APPLICATION OF BEE-BOT IN FIRST GRADE MATH LESSON

Hristina Hristova
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria, tina_358@mail.bg
Radoslava Topalska
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria, topalska@swu.bg

Abstract: This paper explores the potential of educational robotics, in particular robot Bee-Bot, as an innovative tool for learning subtraction with regrouping at the number 14 in first grade. The theoretical review systematizes empirical research that demonstrates that play activities, number talk, and new technologies promote children's motivation and achievement. Educational robots are seen as a bridge between abstract concepts and concrete action, minimizing cognitive load and making error a natural phase of learning. The lesson developed and implemented includes clearly stated objectives: reinforcing the 14-n algorithm, developing logical thinking and encouraging collaboration. The lesson structure combines a motivational introduction, group work with Bee-Bot, presentation of solutions and reflection on difficulties and lessons learned. Groups of students program the robot to reach the correct answer, which turns the numerical expression into a visual-kinetic task and stimulates dimensional orientation. Observations show a success rate of approximately 20%, but record high engagement, sustained interest and positive emotional attitudes towards mathematics. Basic difficulties related to orienting on the template and constructing an accurate sequence of commands are identified, which outlines guidelines for targeted exercises. The discussion section highlights that Bee-Bot functions as a facilitator for the development of algorithmic thinking, communication skills and effective teamwork at an early age. The robot normalizes the trial-and-error process, encourages creativity, and provides immediate feedback that is rarely achieved through traditional methods. In the long term, the use of Bee-Bot builds a STEAM bridge, preparing students for more complex concepts in programming, engineering, and science. The results provide evidence that the game-technology environment stimulates self-motivation and creates a positive affective climate that fosters the learning of mathematical operations. The observed weaknesses are interpreted as opportunities to plan targeted interventions that gradually lead to increased accuracy and independence of students. Extending the pedagogical toolkit with Bee-Bot allows transforming the classroom into a laboratory for design-thinking and real-world problem solving. The method activates multisensory learning by combining visual, auditory and kinesthetic stimuli, which increases the durability of the acquired knowledge. Evidence confirms that early incorporation of technology and play into mathematics is a strategic move to prepare students for the future demands of a digital society. The study concludes that Bee-Bot significantly contributes to mastering subtraction with regrouping, develops algorithmic and critical thinking, and strengthens collaboration skills. Systematic integration of the robot into the learning process can optimize achievement in the primary stage and build a solid foundation for future STEAM initiatives.
Keywords: Bee-Bot, educational robotics, subtraction with regrouping, algorithmic thinking, STEAM.

1. INTRODUCTION

Many young people stop developing their mathematical skills at a relatively young age. This potentially reduces the number of people with mathematical skills in society and the workforce (Organisation for Economic Co-operation and Development, 2024). It is the recommendation of the Oregon State Department of Education that all students be given the opportunity to master grade level core content (Oregon Department of Education, 2021). Children's early math skills are an important predictor of later math and reading achievement, high school graduation, and college attendance (Mattera, 2024). Engaging children in simple number games or talking about numbers during everyday activities has been found to boost their early math skills ... and innovative tools and specialized programs are proving effective for children facing learning difficulties (Hidayah & Retnawati, 2024).

Viewing mathematical difficulties as a continuum of abilities can help educators implement appropriate, personalized instructional strategies to support both strengths and weaknesses (Karagiannakis et al., 2024). **The fun and tangible approach introducing programming supports the development of both computational thinking and soft skills - communication and collaboration (**Videnovik et al., 2018). **New technology toys, such as simple robots, allow young children to engage in complex mathematical processes at an early age... toys act as catalysts, providing unique opportunities for dynamic movement tasks (**Highfield, 2010).

The application of educational robotics improves cognitive skills and academic achievement, as learning occurs in a more interactive and engaging way, focusing students' interest and attention (Aslanoglou et al., 2025). It is concluded that computational thinking can be developed from the earliest school grades with the help of the Bee-Bot robot (or similar) (Salinas et al., 2024). Overall, robotics, such as Bee-Bot, can be used as a tool to increase student engagement with mathematics while addressing content and processes within the mathematics curriculum (Attard, 2012). Helping your class develop their mental maths in a different way using Bee-Bot. They will need to find the answers to sums obtained by rolling three dice, and then program the Bee-Bot to reach that number (Lydon, 2007). **After the activity, students showed significantly higher learning motivation, and the Bee-Bot activities had a positive impact on all sub-dimensions of the ARCS model - attention, relevance, confidence and satisfaction** (Choi et al., 2024). **Data analysis shows positive attitudes and high continuity toward robotics from both teachers and students; game-based programming experiences with Bee-Bot proved effective in reinforcing task design and assessment mechanisms (**Muñoz et al., 2020).

