Teachers' Opinions on Integrating AI-powered Robotics in STEM Education for Elementary Learners in Lebanon

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Abstract:

Attracting young learners with necessary skills for future success in the age of quick technological development is a must. This paper of research focuses on the primary school teachers (grades 1-5) in Lebanon and their opinion about the use of AI-powered robotics in STEM (Science, Technology, Engineering and Mathematics) education. A structured questionnaire was used to collect data from 42 elementary teachers from three different private schools in Lebanon about their demographic information, previous engagement with STEM teaching processes, thoughts concerning the benefits of using robot devices as well as challenges faced while fusing them with other subjects. According to the study findings, instructors have positive attitudes towards preparing pupils through machines for tomorrow's jobs; they also feel that critical thinking skills would be improved if these were introduced alongside problem solving methods since this would make lessons more interactive. Teachers acknowledge that AI-powered robots have potential to enhance student interest in STEM subjects, communication skills and teamwork. Nevertheless, professionals tackle some of the concerns regarding the costs, the adjustments in the curriculum and the professional development and training facilities for the integration of the AI-powered robotics. The possible effectiveness of the use of AI-powered robots to encourage student learning and engagement in STEM education is still highlighted in the study even though these disadvantages exist.

Keywords:

Résumé

À une époque marquée par des progrès technologiques rapides, il est impératif de doter les jeunes apprenants de compétences essentielles pour réussir à l'avenir. Cette étude explore les points de vue des éducateurs des écoles élémentaires (grades 1-5) au Liban concernant l'intégration de la robotique alimentée par l'IA dans l'éducation STEM (Science, Technologie, Ingénierie et Mathématiques). À l'aide d'un questionnaire structuré, l'étude recueille des informations sur les antécédents des enseignants, leur participation passée à l'éducation STEM, leurs opinions sur les avantages de la robotique et les difficultés liées à l'intégration de robots alimentés par l'IA. Les résultats révèlent une perception positive parmi les enseignants concernant le rôle de la robotique dans la préparation des étudiants à des carrières futures, l'amélioration de la pensée critique et des compétences en résolution de problèmes et de rendre les sujets STEM plus intéressants. Les enseignants reconnaissent également que les robots alimentés par l'IA ont le potentiel de stimuler l'intérêt des élèves pour les sujets STEM, les compétences en communication et le travail d'équipe. Cependant, la recherche souligne également des préoccupations concernant les conséquences des coûts, les modifications des programmes d'études et la disponibilité d'opportunités de développement professionnel et de formation pour l'intégration de la robotique alimentée par l'IA. L'étude souligne l'efficacité potentielle des robots alimentés par l'IA pour améliorer l'apprentissage et l'engagement des élèves dans l'éducation STEM, malgré ces obstacles.

Mots-clés

Robotique, Éducation STEM, AI, Niveau élémentaire, Opinions des enseignants

مستخلص:

في عصر يتسم بتقدم تكنولوجي سريع، لا بد من ضرورة تزويد المتعلمين الشباب بالمهارات الأساسية للنجاح في المستقبل. يركز هذا المقال على آراء معلمي المدارس الابتدائية (الصفوف من 1 إلى 5) في لبنان حول استخدام الروبوتات التي تعمل بالذكاء الاصطناعي في تعليم العلوم والتكنولوجيا والهندسة والرياضيات (STEM). وباستخدام استبيان محدد ومنظم، تجمع الدراسة معلومات عن خلفيات

معلمي المدارس الابتدائية من مختلف ثلاث مدارس خاصة في لبنان، ومشاركتهم السابقة في تعليم العلوم والتكنولوجيا، وآرائهم بشأن مزايا الروبوتات، والصعوبات التي ينطوي عليها إدماج الروبوتات بتعليم صفوق المرحلة الابتدائية. وتكشف النتائج عن تصور إيجابي لدى المدرسين بشأن دور الروبوتات في إعداد الطلاب لمسيراتهم الوظيفية في المستقبل، وتعزيز التفكير النقدي ومهارات حل المشاكل، وجعل مواضيع العلوم والتكنولوجيا والهندسة والتكنولوجيا أكثر مشاركة. ويدرك المعلمون أيضاً أن الروبوتات التي تعمل بقدرة الذكاء الإصطناعي لديها القدرة على تحسين اهتمام الطلاب بمواضيع العلوم والتكنولوجيا والهندسة والرياضيات ومهارات الاتصال والعمل الجماعي. غير أن الباحثين يسلطون الضوء أيضاً على الآثار المتعلقة بالتكلفة، والتعديلات في المناهج الدراسية، ومدى توافر فرص التطوير المهني والتدريب من أجل إدماج الروبوتات الآلية التي تعمل بالطاقة الذاتية. وتسلط الدراسة الضوء على الفعالية المحتملة للروبوتات التي تعمل بقدرة الذكاء الاصطناعي في تعزيز تعلم الطلاب وإشراكهم في تعليم العلوم والتكنولوجيا والهندسة، على الرغم من وجود هذه العقبات.

