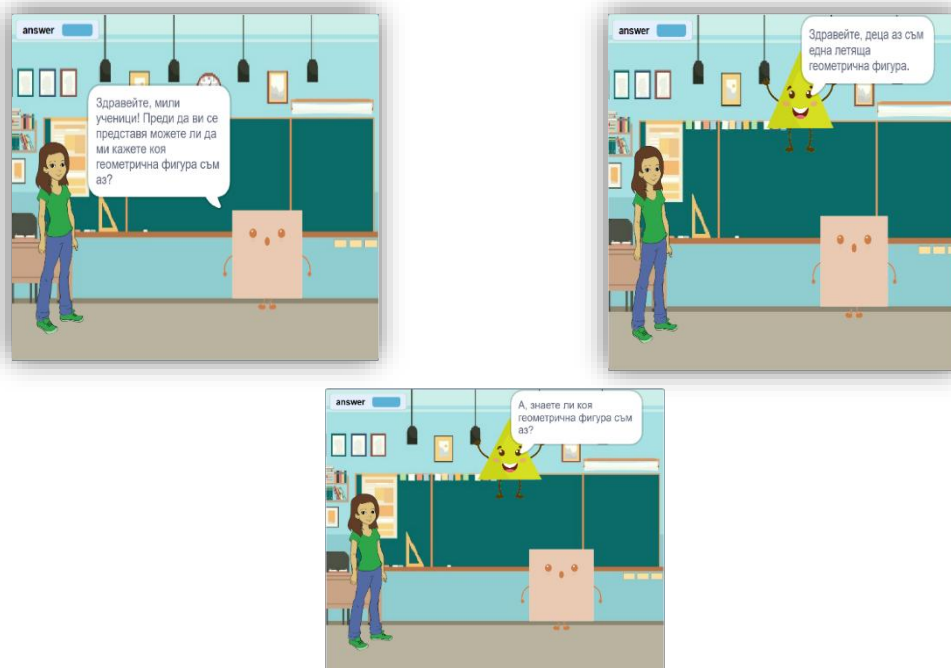
The characters in the game always give a positive assessment in support of the student, noting his knowledge, and for each correct answer he receives praise, this is key to achieving a pleasant atmosphere for the student, and at the same time maintaining his interest in the game. When the student makes a mistake, he is instructed to correct his mistake with an indefinite number of attempts. The game is dynamic and interactive for students.

In the first scene, students are introduced to a character named Annie, who is selected from the library available in "Scratch", and she is in a "school corridor" decor, which was selected specifically for the game itself. This is an introductory scene before the game begins, so the character only welcomes the student and tells him that it is time to review the geometric shapes studied (square and triangle). Annie goes to the classroom to introduce the student to an old acquaintance from math class. (Fig. 1)



**Fig. 1.** Module "Geometric Friends", Scene 1.

The next scene is in a “math classroom” setting, which was again specially selected for the task. After Annie entered the room, she introduced the student to her old acquaintance from math classes, the square “Square”. Before introducing herself, the square wants to have a talk by asking the student what geometric figure she is. After the student answers the question, “Square” introduces the student to his assistant “Triangle”, when the triangle appears in the scene he does not forget to ask the student what geometric figure she is, after answering correctly, the heroine Annie leaves and the game begins. Both characters are not available in “Scratch”, but are specially selected for the content of the game. The goal in this part of the game is to consolidate the student’s knowledge of the geometric figures square and triangle. (Fig. 2)



**Fig. 2.** Module "Geometric Friends", Scene 2.



When the game begins, the decor remains unchanged. The two characters state the condition of the task, they take turns, giving the student an instruction in advance to read carefully. To make the game more interesting for the student, the condition is a little more broken down, instead of "The perimeter of the square is ..." the character says: "My perimeter is ..." (Fig. 3). The goal of this part of the game is for the student to consolidate his ability to solve a geometric problem and to compose and calculate numerical expressions to solve the specific task. After they finish stating the condition of the task, the character "Square" checks whether the student has been paying attention, by asking him what is known from the condition and what is being sought. The student has time in which to answer these two questions orally. This is followed by a question in which the student must again verbally state what type of triangle is in the problem, thereby consolidating his knowledge and skills in recognizing the types of triangles according to their side (Fig. 4). When the student answers this question correctly, the problem is solved. Together with the help of the square and the triangle, the student must be able to write down and solve the three numerical expressions. With the help of the "Triangle", the fourth-grader must be able to find the side of the square by dividing the perimeter by the number of sides of the square. After finding the side of the square with the help of the "Square", he must be able to find the side of the triangle, using the information available about the side of the triangle from the condition. When he is completely ready with these solutions with the help of the "Triangle", the student will also be able to find the perimeter of the triangle.

