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Assessing Teachers' Perspectives about the Use of Educational Robotics in Mathematics Instruction

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Abstract

Background/purpose. Rapid developments in educational technology have led to the emergence of educational robots that serve as interactive tools aimed at enhancing active learning and stimulating students' thinking and problem-solving skills. The study aimed to evaluate teachers' perspectives on the use of educational robots in teaching mathematics. Specifically, the study sought to assess teachers' acceptance of this technology and their perceptions of its effectiveness, as well as to identify the key benefits and challenges they encounter in its application.

Materials/methods. This study employed a quantitative approach, utilizing an attitude questionnaire as the primary data collection tool. The questionnaire was administered to a sample of 75 primary school mathematics teachers.

Results. The findings indicated that teachers perceive educational robots as effective tools for enhancing students' motivation to learn mathematics and for developing their problem-solving skills. However, the results also revealed that teachers face various obstacles in integrating robots into math lessons.

Conclusion. The study offers several recommendations, including the provision of specialized training programs, enhancement of technical infrastructure, and strengthening of institutional support for teachers. These interventions could advance mathematics education and improve students' academic outcomes.

1. Introduction

Since the advent of the technological revolution in our contemporary world, life has witnessed significant and astonishing changes across all areas of society. The education field has taken the lion's share of these positive changes, with the use of new models having a significant impact and overcoming traditional methods, which relied heavily on rote learning and indoctrination. Studies and research (Majadly et al., 2024) have shown that traditional methods are less attractive and useful in comparison with digital and technological world that has provided us with applications and devices that support new horizons, embodying the concept of student-centered learning, which has become increasingly prevalent in our current era (Kandlhofer & Steinbauer, 2018; Hamad et al., 2025).

Educational technology has gained more interest and attention among teachers and researchers in recent years, hopefully improving students' motivation and educational outcomes. The rapid development of robotics (and artificial intelligence) has led to a significant increase in the use of robots to perform many tasks in education. Many countries have sought to invest in this field by developing research and development capabilities, as robotics is considered a fundamental and primary approach to teaching the basics and principles of design, programming, implementation, and research. They have also worked to create an educational environment that encourages manual work and enhances communication, role exchange, and decision-making. Robotics also relies on the integration of various sciences to acquire knowledge and design fundamentals, in addition to electronics and mechanical engineering. Whether used as an educational curriculum within specific objectives and plans, or as an extracurricular educational activity given after school hours or during classroom activities and competitions, it relies on project foundations, hypotheses, and their evaluation, followed by solving difficult problems that require higher-order thinking skills. Robotics has dominated many fields and disciplines, and the standard and evidence of a country's industrial strength is measured by the level of development of its robots (Elkin, Sullivan & Berss, 2014).

Several studies (Mubin et al., 2018; Hammouri & Abu-Shanab, 2018) have shown that educational technology can be more effective for students at the primary school level and can significantly support learning in science and mathematics. In this context, robotics is a fertile and interesting educational environment for STEM (Science, Technology, Engineering, and Mathematics) education. Robotics could enhance learners' higher-order thinking skills and increase students' motivation for exploration, understanding, and achievement (Barak & Assal, 2018). Therefore, educational robotics could help science teachers explain scientific concepts through inquiry and discovery-based modules, enabling learners to connect scientific and mathematical concepts and focus on engineering design (Plauska & Damasevicius, 2014).

Educational robotics is defined as a set of tools and programs that aim to create a competitive and stimulating environment by fostering an innovative generation that controls various computer materials and designs. An educational robot incorporates the fundamentals and programming mechanisms to perform multiple tasks (Jarwan & Al-Duwaik, 2016). A robot is also defined as a tool having mechanical properties that performs various tasks. It is programmed by connecting it to computers. Robots explore their surroundings using sensors, thereby exhibiting the desired behavior and movement, reflecting the machine's intelligence and making it unique. The importance of robotics and its use in education stems from the constructivist approach, also known as constructivist theory. Students utilize information and prior knowledge, influenced by their surrounding environment, as well as society, language, and other factors. Each student has a unique ability to apply this knowledge and design and program a robot in a way that aligns with their ideas and creativity in applying knowledge to real-world situations (Atmatzidou & Demetriadis, 2016; Nusairat et al., 2023). To emphasize, effective implementation of educational robotics depends not solely on knowledge transmission but on mechanisms that enable knowledge integration, real-world application, and problem-solving engagement (Alimisis, 2013).