2. MATERIALS AND METHODS

This paper presents an innovative approach for teaching the mathematical operations of subtraction with regrouping at the number 14, using the educational robot Bee-Bot. Through game activities, students develop mathematical thinking, teamwork skills and initial programming competencies. Educational robots like Bee-Bot are establishing themselves as valuable tools in primary education. They offer the opportunity for students to actively participate in the learning process through play. Their application in mathematics classes motivates children and engages them in problem solving in a fun and effective way.

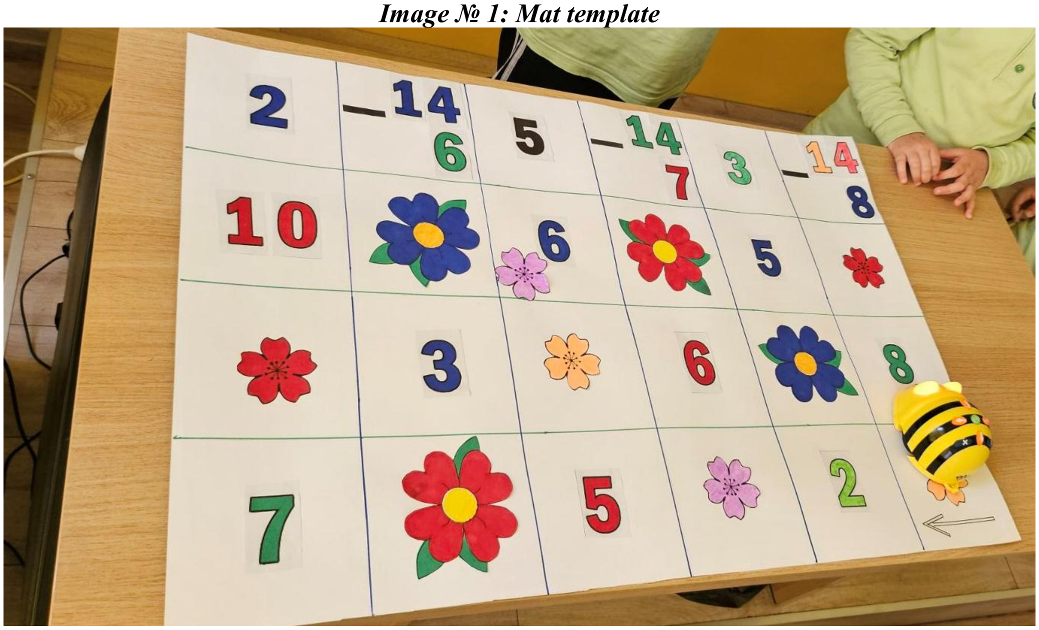
Description of a example lesson in Mathematics for grade 1:

We have formulated the following lesson objectives: to consolidate the ability to subtract a single digit number from 14 by regrouping; to develop logical thinking and planning skills and to encourage teamwork. Solving specific expressions and problems. (After solving the problem (14 - 6), students direct Bee-Bot to the box with the correct result).

Lesson plan:

- ✓ Motivation (5 minutes): introduction of Bee-Bot and a short example on how to use it.
- ✓ Task Explanation (5 minutes): The teacher explains that today they will be practicing a special "subtraction with regrouping" using the Bee-Bot.
- ✓ Group Work (20 minutes): Students work in groups of 3-4 children. Each team solves their problem, enters the commands into the Bee-Bot and sends the robot to the correct square.
- ✓ Solution Presentation (5 minutes): Groups demonstrate Bee-Bot's movement and explain the solution.
- ✓ Summary (5 minutes): Discussion: "What difficulties did we encounter?" and "What did we learn today?"

Image № 1: Mat template



Source: Authors

The lesson opened with an engaging hands-on demonstration of the Bee-Bot robot (Image № 2) alongside the custom grid template that serves as its playing field. To spark curiosity, the teacher first invited the class to observe how the robot’s directional buttons translate into precise forward, backward, left-, and right-turn movements across the colour-coded squares. Building on this specific exploration, students learned to encode a simple journey as a finite sequence of discrete commands, foreshadowing the core principles of algorithm design. The teacher then modelled the process of breaking a larger goal—reaching a target number square—into smaller, ordered steps, highlighting the cause-and-effect relationship between each button press and the robot's subsequent position. Through think-aloud prompts ("If we need Bee-Bot to move two steps forward and then turn right, which buttons and in what order should we press?") learners began to internalise the logic of sequencing, iteration, and debugging. This introductory phase thus served a dual purpose: it familiarised pupils with the tactile interface of Bee-Bot while simultaneously scaffolding their transition from intuitive trial-and-error to deliberate algorithmic reasoning.