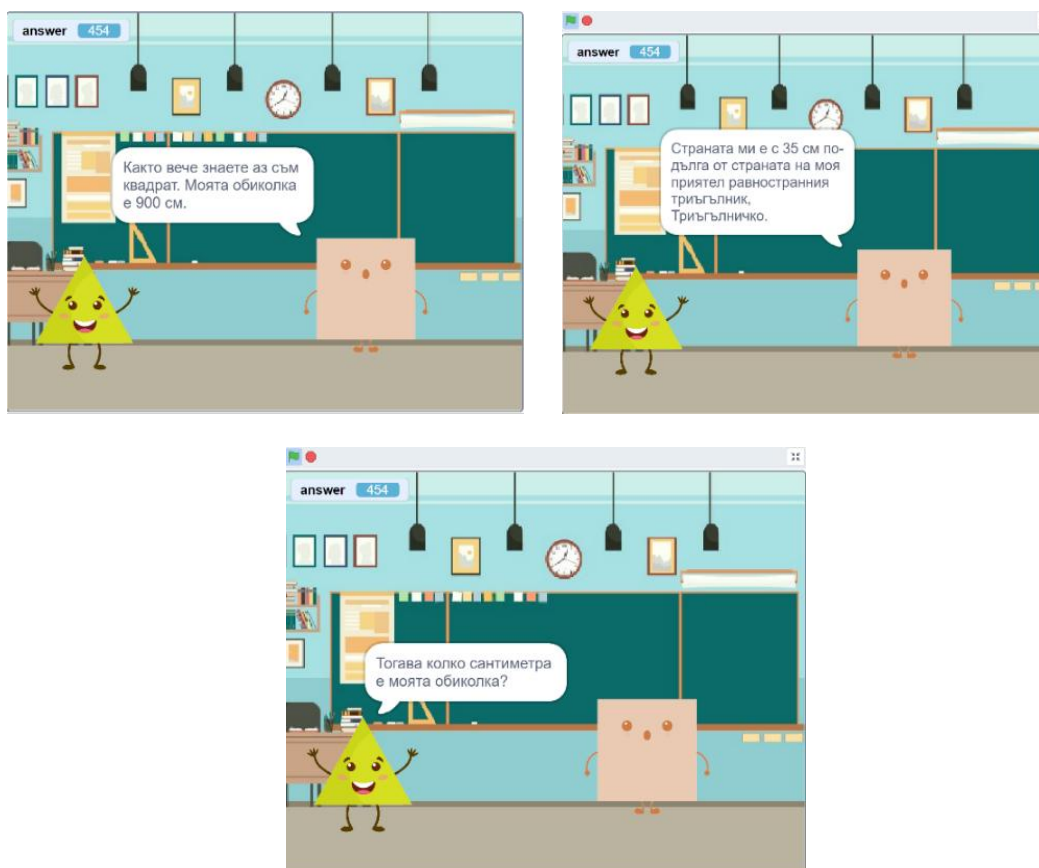


Fig. 3. Module "Geometric Friends", Scene 2.

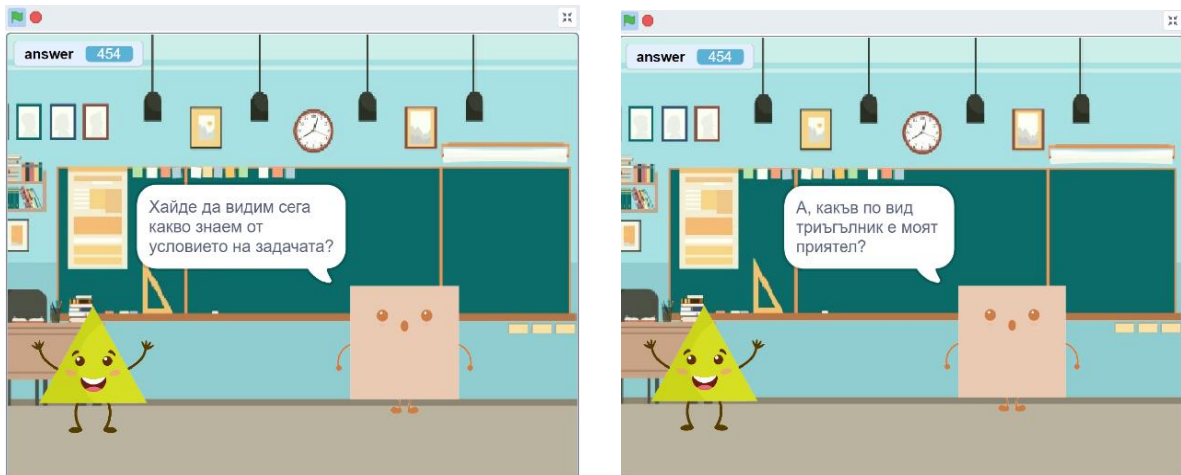


Fig. 4. Module "Geometric Friends", Scene 2.