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Although educational robotics has high potential to support learning, its real implementation in educational process remains limited due to several factors, among them relates to the extent to which teachers accept it, evaluate its effectiveness, and recognize how face obstacles accompanied to implementation. Therefore, this study aims to assess teachers' perspectives on the effectiveness and use of educational robots in mathematics teaching by analyzing teachers' level of acceptance, identifying the most prominent benefits and challenges associated with the use of robotics. For this purpose, the current research aims to delve deeper into the use of robotics in teaching mathematics in the Palestinian Arab community in Israel. It examines teachers' viewpoints on the effects of educational robotics on students' motivation and the acquisition of problem-solving skills. Teachers' difficulties and challenges in employing educational robotics are also addressed.

The theoretical significance of the study lies in its contribution to enriching the educational literature on integrating robotics into mathematics teaching, specifically the use of educational robots. This field of research is relatively new and requires in-depth studies. The results of this study could also help clarify teachers' attitudes and their training and technical needs, thereby contributing to the development of professional qualification programs and to the effective use of educational robots in classrooms, thereby improving the quality of mathematics teaching.

2. Literature Review

2.1. STEM – Interdisciplinary Education Approach

The concept of STEM (Science, Technology, Engineering, and Mathematics) expresses a multidisciplinary teaching approach. Many researchers (Awad , 2021; Mansour & EL-Deghaidy, 2021) assert that the importance of STEM lies in combining the learning of two or more subjects in order to foster conceptual understanding. Integrative STEM provides students with opportunities to acquire academic concepts alongside appropriate real-world applications, thereby helping learners internalize these concepts in life contexts. In this context, robotics could be an effective learning environment for STEM education (Barak & Assal, 2018). In addition, robotics could promote problem-based learning and stimulate higher-order thinking skills, such as critical and creative thinking, rather than relying on memorization and indoctrination. Educational robotics could provide students with opportunities to examine and check technology through designing and programming, so that it is not only about learning how technology works but also about the endeavor to integrate technology with other disciplines (Eguchi, 2014; Ghaith et al., 2023).

2.2. Educational Robotics

The term "educational robotics" refers to a field of study that aims at enhancing students' learning experiences through the creation and implementation of robot-related activities and technologies. These activities can take the form of interventions, after-school activities, or entire courses focused on robotics (Gubenko & Houssemand, 2021). Educational robotics activities typically involve a toolkit through which students learn to build and program robots for specific tasks (Jung & Won, 2018). The idea of employing educational robots stems from several theoretical foundations, the most prominent of which is constructivist theory, which provides an approach to fostering creativity in the school context (Danahy et al., 2014). Robots can be used at educational levels from the early grades through graduate studies (Gubenko et al., 2021).

A wide range of skills can be developed in students through the use of educational robots, including thinking, observation, estimation, calculation, problem-solving, teamwork, and social interaction skills. Educational robots also provide valuable opportunities for students to engage with diverse content areas such as physics, chemistry, biology, geography, electronics, and mechanical engineering. In addition, it enhances the development of academic skills such as writing, research, reading, creativity, decision-making, and communication. Moreover, educational robots are powerful teaching tools because they help create an enjoyable learning environment for students, and particularly support learning that is based on exploring the real world (Eguchi, 2014).

2.3. Problem and Project-based Learning

Barak and Assal (2018) define problems as small, open-ended, limited tasks in which students may use different solutions and reach different outcomes. The problem may be a question, an arithmetic issue, or even the design of an experiment or the learning of a new skill. Whatever the problem, it creates a state of cognitive, psychological, or social imbalance for learners and requires them to develop problem-solving skills (Al-Zaboun, 2018). In this context, projects are considered sets of difficult, complex tasks in which the problem is unclear, and students are engaged in determining their features, objectives, obstacles, and the appropriate solution. Therefore, many researchers recognize the importance of guidance and accompaniment in the learning process through projects. Several studies have confirmed that robotics promotes project-based learning (PBL) approach, such as designing a car or a robotic arm (Al-Khalidi & Al-Wareikat, 2013). Robotics could be an effective way to develop problem-solving skills, as students encounter problems, consider how to tackle them, and design solutions (Al-Zahrani, 2014; Al-Aqeel, 2014).