Image № 2: Presentation of the robot Bee-Bot

Source: Authors

Group work: During the collaborative phase, the class was strategically organised into heterogeneous teams of four so that each group included at least one mathematically stronger pupil who could act as a peer mentor. This deliberate composition fostered a supportive micro-environment in which knowledge flowed laterally as well as vertically from teacher to student. At the outset every team received an individual challenge card displaying a subtraction expression within the target family of 14 – n (Image № 3).
Members were encouraged first to discuss solution strategies aloud—using manipulatives, number lines, or mental decomposition—until they collectively agreed on the correct difference. Once consensus on the numeric answer was reached, the cognitive focus shifted from arithmetic to computational thinking. Learners converted the abstract result into a concrete navigation goal by locating the corresponding square on the Bee-Bot grid.
They then co-constructed an action plan, sequencing directional commands that would guide the robot from its start position to the target cell. Typical conversations revolved around decomposing the path into successive moves, predicting the robot's orientation after each turn, and iteratively refining the sequence to remove redundancies—an authentic introduction to the debugging cycle.

Image № 3: Group work of students

Source: Authors

Reflection: the lesson ended with a short discussion. Students shared what they found difficult, how they coped in their teams and what new things they learned.
Achieved results: increased engagement and interest in the learning process; initial formation of algorithmic thinking skills; improvement of communication skills and cooperation; success rate in the tasks was about 20%, but students showed high motivation and willingness to participate.
Difficulties observed: difficulties in orientation in space; inaccuracies in drawing up algorithms; lack of confidence in independent decision-making.
Suggestions for improvement: Incorporate pre-orientation exercises; Use more clearly labeled templates; Reuse Bee-Bot in other lessons to reinforce knowledge; Individual demonstrations to the class to reinforce correct programming.
The use of Bee-Bot as a tool in the primary stage is justified by the need for learning through action and play. The robot combines technology, logic and teamwork in one activity, making the learning process more engaging and effective for first grade students. The method develops key competencies and prepares children for future STEAM activities.

3. DISCUSSION

This lesson demonstrates that integrating Bee-Bot into mathematics education combines several key benefits:

- ✓ Active learning through play - students solved problems and immediately saw the “live” execution of the algorithm, which kept their attention and reduced the fear of making mistakes.
- ✓ Development of algorithmic thinking - turning the arithmetic operation 14 - n into a sequence of commands made the abstract process tangible and logically connected.
- ✓ Social learning - group work encouraged each other’s help, reasoning about decisions and role rotation (programmer, checker, “navigator”).

- ✓ Challenges - the most common difficulties were orientation on the pad and constructing the right command sequence. However, high motivation indicated that with additional practice these barriers were surmountable.
- ✓ Early formation of STEAM competencies - children connected math to technology, and experiences with collaboration and presentation also supported soft skills.

4. CONCLUSION

The application of the Bee-Bot in teaching subtraction with regrouping demonstrates significant potential not only to facilitate mastery of a particular arithmetic skill, but also to activate a whole ecosystem of cognitive and social processes. The robot created a natural context in which children "translate" a numerical expression - such as 14 - n - into a planned sequence of movements, building strong connections between abstract mathematical rules and their real-world application. This transformation from symbol to action reduces cognitive load, supports motor-sensory learning, and enhances long-term memorization.

In addition to the purely mathematical benefits, the lesson showed that educational robotics acts as a catalyst for the development of algorithmic thinking, communication and cooperative skills - skills that are embedded in the European Key Competences Framework and in the national digital literacy standards. The high motivation recorded even in partially successful solving is an indicator that the game-technology environment stimulates built-in motivation and sustained participation, factors that traditional frontal methods struggle to achieve. The observed difficulties (spatial orientation, algorithm planning) actually mark key areas for further development; regular incorporation of Bee-Bot and gradual complexification of tasks can turn these weaknesses into targeted learning goals.

Eventually, the integration of such robots into the elementary curriculum creates a STEAM bridge - a smooth transition from early math to more complex concepts in programming, engineering and science. Students gain positive experience with shared problem solving, error is normalized as a step toward a solution, and the classroom becomes a laboratory where every movement of the robot is an experiment with immediate feedback. Combining the Bee-Bot with a well-thought-out pedagogical framework not only improves basic mathematical operations, but also builds students' valuable 21st century skills - creativity, critical thinking and effective collaboration. This makes the approach sustainable and strategically significant for future STEAM initiatives in primary education.

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