Each numerical expression and its solution should be written in the field indicated for this with a blinking cursor, and the time for writing the solution is unlimited. After the student writes his answer, he should confirm the command by clicking on the blue tick with the mouse or pressing the "enter" button on the keyboard. When the student's answer is correct, he receives praise from the geors "Great!", and when the answer is wrong, he is given the opportunity to try again to solve the expression – "Try again!", and this opportunity for correction is unlimited. (Fig. 5)

Only when the student has solved the entire geometric problem does the final scene follow, in

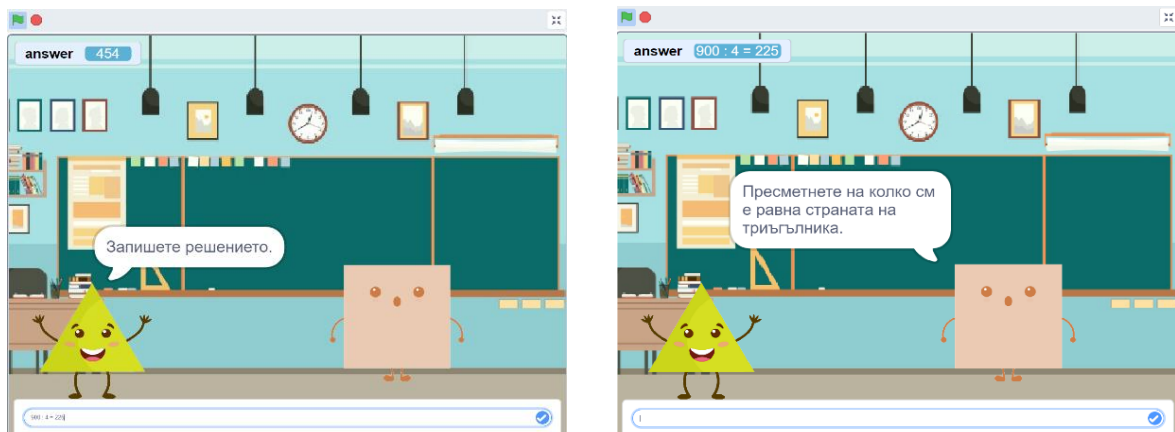


Fig. 5. Module "Geometric Friends", Scene 2.

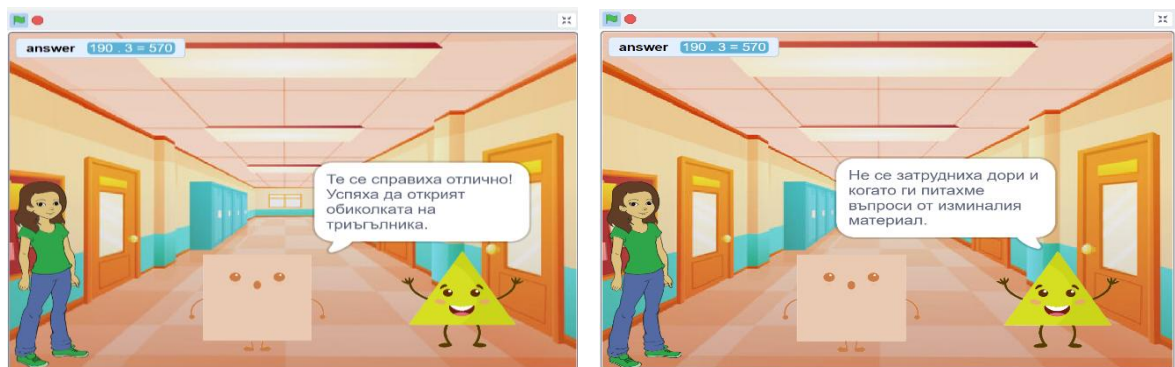


Fig. 6. Module "Geometric Friends", Scene 2.

which the decor changes again to a "school corridor", where Annie waits for the other two characters to give an assessment of how the student coped with solving the problem, of course the assessment is positive. (Fig. 6)



The game is suitable for both review and practice classes, as well as for individual preparation for each student.

### 3. Results

The pedagogical experiment was conducted in a class with 24 students. The class was divided into two groups of 12 students. The experimental group solved the task in Scratch within the framework of a lesson, while the control group worked with traditional exercises from the "Prosveta Plus" textbook. In the experimental group, the success rate in integrating Scratch was 89%, without violating the logic of the educational content in compared to 67% in the control group. These data show that creating and implementing digital electronic resources using Scratch facilitates the consolidation of learning content in mathematics classes. After completing this task, students in the experimental group were much more motivated and engaged with the remaining tasks during the lesson, while students in the control group did not change their motivation in any way, which confirms the role of visualization in increasing engagement. At the end of the class, a test was given to the class with the same task from the textbook, and students who had solved the task earlier with Scratch had 93% excellent results, while the group that solved the task in the textbook had an average result of 75% correct answers, which confirms the effect of visualization on the acquisition of skills.

### 4. Conclusion

The use of block-based programming in Scratch and the continuous enrichment of the methodological palette of 4th grade mathematics teachers is key to increasing student engagement and their motivation to learn. Digital educational tools will never stop developing, and to overcome the deficits in learning "Geometric Figures", the teacher must turn Scratch into his ally.

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