كلمات مفتاحية:

الروبوتات، والتعليم في مجال العلوم والتكنولوجيا، والآداب، والمستوى الابتدائي، وآراء المدرسين، والتحديات

1. Introduction

In the last ten years, the application of artificial intelligence (AI) and robotics has gradually grown in many industries all over the world. Technologies which are created through AI, machine learning, and automation, are changing the way people work and get information. The development of these technologies has created a greater interest in their combination into science, technology, engineering, and mathematics (STEM) education to get ready for future jobs (Manyika et al., 2017). Nevertheless, research on the usage of AI and robotics in elementary classrooms is just starting.

In Lebanon, the project of building the country's STEM education is going on. To demonstrate this, let us take the case of Lebanon that launched a National STEM Strategy in 2019 which is centered on areas such as the upgrading of the curricula, the enhancement of the teacher training, and the establishment of partnerships between schools and tech companies (UNESCO, 2021). The mixture of AI technologies such as robotics and STEM at elementary schools is in accordance with

the digital transformation strategy of the school. The teachers' opinions are the most significant factor for the success of any new classroom technology (Shahin, 2019).

While Lebanon is busy with the reforms in the STEM education, the research of the teacher views on the use of the AI robotics in the elementary level can be the basis for the effective implementation. Teacher views on the importance of AI robotics in achieving learning objectives, the training, and resources necessary, the challenges they perceive, and the overall reception can help to shape professional development and change management strategies. The future research should be about the teachers' view on the use of the new technologies like the robotics that is being powered by the AI in the STEM classrooms at the elementary level in the Lebanese and in the Arabic education context.

1.1 Background of the Study

Lebanon must adopt technology-driven approach in education. This approach is vital for developing a generation of learners who actively seek and generate knowledge have critical thinking skills. They are also passionate lifelong learners. Traditional teaching methods don't suffice in a rapidly changing world where scientific and technological advancements come at an accelerated pace. Learners need to acquire critical thinking and problem-solving abilities. More so they must learn, apply knowledge, and adapt to evolving information. Lebanon must restructure its education system. It should incorporate technology into teaching and learning process. This strategy is instrumental in creating learners equipped with necessary skills that guarantee future success with a deep-seated foundation in critical thinking skills. By adopting practical approach Lebanon can cultivate learners fit for future. (Karagounis, 2023)

In today's world of advanced technology, such skills as critical thinking, creativity and problem solving are vital, thus making STEM education very important at the elementary level. This will facilitate their readiness for future jobs and success in a globalized society; therefore, schools should incorporate STEM education in their core syllabuses. The use of targeted technologies like robotics can make learning more interactive and interesting for students. This way, learners get a deeper understanding of STEM concepts while developing a sense of questioning that is fundamental to life-long learning. Young children in primary school could build up this essential

knowledge base for science, technology engineering and math to do well later in academics and careers with appropriate support systems. (Chaudhary et al., 2016)

This study investigates the impact of integrating AI-powered robotics into elementary STEM education in Lebanon. Despite its relatively new concept, the traditional approach to education in Lebanon is characterized by memorization and minimal practical application of material. The Ministry of Education in Lebanon is implementing new initiatives to modernize and stay relevant in the 21st century. The research aims to explore how integrating AI powered robotics can enhance elementary STEM education, ultimately benefiting students' academic achievements and motivation levels.

1.2 Research Questions

In this analysis, we will focus solely on the following two questions. The first question explores the opinions of elementary school teachers regarding the integration of robotics with AI options in STEM education. We aim to understand their viewpoints and gather insights on this matter. The second question delves into the challenges faced by teachers when incorporating robotics into STEM education. We aim to identify the specific difficulties they encounter and the support they require to successfully integrate robotics into their curriculum.

