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HOW TO ANALYZE OBJECTS IN THE CONTEXT OF REALISTIC MATHEMATICS EDUCATION (RME) USING SCRATCH PROGRAMMING?

RATU SARAH FAUZIAH ISKANDAR, DARHIM,
JARNAWI AFGANI DAHLAN, AL JUPRI*, EDI SUPRIYADI

Universitas Pendidikan Indonesia, Bandung, Indonesia.
*Corresponding Author: aljupri@upi.edu

Abstract

The objective of this study was to investigate the initial obstacles and learning processes associated with the integration of Scratch programming for mathematics education. This study was accomplished through a case study approach involving three students and one teacher from a middle school in Tangerang, Indonesia. During a sequence of lessons that introduced students to Scratch, data were obtained through interviews and observations. This approach was based on Realistic Mathematics Education (RME) to provide contextual grounding with real-world patterns as tangible examples. The study documented the students' progress and challenges, disclosing substantial benefits and obstacles. The comprehension of mathematical concepts, critical thinking, and creativity is ultimately improved by Scratch, despite the steep initial learning curve, as both the instructor and students observed. The results indicate that effective implementation necessitates a structured introduction and incremental project complexity, with ongoing support from educators being essential. This investigation suggests that Scratch has the potential to enhance the engagement and interactivity of mathematics, thereby cultivating a more profound comprehension and enthusiasm for STEM disciplines. Future research should examine the long-term effects on student performance and the effective integration of Scratch into other subjects to facilitate a comprehensive interdisciplinary learning approach.

Keywords: Number pattern, Numerical literacy, RME, Scratch.

1. Introduction

Scratch has been extensively implemented in educational institutions worldwide, providing students with an introduction to programming concepts and computational reasoning [1]. Scratch has been demonstrated to improve the technological fluency, problem-solving abilities, and logical thinking of learners in studies and as a didactic tool in a variety of educational settings [2-4]. Scratch is a favoured option for introducing programming to young learners, as it is praised for its capacity to captivate students and pique their interest in coding [5, 6]. Scratch's user-friendly interface facilitates the object analysis process for students by representing programmatic constructs as puzzle pieces that fit together based on syntax. Here, this study aimed to explore the initial challenges and learning processes associated with integrating Scratch programming into mathematics education. Mathematics is one of the difficult subjects, making much research has been done to solve this issue [7-11].

This study was done based on Realistic Mathematics Education (RME). The term realistic in RME has meanings including: (i) a real-world environment connected to everyday life, (ii) something that does not exist in reality but can be imagined, and (iii) formal mathematical context contained in mathematics. The three meanings refer to the extent to which the context can be thought of by students who are learning mathematics and situational problems can be raised from everyday problems or abstract things as long as the mathematical problems are meaningful to students [12-15]. Different from other studies, the novelties of this paper were (i) the utilization of the scratch programming language to analyse objects in the context of RME, (ii) learning number patterns about object configurations using scratch, and (iii) use of reproductive context in rabbits to create number pattern questions.

2. Literature Review

Scratch programming has been demonstrated to be effective in the instruction of mathematical concepts and the development of computational thinking in the classroom. Scratch activities have been shown to enhance students' mathematical problem-solving abilities and to develop metacognitive functions in the solution of mathematical-based programming problems [16, 17]. Scratch has been identified as an appropriate approach for offering introductory programming courses and has the potential to improve mathematics learning through programming activities [18, 19]. The initial appearance of the scratch in the online version is shown in Fig. 1.

In many countries, RME has been implemented as an instructional theory to establish a connection between mathematics and real-world scenarios. It was directed toward the development of a learning sequence on number patterns that adhered to the principles of RME [20], rendering this research directly applicable to the instruction of number patterns. Additionally, the RME approach can improve mathematical communication skills, which are essential for teaching number patterns [21]. Figure 2 is a description of the mathematization process in RME learning.

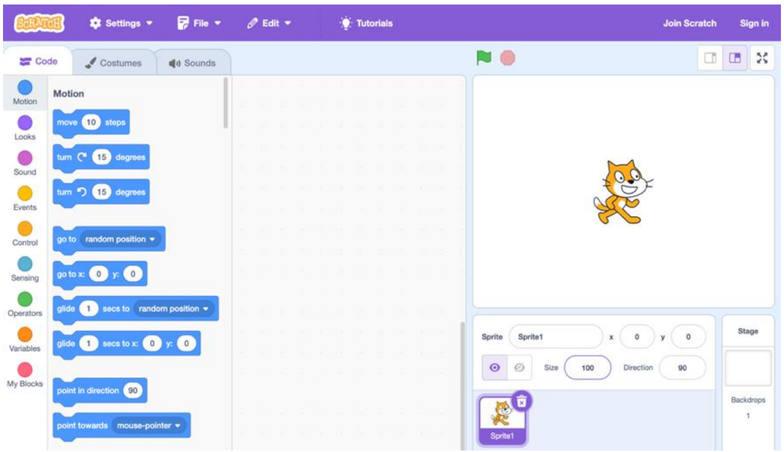

Fig. 1. Initial display of scratch.