2.4. Robotics in Teaching and Learning

Robotics is known as an educational and technological platform to integrate subjects. The use of robotics prepares students for emerging, innovative technological changes, which, in turn, nurtures them to become active creators rather than just consumers of products in the future (Eguchi, 2014). Students participating in robotics projects might demonstrate greater problem-solving ability and greater integration of mathematics, science, and engineering (Al-Aqeel & Al-Shammari, 2015). In addition, the use of robotics in education could help develop communication skills and sense of responsibility. It enhances students' self-confidence, increases their interest in scientific research, and develops their thinking skills. In addition, it helps teachers implement enjoyable student-centered learning, making the educational process more effective (Al-Khalidi & Al-Warekat, 2013).

2.5. The Role of Robotics in Promoting Students' Motivation

Teaching is considered a challenging task. In addressing this challenge, educators must adjust their teaching strategies, revise their learning activities, and choose activities and teaching methods that capture students' attention and increase their enthusiasm and desire to study. According to Al-Aqeel (2014), robotics increases students' motivation to learn mathematics and could also help address the problem of low achievement in the subject. Lopez-Caudana et al. (2020) claim that students who engage with robotics through authentic projects can acquire diverse mathematical skills and concepts and then apply them to real-world, practical projects. Furthermore, many studies indicate a positive impact of educational robotics on students' achievements in mathematics (Al-Nafî, 2017; Julià & Antolí, 2016; Brown & Howard, 2014). Abu Baker et al. (2020) state that robotics integration could improve mathematical achievement when applied to the concept of active learning, which involves collaborative metacognitive activities. However, other studies (Zhong & Xia, 2020; Walker, Girotto, Kim & Muldner, 2016; Lindh & Holgersson, 2007; Nusairat et al., 2024) report that no significant improvement was found in students' mathematical learning.

2.6. Difficulties in Using Robotics in Mathematics Teaching

Despite the expected benefits and capabilities of robotics in achieving various educational goals, both teachers and students may face limitations and difficulties when using robotics in the classroom. One difficulty pertains to robotics itself as a complex machine that comprises software, electronics, and control systems. Another difficulty arises from the fact that mathematics and physics are relatively complex subjects; hence, robotics intervention, especially with young students, could fail due to a lack of or mismatch in relevant knowledge in these subjects. For example, Barak and Assal

(2018) assert that a fourth-grade student who lacks prior knowledge of the circumference of a circle (because the robot's movements, due to its tires, are sometimes circular) could face difficulties participating in or implementing robotics activities.

Furthermore, programming, as a computational thinking skill that constitutes a central part of robotics processes, is also considered arduous. Many studies have shown that robotics programming is the most difficult part for students in robotics projects. Teachers also find it difficult to program, as many are not sufficiently qualified (Al-Hadabi & Al-Jajji, 2011). In addition, Omrani (2013) identified several obstacles and technical challenges, including the cost of learning materials and the lack of appropriate educational programs, which, in turn, could lead to teachers' lack of mastery and negative attitudes towards technology. Safar (2012) summarized the obstacles to integrating robotics as follows: high costs, insufficient practical training to teach the curriculum, large class sizes and high student density, teachers who are unconvinced they can teach the curriculum, and the need for ample time for preparation and planning.

Based on the literature review, the following hypotheses are formulated (from teachers' perspectives):

1. A positive relationship exists between the use of robotics and students' motivation to learn mathematics.

2. A positive relationship exists between the use of robotics and students' acquisition of problem-solving skills.

3. A positive relationship exists between the use of robotics and the difficulties that teachers and students face.

3. Methodology

This research employed a quantitative, descriptive, cross-sectional survey to measure teachers' perspectives on the use of educational robotics in mathematics instruction. The cross-sectional design was used to capture teachers' current attitudes and perceptions at a specific point after they had participated in professional development training. Teachers' perspectives about the effectiveness of educational robotics in enhancing students' motivation and problem-solving skills were assessed. In addition, barriers and challenges in the application were explored.

3.1. Participants

The study sample comprised 75 out of 90 Arab primary school teachers (in Israel) who participated in a 30-hour professional development course about using educational robotics in mathematics. The course was organized by two teacher education colleges and was provided in two cohorts during the years 2023-2024. All of the participants were in-service mathematics teachers living in Israel's northern district. Table 1 presents the demographic distribution of the study participants. Most participants completed the questionnaire at the end of the course in each cohort; others completed it after being contacted via e-mail. Two email reminders were sent to participants to encourage them to complete the questionnaire, which was voluntary. To note, some of the teachers who completed the course started a pilot implementation in a school, offered as an extracurricular (informal) program. Appendix 1 presents the main topics covered by the teachers.