2. Literature Review

The use of robotics and AI in STEM education is becoming a popular subject as technology is developing (Eguchi, 2014). The researchers have started the journey of the use of robotics and AI to engage the students in the STEM subjects from the very early ages (Sullivan & Bers, 2016). Numerous research has proved that the use of robotics in primary STEM education can be advantageous for the learning and students’ attitudes towards the STEM fields (Bers et al., 2014; Sullivan & Bers, 2013).

On the other hand, the research on the application of these technologies in developing countries is still very limited (Benitti & Spolaôr, 2017). Lebanon alone does not have any resources to learn how AI-powered robotics could be correctly incorporated into the elementary STEM curriculums (Majed & Khanlari, 2022). More studies should be done to the Lebanese teachers' views on the

use of such tools to improve the STEM education in the specific cultural and political environment of Lebanon.

Teachers are the ones who decide how technology is used in classrooms and thus, they have a crucial role in the integration of technology into the classrooms. The knowledge on their opinions about the use of robotics and AI will give us a good idea on how robotics and AI can be best used (Hong et al., 2022). Studies show that teachers usually have a positive attitude regarding the incorporation of robotics in the education system (Mikropoulos & Bellou, 2013). On the contrary, they are still blocked by the following obstacles: the lack of proper training, the limited access to resources, the curriculum constraints and the classroom management concerns (Beltramone & Marsh, 2022; Sullivan & Bers, 2016).

The hardships that are caused by the daily schoolwork are more in developing countries like Lebanon, where teachers have not even the slightest idea about the advanced technologies like AI (Khanlari & Kia, 2017). The necessary research must be done to know the difference between the teachers' opinions in Lebanon and the Western contexts. The research of their perceptions can be helpful in the discovery of the needs, obstacles, and the best ways of implementing AI robotics to successfully involve Lebanese students in STEM subjects. This is the case which is essential in the process of enhancing education and the creation of a qualified future workforce in developing nations.

2.1 Benefits of Integrating Robotics in Elementary Education

Teachers have observed that robotics has several advantages in elementary school classrooms. Robotics gives students a chance to be active and collaborative in their learning, which research shows is much better for students than the traditional lecture-based teaching methods (Knoll, 1997). Teachers have managed to use robotics to teach students the interdisciplinary subjects in computer programming, science, math, language arts, history, and foreign languages. (Kerimbayev et al. 2020).

Robotics cultivates students’ problem-solving skills by enabling them to methodically identify, plan, execute, and evaluate solutions to real-life problems (Almahameed et al. 2020). The study that has been done shows teaching children the basics of programming has been proved to be better

than the usual teaching methods. This in turn helped the children a lot in the aspects of thinking and reasoning. The open-ended design challenges of robotics, which stimulates creativity, innovation, and engagement in the learning process (Sawyer, 2012; Zviel-Girshin et al. 2020). Furthermore, robotics work is an important part of the development of the skills that are needed for academic and life success, such as inquiry, analysis, imagination, and judgment (Liu et al., 2014; Duban, 2010; Clark et al. 2012).

2.2 Challenges and Limitations of Robotics Integration

The introduction of robotics into classrooms is confronted with several serious problems. The Robotics equipment, resources and professional development are expensive which makes it difficult for the schools with limited funds (Burns 2023; Metni 2022). Besides, the accessibility of quality robotics instruction is a hard task to achieve, for the curriculum design, the tutoring format, and the types of robotics tools, etc. are the factors that affect the outcomes (Burns 2023).

Besides, the lack of teacher training and professional development is again the reason for the need of improvement. Scientific studies reveal that participatory, hands-on, and customized training is the most effective way for the teachers in achieving successful integration (Jones et al. 2011; Chalmers et al. 2011). Despite this, numerous teachers still must deal with the fact that they don't have the training and support systems which are required to use these technologies (Kong et al. 2014; Kaburlasos et al. 2014). The teacher confidence in using robotics as a teaching tool is a key issue (Harrison 2011).

The integration of robotics into the standardized curricula is a difficult task to carry out. Pressure to teach to exams thus can prevent the innovative applications, which ultimately leads to knowledge gaps (Cannon-Ruffo 2020). The project-based approach, which is interdisciplinary, has a great potential to use robotics for the increase of student's engagement. (Lave & Wenger 1991; Screpanti et al. 2021).