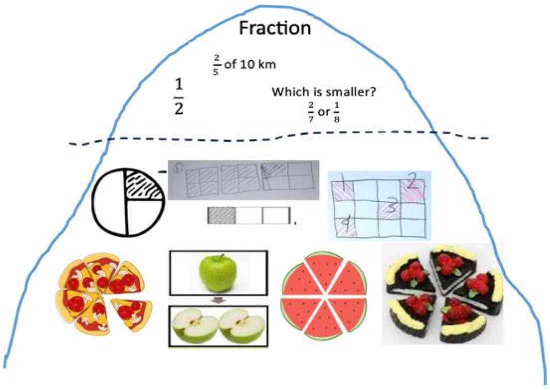

Fig. 2. Mathematization process in RME approach.

3. Method

Three students and one teacher from a middle school in Tangerang, Indonesia, became the focus of this study, which employed a case study methodology. This study sought to investigate the initial obstacles and learning processes that are associated with the integration of Scratch programming into mathematics education. Throughout a sequence of courses, students were initially introduced to Scratch, and the data was gathered through interviews and observations. To establish a contextual foundation, the students were initially instructed using a realistic mathematics education (RME) approach.

4.Results and Discussion

The results of the case studies conducted on three students and a teacher indicated that the initial use of Scratch was challenging for the students. The first task is about shapes. The students were very enthusiastic to acquire this beginning operation skill. The teacher provides instructions on how to utilize this scratch to create a model that includes a collection of scripts. The following are the stages of the algorithm that has been made as shown in Fig. 3.

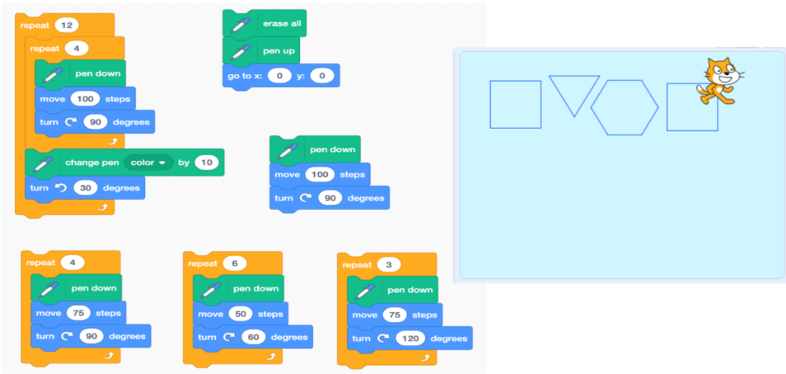

Fig. 3. Algorithm stages.

The first image depicts a quadrilateral shape, while the second image displays a triangle and concludes with a hexagon, as illustrated in Fig. 3. This pattern will persist until the subsequent pattern is produced. Describe the shapes that are present in the tenth pattern. Students are encouraged to do so. Then, students are encouraged to record the shapes that are generated in the tenth row of the pattern in the display. Students are exceedingly enthusiastic about acquiring the ability to operate this startup.

Another explanation of number patterns is illustrated in the birth process of rabbits. At first, there is a pair of rabbits. In the first month, the pair has not produced any offspring. After the second month, the pair will produce a new pair of rabbits. After that, starting from the third month, every month, the pair will produce another pair of rabbits. And so on. The number of rabbit pairs for the first five months is equivalent to Fibonacci numbers 1, 1, 2, 3, 5. Figure 4 shows the reproductive process of rabbits that resembles a Fibonacci sequence.