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Table 1. Demographic profile

Study Variables	Number	Category	Percentage
Gender	41	Male	54.7
	34	Female	45.3
Experience	64	Less than 10 years	85.3
	11	10 years or more	14.7
Academic	55	Bachelor's degree	73.3
Qualification	20	Postgraduate studies	26.7
Total	75		100.0%

3.2. Data Collection Tools

The questionnaire aims to examine teachers' views on the use of educational robotics in teaching mathematics to primary school students in Arab schools in Israel. The questionnaire categories were built based on the studies of Castledine and Vhalmers (2011) and Barak and Assal (2018). Changes and adjustments were also made to the original items to adapt them to the current study. The final questionnaire included 23 Likert-scale items rated from 1 (strongly disagree) to 5 (strongly agree), organized into three key categories: Students' motivation to learn (9 items), Problem-solving skills (8 items), and Challenges (6 items). Sample items from each category include: "Students are keen to participate in math lessons that integrate educational robots" (motivation), "Integrating robotics into mathematics teaching enhances students' ways of thinking around a problem" (problem-solving skills), and "Teachers have a deficiency in the skills necessary to use educational robots within classrooms" (challenges).

Following the adaptation of the questionnaire items, the internal consistency reliability was examined using Cronbach's alpha. The reliability coefficients were as follows: Student motivation (α=0.89), Problem-solving skills (α=0.85), Challenges (α=0.82). Alpha Cronbach for the total questionnaire was α=0.91. All the scales showed a high degree of internal consistency (α>0.70) and therefore provide evidence of the reliability of the adapted questionnaire.

4. Data Analysis and Findings

To answer the research questions, data were processed in SPSS/V23, extracting averages, standard deviations, and ranks. To analyze the results and evaluate the values of the arithmetic means, the standard values for judgment were adopted according to the following equation:

(Lower limit of alternatives - Upper limit of alternatives) / (Number of levels) 1.33 = (1-5)/3

The standard values for judging the arithmetic means of responses from the sample individuals in the study tool appear in Table 2.

Table 2. Standard values for interpreting the response means

Mean	Level
1.00 – 1.33	Low
1.34 – 3.67	Moderate
3.68 – 5.00	High

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In addition, the independent t-test was used to verify the results. Each category average was compared with the mid-scale value (3.00) to examine whether the calculated average is neutral or significantly higher (or lower).

Below, we examine the main hypotheses that guided the current study.

H1: Students' motivation to learn mathematics using robotics.

To assess teachers' perspectives on students' motivation in math lessons (robotics-integrated), arithmetic means, standard deviations, ranks, and levels of effectiveness were calculated for all items related to the role of educational robots in enhancing student motivation. Table 3 illustrates these findings.

Table 3. Means, SDs, ranks, and levels of effectiveness of educational robots related to students' motivation

Item No.	Item	Mean	SD	Rank	Level of Effectiveness
4	Students are keen to participate in math lessons that integrate educational robots.	4.41	0.68	1	High
7	Students enjoy studying mathematics with robotics.	4.28	0.83	2	High
1	Educational robots make students more enthusiastic in math classes.	4.27	0.92	3	High
2	Educational robots help students better understand study materials.	4.25	0.97	4	High
5	Educational robots enable students to develop new skills, thereby enhancing their motivation to learn.	4.17	0.89	5	High
8	Students try their best to answer the questions posed by the teacher.	4.16	0.94	6	High
9	Students are always eager to participate in solving higher-level math questions.	4.07	0.98	7	High
3	Students are willing to continue studying mathematics even when they encounter difficulties.	3.83	1.04	8	High
6	Students are keen to complete all their math homework related to robot use.	3.79	1.12	9	High
	Overall Arithmetic Mean	**4.14**	**0.75**		**High**

Table 3 shows that the means for all items ranged between 3.79 and 4.41, all at a high level (overall arithmetic mean: avg=4.14, SD=0.75). The highest-scoring item (M=4.41) shows that teachers perceive students to be very actively involved when robots are integrated into the lessons. Even the least highly rated item (completing homework, M=3.79) still shows a strong agreement. These results indicate that teachers have strong opinions about robots as educational resources that could greatly inspire students to engage in and be enthusiastic about mathematics learning. In other words, these results indicate the significant effectiveness of educational robots in enhancing student motivation towards learning.