The main purpose of this limit is to make robotics a common and positive phenomenon in education. Due to the advancement of technology, teachers must modify the curriculum and

policymakers must give the necessary funds. Though the challenges are there, robotics technology holds the key to change the learning process.

3. Methodology

3.1 Design

This study used a quantitative design through which elementary school teachers' perceptions and attitudes towards the infusion of robotics and AI within STEM education in Lebanon were further assessed. The use of a questionnaire comprising of closed-ended questions were presented to the participants in order to gather a general picture of teachers views on robotics with two purposes: 1) to consider its use in the elementary education (K 1 - 5) and identify the benefits that they believe robotics pose for their students and 2) to visualize the challenges that might arise if robotics is infused within STEM education.

3.2 Participants

The participants in this study were elementary STEM teachers from three different private schools in Lebanon. We aim to sample a wide range of opinions and viewpoints by including experienced masters and novice teachers with different backgrounds in STEM education. A total of 32 elementary teachers participated in this study. Their opinions informed the findings and discussions of this chapter.

Table 1. Breakdown of survey participants

Competence Type	Number	Percentage
Age:		
30-39	13	40.6
40-49	11	34.4
50 and above	1	3.1
Under 30	7	21.9
Years of teaching experience:		
1-5 years	7	21.9
6-10 years	5	15.6
11-15 years	12	37.5

16+ years	8	25
Do you have prior experience with teaching or integrating the principles of STEM education into your lessons? No		
Yes	14	43.8
	18	56.3

3.3 Instrument

The main tool for getting data was a structured questionnaire of multiple-choice and Likert-scale questions. The questionnaire was made to get the answers on different things, like the students' views on being ready for future tech jobs; opinions on promoting collaboration and communication skills through robots; attitudes on enhancing critical thinking and problem-solving skills; views on making STEM subjects more interesting by using robots with AI features; the benefits of robotics in education; and the challenges that teachers face when they integrate The questionnaire was tested with an EdTech Coordinator in a private school and an educational technology research master student to check the clarity, relevance and comprehensiveness of the questions. The suggestions given by the participants were the basis for the minor modifications that were made to the questionnaire to make it more efficient and accurate.

Table 2. An overview of the questionnaire

Questions
Section 1: Prior Experience and Perspective on STEM Education: • Do you have prior experience with teaching or integrating the principles of STEM education (Science, Technology, Engineering, and Mathematics) into your lessons? • How important do you believe STEM education is for elementary school students?
Section 2: Perceived Benefits of Robotics and Coding Education • What do you believe are the key benefits of robotics in education? (Select all that apply) • Using robots with AI features can make STEM subjects more engaging for elementary school students. • These programs can enhance students' critical thinking and problem-solving skills. • These programs can promote collaboration and communication skills among students. • These programs can prepare students for future careers in technology-related fields.
Section 3: Perceived Challenges of AI-powered Robotics: • The cost of acquiring and maintaining robots with AI features is a major concern for using them in schools.

- Integrating AI-powered robots would require significant changes to my existing curriculum.
- I feel uncomfortable or unsure about using technology with AI capabilities.
- The availability of professional development and training opportunities for using AI-powered robots is limited.
- Concerns about classroom management and safety arise when using robots.
- In your opinion, how effective would AI-powered robots be in enhancing student learning and engagement in STEM education?

3.4 Validity and Reliability

The questions were adjusted to the research goals and the available literature on robotics integration in STEM education so that the completeness of the questionnaire was guaranteed. The questionnaire aimed at collecting the complete data about the teachers' opinions, experiences, and challenges that they face at the elementary level regarding the robotics integration in Lebanon. Furthermore, the pilot testing phase made the questionnaire more appealing to the target audience by verifying its significance and clarity.

The internal consistency of the questionnaire was checked via Cronbach's Alpha coefficient which is a popular method for the evaluation of the reliability of a scale or questionnaire. The Cronbach's Alpha, which is the coefficient of the questionnaire, was calculated to be 0. The researchers came up with 0.855 as the score of the instrument which is the high degree of the internal consistency and the reliability of the instrument. This implies that the items in the questionnaire are very much related and unfailingly assess the targeted constructs, thus the reliability of the data collected through the questionnaire is verified.