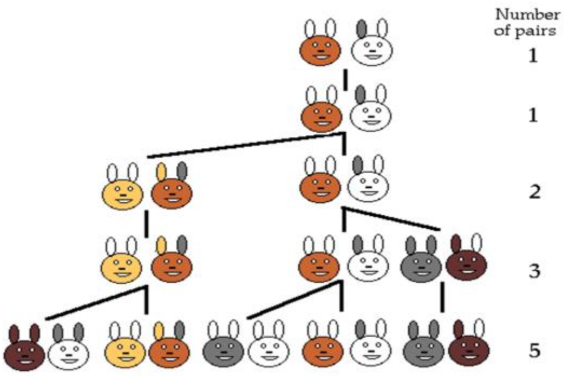

Fig. 4. Reproductive process in rabbits.

The number of rabbit pairings in the subsequent months will constitute the Fibonacci number if this birth pattern persists. The reproduction process in Fig. 4

is shown in the Scratch programming language. The scratch appearance is shown in Fig. 5.

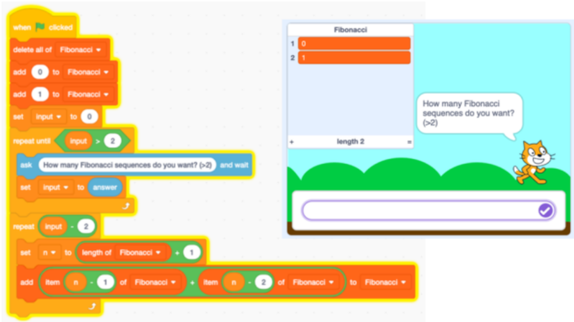

Fig. 5. Algorithm stages.

The interview emphasizes the teacher's initial lack of familiarity with Scratch and their recent rekindled interest in utilizing it to teach mathematics. They believe that Scratch can assist students in acquiring a fundamental understanding of coding by employing interactive projects and games. The educator also recognizes substantial long-term advantages, stating that the acquisition of mathematical knowledge through Scratch cultivates creativity, critical thinking, and problem-solving abilities. Teachers can effectively integrate Scratch into mathematics education by following practical steps, such as beginning with simple projects and gradually increasing complexity, encouraging independent exploration, providing professional development, integrating Scratch into the curriculum, and using formative assessments [22]. These strategies are consistent with the significance of computational thinking skills [23, 24]. Teachers can cultivate a compelling learning environment that improves students' cognitive abilities and mathematical comprehension by employing Scratch [25].

The interviews with three students provide insight into their experiences with Scratch in the context of mathematics education. Initially, they found Scratch to be complex due to the requirement to comprehend a variety of command buttons and memorize codes. Nevertheless, they became more accustomed to its capabilities as a result of the teacher's repeated explanations and practice. They completed projects that involved the Fibonacci sequence and object configurations, and they discovered that Scratch made the learning of coding and arithmetic enjoyable and engaging. Scratch's interactive nature cultivated critical and inventive thinking abilities, rendering it more captivating than conventional methodologies.

Scratch's integration into mathematics education facilitates a fundamental comprehension of coding by offering interactive projects and games that improve students' numeracy abilities. Scratch fosters creativity and structured thinking beyond coding, enabling students to develop critical thinking and problem-solving skills [26]. It provides students with the ability to create an application (learning object), which will be used in teaching [27]. Students discovered Scratch to be engaging in learning coding and arithmetic, which resulted in an improvement in their numeracy abilities, despite the initial challenge. This method is consistent with research that underscores the significance of numeracy literacy skills in both the workforce and daily life [28]. By employing instruments such as Scratch, educators can effectively develop students' numeracy skills, thereby contributing to their overall cognitive development.

Numeracy literacy skills are indispensable for students to improve their comprehension of arithmetic and coding by employing tools such as Scratch. By participating in interactive projects and activities, students can cultivate their critical thinking and problem-solving skills, which extend beyond the realm of coding and promote creativity and structured thinking [28]. This method is consistent with the importance of numeracy literacy skills in educational settings and daily life [29]. This study adds new ideas and information, especially in teaching and learning for improving numeracy literacy skills in mathematics, as reported elsewhere [30-32].

5. Conclusion

The integration of Scratch into mathematics education presents substantial advantages and obstacles. The teacher and students observed that Scratch is initially challenging to learn, but it ultimately improves comprehension of mathematical concepts, critical thinking, and creativity. Additionally, the results indicate that effective implementation necessitates a structured introduction and incremental project complexity. Continuous assistance and resources should be offered by educators to facilitate the transition. The implications for education are significant, as Scratch has the potential to enhance the level of engagement and interaction in mathematics, thereby cultivating a more fundamental understanding and interest in STEM subjects. In the future, research should investigate the long-term effects on student performance and the effective integration of Scratch into other subjects, providing a comprehensive approach to interdisciplinary learning.

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