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To verify the previous results, the average score was compared with the neutral mid-scale value (3.00) using the one-sample t-test. Table 4 presents the findings.

Table 4. One-sample t-test on the effectiveness of educational robots in enhancing student motivation

	Test Value = 3				
	Mean	SD	df	t	Sig
The effectiveness of educational robots in enhancing student motivation towards learning	4.14	0.75	1.136	13.102	0.000

Table 4 shows statistically significant differences (t=13.102, sig=0.000) between the category average score (4.14) and the mid-scale value (3.00). Hence, hypothesis 1 is confirmed.

H2: Teachers' perspectives about students' problem-solving skills.

Arithmetic means, standard deviations, ranks, and levels of effectiveness were calculated for all items related to the role of educational robots in enhancing students' problem-solving skills, as presented in Table 5.

Table 5. Means, SDs, ranks, and effectiveness levels of educational robots related to problem-solving skills

Item No	Item	Mean	SD	Rank	Level of Effectiveness
11	Educational robots enhance students' ability to design steps for problem-solving.	4.36	0.85	1	High
10	Educational robots help students think logically while solving problems.	3.89	1.19	2	High
16	Educational robots facilitate students' understanding of the steps for solving complex problems through practical interaction.	3.71	1.30	3	High
14	Educational robots enhance students' ability to examine problems and search for appropriate solutions.	3.69	1.07	4	High
17	Educational robots engage students in making appropriate decisions when solving problems.	3.60	1.07	5	Moderate
12	Educational robots develop students' skills in exploring alternative solutions to mathematical problems.	3.59	1.26	6	Moderate

15	Educational robots provide a learning environment that encourages teamwork in problem-solving processes.	3.51	1.41	7	Moderate
13	Educational robots help students link theoretical concepts to practical applications when solving problems.	3.42	1.08	8	Moderate
	Overall Arithmetic Mean	**3.72**	**0.59**		**High**

Table 5 shows that the arithmetic means for the items ranged between 3.42 and 4.36, with levels ranging from moderate to high. Although the overall level regarding the effectiveness of educational robots in enhancing students' problem-solving skills is high (overall arithmetic mean: avg=3.72, SD=0.59), we notice that the results are mixed; some problem-solving skills are easier to develop with robots than others. For example, teachers strongly agree that robots teach students how to break down problems into steps (M=4.36); however, they are less sure about robots helping students connect math concepts to real-life situations (M=3.42).

To verify the results, the average scores were compared with the neutral mid-scale value (3.00) using the one-sample t-test. Table 6 presents the findings.

Table 6. One-sample t-test on the effectiveness of educational robots in enhancing problem-solving skills

	Test Value = 3				
	Mean	SD	df	t	Sig
The effectiveness of educational robots in enhancing students' problem-solving skills	3.72	0.57	0.718	8.039	0.000

Table 6 shows a statistically significant difference (t=8.039, sig=0.000) between the category average score (3.72) and the mid-scale value (3.00). Therefore, hypothesis 2 is confirmed.

H3: Teachers' perspectives about difficulties in using robotics in mathematics.

To address this aspect, we calculated the arithmetic means, standard deviations, ranks, and levels of estimation for the items related to the obstacles that math teachers face when employing educational robots. Findings are presented in Table 7.

Table 7. One-sample t-test, means, SDs, ranks, and levels of effectiveness of obstacles faced by math teachers in using educational robots (descending order)

Item No	Item	Mean	SD	Rank	Level of Effectiveness
19	Lack of teacher training in using educational robots hinders their investment and employment in the educational process.	3.69	1.07	2	High
20	Teachers have a deficiency in the skills necessary to use educational robots within classrooms.	3.66	1.12	3	Moderate
18	There is a shortage of availability of devices and educational robots in schools.	3.37	1.18	1	Moderate

21	The high cost of acquiring educational robots prevents them from being adequately available in schools.	3.23	1.02	4	Moderate
23	Schools lack the appropriate technical infrastructure to support the use of educational robots.	3.18	1.15	6	Moderate
22	Students encounter difficulties in utilizing educational robots due to their lack of basic technical skills.	3.11	1.37	5	Moderate
	Overall Arithmetic Mean	**3.37**	**0.84**		**Moderate**

Table 7 shows that teachers face moderate challenges when using robots in math classes (M=3.37; SD=0.84). The greatest problem is a lack of training; teachers don't feel prepared enough to use robots effectively (M=3.69). Teachers also worry that they lack sufficient technical skills (M=3.66). Other challenges include not having enough robot devices in schools (M=3.37) and high costs (M=3.23). Students having difficulty with technology is the least concerning problem (M=3.11). To verify the results, the average scores were compared with the estimated neutral mid-scale value (3.00) using the one-sample t-test. Table 8 presents the findings.