3.5 Ethical Considerations

We started with ethical considerations and then went on and we prioritized them for the entire research process. The whole body of people was required to give their informed consent before they were going to fill in the questionnaire. We described the objectives of the project, how the information of the students would be applied, and guaranteed them their choice to stay in the study at any time. We kept all the data safely and confidentially; the research team was the only party who could access it.

3.6 Limitations

Although our research was designed to reflect the opinion of a large group of elementary school teachers in Lebanon, we should still consider that our sample was not big enough. Hence, the results may not be applicable to all elementary school teachers in Lebanon or even in other circumstances.

Although these constraints are evident, our study gives us the chance to get the views of teachers on using AI-powered robots in STEM education at the elementary level in Lebanon. The findings on the effects of these policies are the basis of future research and can help in designing education strategies and making policy decisions.

4. Analysis of Data and Discussion

In this chapter, we delve into the analysis of the data collected from elementary school teachers in Lebanon regarding their perceptions and attitudes towards integrating robotics and AI into STEM education. The discussion encompasses key themes such as the potential benefits, challenges, and implications for future educational strategies.

4.1 Perceptions on Preparing Students for Future Careers

The data shows that the teachers agree about the function of robotics in the preparation of students for the jobs of the future technologies. A significant 56. 3% of respondents strongly agree, and 34.4% of the people support the statement that robotics programs can help students to acquire the required skills and knowledge for future careers in fields related to technology. The cumulative percentage of 90.7% underscores a positive perception among teachers about the vocational relevance of robotics education.

The high percentage of the teachers' agreement with the statement implies that the teachers also know the importance of merging AI powered robotics in the course to make students ready for the digital future. Robotics is not only a tool for the students to get to know the technology but also it fosters problem-solving, critical thinking, and technical skills which are the most important in the 21st-century job market.

4.2 Perceptions on Promoting Collaboration and Communication Skills

Regarding the promotion of collaboration and communication skills, the data indicates that 40.6% of respondents agree and 34.4% strongly agree that robotics programs can be the factor of improvement of these skills among students. However, 25.0% of teachers are neutral about this aspect.

Although most teachers are sure that robotics is a team activity, a significant part of them are still not able to decide. This implies that teachers might have different levels of knowledge or experience when it comes to the team-based activities that robotics programs are promoting. The future professional development activities could, for example, be geared towards improving the teachers' knowledge and the actual practice of collaborative AI powered robotics projects in school.

4.3 Perceptions on Enhancing Critical Thinking and Problem-Solving Skills

A substantial 46.9% of teachers strongly agree, and 34.4% agree that robotics programs can be a means for students to sharpen their critical thinking and problem-solving abilities. The cumulative percentage of 81.3% emphasizes the educational benefits of robotics as it is a practice that encourages critical and practical skills.

The high degree of the cons on this side stresses the fact that robotics is a good asset for the cognitive development of students. Robotics projects usually involve the students to use theoretical knowledge to the real problems, thus, the students are encouraged to think critically and solve the problems they face in real life.

4.4 Perceptions on Making STEM Subjects More Engaging

Regarding the engagement factor, 40.6% of respondents agree and 31.3% strongly agree that the application of robots with AI features can make STEM subjects more interesting for elementary school students. However, 28.1% of the teachers don't take any sides on this issue.

The good impression of the AI technology-based robots being used to make the STEM engagement more interesting is hopeful. Although some teachers show neutrality in using AI technologies to teach the students, the need for more exposure and training in how to use these technologies to capture the students' attention and make learning more interactive and fun is still there.

4.5 Key Benefits of Robotics in Education

The data also sheds light on the key benefits of robotics as perceived by teachers. Most of the respondents think robotics is the best way to teach programming and engineering concepts (65.6%) and improve their problem-solving skills (75.0%). Additionally, 53.1% admit that it is the key factor in fostering the development of critical thinking.

The numerous benefits that were picked up by teachers prove that robotics is a flexible instrument that can be used for many educational purposes. Start from the creativity and innovation thus also gives the teamwork and collaboration to the students. All these things make robotics a holistic learning experience which also is made to suit the students of different interests and needs.

4.6 Descriptive Statistics Insights

The mean score of 4.03 with a standard deviation of 0.782 for the question on AI-powered robotics' engagement potential plus the positive views among teachers from the other study strengthen the argument. Nevertheless, the fact that the people were not evenly distributed indicates that there might be a difference in enthusiasm or concern among educators.