Table 8. One-sample t-test results on obstacles faced by math teachers in using educational robots

	Test Value = 3				
	Mean	SD	Df	T	Sig
Level of barriers faced by mathematics teachers when employing educational robots	3.37	0.84	0.373	3.498	0.001

Table 8 shows statistically significant differences (t=3.498, sig=0.000) between the category average score (3.72) and the mid-scale value (3.00). Hypothesis 3 is confirmed.

5. Discussion

This study aimed to evaluate teachers' perspectives on the use of educational robotics in mathematics instruction. The findings showed that there are positive effects of using educational robotics in mathematics on students' motivation towards learning. These findings agree with previous studies (Selcuk et al., 2024; Al-Ajlouni & Jaradat, 2023; Chen et al., 2023; Cam & Kiyici, 2022; Al-Aqeel, 2014), which indicate that robotics could engage learners and create an effective learning environment that arouses students' interest and fosters their desire to learn.

Based on questionnaire findings, the teachers pointed out noticeable students' enjoyment, enthusiasm, and active participation as a result of the robot's integration into math lessons. Several factors could explain this positive effect of integrating robots on students' motivation, mainly practical vs theoretical teaching-learning, and individual vs collective learning. Researchers (Cakiroglu & Yildirim, 2024) assert that bringing a robot to math class and engaging students in robotic activities assists in demonstrating mathematical thinking within mathematical contexts (instead of keeping it only theoretical or abstract). Hence, the ability to make mathematics more practical and applicable could draw students to the learning processes. In addition, other researchers (Ardito, Mosley & Scollins, 2014; Caballero-Gonzalez, Muñoz-Repiso & García-Holgado, 2019) emphasize robotics teamwork in which a group of students usually collaborates and examines different solutions

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together, and the central role this plays in drawing students to the learning process while developing their social skills.

Moreover, the study indicated to teachers' positive viewpoints regarding the effect of using educational robotics in learning mathematics on students' acquisition of problem-solving skills. In other words, findings show that teachers evaluated robotics as a platform that could engage learners in solving problems and assist them in developing higher-order thinking skills. Actually, the teachers expressed a high level of agreement with questionnaire items that highlighted different cognitive skills needed for students during robotics integration in math lessons. For example, the need to analyze the situation, define clear steps to reach a solution, examine different alternatives, and engage in trial-and-error processes. These skills could actually enhance and cultivate students' ability to think and design a systematic solution (Ching & Hsu, 2024). These results are also in agreement with other studies (Taha et al., 2023; Al-Aqeel, 2014). However, it is noticeable that findings about problem-solving were the lowest in comparison to other variables investigated. This insight is in line with other studies (Durak et al., 2019; Soza et.al., 2018; Al-Khalidi & Al-Shammari, 2013), which, on the one hand, assert the important role of robotics in cultivating students' problem-solving skills and fostering innovative ideas, but on the other hand, point out real challenges in achieving or accomplishing these goals. To avoid this gap, in the current study, we designed and prepared the learning tasks in advance, before conducting the research in the field. Nevertheless, the averages of several items were relatively low, for example, item 13: Educational robots help students link theoretical concepts to practical applications when solving problems. Hence, Barak and Assal (2018) emphasize that robotics could provide a rich and attractive learning environment for STEM education only when careful design of the class, especially students' assignments, is ensured. Atmatzidou et al. (2018) also call for the development of suitable tasks to support the gradual development of students' problem-solving skills.