The low level of opinion about the cause is the reason for the need for interventions and support systems that help to overcome the possible concerns and make the educators feel more confident. The professional development programs having a strong focus on AI and robotics integration might be the key to the connection between the teachers with the different levels of expertise

Table 3. Mean and SD.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation

Using robots with AI features can make STEM subjects more engaging for elementary school students.	32	3	5	4.03	.782
Valid N (listwise)	32				

5. Conclusion

The data analysis shows that the teachers in Lebanon generally have a positive view on the use of robots and AI in STEM education. Robotics can prepare students for their future careers, while at the same time, it develops critical thinking and problem-solving skills that are essential for their success. Nevertheless, the study also accentuates the importance of the need for professional development, curriculum integration and the support systems to realize the full potential of robotics in STEM education.

The study results provided in this way will help us to get a clear view of the robotics integration in elementary STEM education in Lebanon. Besides, more research and cooperation between the teachers, the policymakers, and the technologies experts are needed to make the implementation of this method of education effective and thus to maximize the advantages of the robots in the development of the 21st century skills.

5.1 Summary of Findings

The aim of this research was to investigate the perspectives of the educators on the present abilities of the AI powered robots to teach STEM in Lebanese schools. Apart from that, we also aimed to find out how much the current robotics education tools suit the teachers' different instructional needs. In the Lebanese schools, the technology infrastructure is quite adequate; nevertheless, the teachers' views on robotics in education are mild to low. This observation is alike to other situations in different countries where teachers did not have any previous knowledge of, nor experience in, using robotics for teaching purposes. The time allocation is one of the most important issues in planning to do robotic activities, therefore how these activities fit the curriculum is very significant. Most teachers think that robotics would be a very good tool to be used in the teaching of STEM, since they have a strong conviction that it is the motivational benefits of the students

that are behind it. Nevertheless, the development of the activities that include in robotics, especially in the STEM curriculum might need additional teacher training and professional development. Lebanese educators are so excited about the fact that they can merge STEM and robotics in the classroom. The idea was supported by all teachers, in all disciplines, in fact, it was a great idea.

5.2 Implications for Practice

The research results have proved that the teachers are positive and the prospects of integrating robotics into elementary school education in Lebanon are promising. They believed learning robotics, teacher training, and implementing robotics courses were important and thus expressed their attitudes positively. They claim it is a good way to promote STEM education and technical skills for Lebanese students. The teachers had also noted that the best way in integrating robotics into the curriculum is through its own course or subject. They believe it is not a supplemental tool to aid traditional teaching methods in other subjects, but a core subject in which all students must continue to learn from year to year. The teachers suggest that it serves as an effective motivational tool for students to cultivate 21st-century skills. They noted increased teamwork and problem-solving skills among students and that it sparked interest in students. The teachers agreed that seeing such benefits would encourage other teachers to learn and teach robotics.

The most frequent explanation of why people have such a positive image of this is that the teachers think that the students will be better prepared for their future by going to higher education and getting a job. The teachers are of the opinion that educational robotics is a good thing for the students and it will make them more likely to take a technical career. They think it is a more suitable option for the contemporary students to acquire technical skills rather than the few technical subjects in the Lebanese high schools, not with the equal emphasis as computer programming which the teachers say is too early for the elementary students to learn.

5.3 Recommendations for Future Research

To establish evidence-based guidelines for robotic integration, more research on how students develop skills and knowledge of adding robotics to the curriculum is needed. England (2012) completed a study on Robotic Integrated Systems (RIS) with positive findings. However, findings

were inconclusive as to whether students' success and retention on RIS is due to the hands-on nature or the less abstract learning style involved. Hill (2013) found a similar result: improved learning in robotics (compared to pen and paper activities) and positive student attitudes toward technology, but no clear evidence of enhanced understanding or identifying better concrete learning compared to other methods. Childs and Dafoulas (2013) completed a study on 8–9-year-olds using LEGO robotics to aid understanding of science concepts. A mixed-method case study revealed an increase in duration and attention in such activities and a potential trend in improved attitude towards science; however, no significant evidence was produced. The effectiveness of newer programming environments – that are more ideal for classroom integration – needs to be compared to traditional environments.

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