Finally, the study also showed that teachers and students still face several obstacles and challenges during the integration of robotics into math lessons. These challenges are consistent with the findings of several studies (Abu Bakar & Ismail, 2022; Tuna & Tuna, 2019) that highlight technological and pedagogical difficulties. Although one may think that challenges of robotics integration in common relate to technical obstacles, the current study shows that pedagogical difficulties are of high priority, for example, a lack of appropriate educational programs and insufficient mastery of teachers' knowledge on how to integrate technology. These findings align with those of Al-Hadabi and Al-Jajji (2011) and Omrani (2013), who highlight similar challenges. Safar (2012) also indicates that obstacles to integrating robotics relate mainly to insufficient practical teacher training, before considering the high costs of the required instruments.

6. Conclusion

This study examined teachers' perspectives on the effects of integrating educational robotics into mathematics on students' motivation to learn and the acquisition of problem-solving skills. In addition, it explored difficulties that teachers and students may face. The findings indicated that teachers perceive robotics integration as a mechanism that could enhance students' learning motivation and promote their problem-solving skills. The results highlighted the importance of preparing and designing a suitable learning activity in order to develop students' competencies during robotics integration. Furthermore, teachers reported significant difficulties that could hinder robotics integration. Hence, teachers' prior awareness of these challenges, coupled with the integration of robotics into the daily educational process, could help address and overcome these difficulties. This study, as expressed in the teachers' perspectives, has really challenged the perspective that the role of mathematics in integrated STEM is limited to supporting calculation and representation.

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7. Suggestions

The need to investigate teachers' viewpoints stems from the gap between the theoretical potential of educational robotics and its limited real-world implementation. Teachers' perspectives serve as a critical lens for understanding and promoting the practical realities of robotics integration. However, future research should directly assess students' motivation levels using pre- and post-assessments and behavioral observations. In addition, studies should employ standardized assessments and real-time problem-solving protocols to measure students' acquisition of problem-solving skills. Moreover, research should examine implementation challenges by investigating specific barriers through classroom observations and detailed case studies, and by examining how factors such as inadequate teacher training, insufficient technical infrastructure, and high costs manifest in actual classroom environments. Studies that track both student outcomes and implementation barriers across multiple academic years could provide crucial insights into the sustainability and long-term effectiveness of robotics-enhanced mathematics instruction.

Declarations

Conflicts of Interest. There is no conflict of interest.

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Appendix I.

Intervention program for 10 lessons (3 hours each).

<table>
<tr><th>No.</th><th>Contact</th><th>Aims</th><th>21st Century Skills</th></tr>
<tr><td>1</td><td>Straight line</td><td>To familiarize the student with the robot's sensors:
- the student concludes the function of each sensor
- the student builds programming sentences to move the robot using the Scratch X program
- the student employs experience in practical life</td><td rowspan="10">• Basic computer skills, Microsoft Word
• Internet skills
• Scratch
• +Ev3
• Thinking skills – guided discovery
• Using a modern educational tool, the robot, in systematic learning
• Interpersonal skills, cooperative learning in a small group
• Developing students' self-learning skills – SRL</td></tr>
<tr><td>2</td><td>Scale-sided triangle</td><td rowspan="3">1. The student learns about the triangle in his own language.
2. The student measures the lengths of the sides and angles.
3. The student adopts the robot model according to the instructions.
4. The student programs the robot to follow paths in the form of various triangles.
5. The thrill of learning geometry to take advantage of it in everyday life.
6. Developing learning strategies through computer technology and the Internet.</td></tr>
<tr><td>3</td><td>Isosceles triangle</td></tr>
<tr><td>4</td><td>Equilateral triangle</td></tr>
<tr><td>5</td><td>Parallelogram</td><td rowspan="4">1. The student learns about the quadrilateral.
2. The student deduces the properties of the quadrilateral.
3. The student adopts the robot model according to the instructions.
4. The student programs the robot to follow a quadrilateral trajectory.
5. The thrill of learning geometry to take advantage of it in everyday life.
6. Developing learning strategies through computer technology and the Internet.</td></tr>
<tr><td>6</td><td>Rectangle</td></tr>
<tr><td>7</td><td>Rhombus</td></tr>
<tr><td>8</td><td>Square</td></tr>
<tr><td>9</td><td>Containment relationships in quadrilaterals</td><td rowspan="2">1. The student deduces the relationship between the quadrilaterals.
2. The student adopts the robot model according to the instructions.
3. The student programs the robot to follow a quadrilateral trajectory.
4. The thrill of learning geometry to take advantage of it in everyday life.
5. Developing learning strategies through computer technology and the Internet.</td></tr>
<tr><td>10</td><td>Containment relationships in quadrilaterals</td></tr>
</table>

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