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Profile of Greek primary education teachers regarding their attitude towards STEM

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ABSTRACT

The present study is only part of a broader effort to investigate the profile of active primary education teachers in Greece. It is essential to carry out further research in different countries that examines the factors that determine the attitude of teachers towards STEM, how this attitude affects them, and to what extent the implementation of corresponding programs in the classroom. The research was carried out using questionnaires sent via e-mail to the e-mail addresses of elementary schools and kindergartens in various regions of Greece. From the study findings, the teachers who were at the beginning of their career or had many years of service and had been trained in STEM implemented a tiny percentage of corresponding STEM programs. Furthermore, teachers' training in STEM or taking corresponding courses in their core curriculum does not give them the impetus to implement STEM programs in their classrooms.

Keywords: profile, primary school teachers, STEM

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THEORETICAL FRAMEWORK

The Greek primary education teachers' attitudes towards STEM education reveals a generally positive outlook, although challenges persist. Research indicates that many teachers express confidence in implementing STEM activities, particularly in early primary years, with over 80% feeling comfortable facilitating inquiry-based learning in mathematics and science (Nikolopoulou & Tsimperidis, 2023).

However, obstacles such as limited resources and time hinder effective implementation (Nikolopoulou & Tsimperidis, 2023). Research indicates that teachers' attitudes towards STEM are influenced by their perceptions of its practicality and effectiveness in enhancing the teaching-learning process (Vlasopoulou et al., 2021).

Furthermore, educational coding and robotics training have positively impacted teachers' perspectives on integrated STEM approaches despite the challenges encountered during implementation (García-Carrillo et al., 2021). While teachers' awareness of STEM is relatively high, their attitudes are often undecided, suggesting a need for further professional development to enhance their engagement with STEM practices (Altun & Apaydin, 2022). Additionally, the relationship between teachers' professional experience and attitudes toward STEM indicates that increased experience correlates with more favorable attitudes (Altun & Apaydin, 2022).

Overall, teachers demonstrate a strong orientation towards integrated STEM practices, recognizing their value in fostering a comprehensive educational experience for students (Atalay & Hamurcu, 2022). While Greek primary teachers recognize the importance of STEM, systemic support is essential to overcome practical barriers and foster a more robust educational environment (Samara & Kotsis, 2023c; Wei & Maat, 2020).

Bell and Fogler (1995) support the need to enrich teaching in both schools and universities with the help of technology and information sciences (ICT), which offer new teaching methods and upgrade the quality of the education provided.

To reveal those correlations, it is necessary to investigate the characteristics of primary education teachers in terms of their attitude towards STEM. This will form the theoretical background upon which the actions that will improve their attitude will be based. Globally, there is a significant research gap in examining the association between demographics and teachers' attitudes and perceptions regarding the use of robotic technology in primary education. We aim to fill this gap with this paper, which we believe will significantly interest our readers.

STEM can be used as an educational tool for the active participation of students and the planning and implementation of activities in any subject taught in primary education without, however, being able to replace the teacher and his role in the classroom (Samara & Kotsis, 2023b). STEM education begins in preschool, as engaging preschool children in science and other fields, such as technology, increases their awareness, and stimulates their interest in these fields (Samarapungavan et al., 2009; DeJarnette, 2018).

The need to implement STEM in primary education is now a standard admission of most teachers, even those who express their concerns, due to a lack of adequate, relevant education or experience (Bers & Postmore, 2005). On the other hand, research has shown that STEM can be applied relatively easily by teachers in the classroom since no specialized technical knowledge is required (Samara & Kotsis, 2023d), provided the active participation of children throughout the educational process, so that the tasks arise from the students and the teacher has only an encouraging, facilitating and mediating role both between the students and between the students and the technological tools (Samara & Kotsis, 2023a).

Most curricula aimed at elementary teachers need to adequately prepare them to acquire the ability to design instructional programs with the assistance of technology or STEM programs (Bers & Postmore, 2005). Because of this curriculum inadequacy, teachers feel more confident and effective when designing and implementing lessons with the help of new technologies (Bers & Postmore, 2005).

Also, in a survey involving teachers of various specialties, mainly public elementary school teachers, they expressed a positive attitude toward STEM teaching. In contrast, participating teachers who had not been trained in STEM during their undergraduate education volunteered to receive it in the context of in-service training (Ozdemir et al., 2018).

However, most teachers believe that they will need more time to implement the new programs systematically and organized due to the pressure from the increased workload (Papagiannopoulou, 2022).

The aim of the study by Ivanova (2022) was to determine the level of awareness and implementation by teachers in Bulgaria of the STEM approach and its variations in teaching. Specifically, the subject of the study was the general conditions, qualities, and standards in the implementation of the STEM approach supported by the 76 Bulgarian teachers of pre-school and primary education who participated in the research. Many of the interviewed teachers were familiar with STEM as a concept and activity, but a small percentage had experience implementing it in the classroom. 44% of the surveyed teachers claimed that using educational innovations (software applications, online platforms, cloud technologies, new methodologies, curriculum, etc.) makes implementing STEM activities easier and improves their teaching.

In a study by Kanadli (2019), the practical benefits of STEM education were highlighted. A significant percentage of the survey participants (80%) believed that STEM education is most suitable for teaching or learning about natural phenomena. They also pointed out that STEM education contributes to the improvement of life skills, the development of psychomotor skills, problem-solving, scientific process, engineering and design skills, the cultivation of imagination, the development of inquiry skills, critical thinking skills, as well as the skills of the 21st century. This emphasis on the practical benefits of STEM education underscores its value and keeps the readers interested.

Kanadli (2019) emphasized the significant contribution of STEM education to students' emotional dimensions. STEM education attracts attention and interest, arouses curiosity, provides learning desire and motivation, and enhances students' self-confidence. Moreover, it helps students realize real-life problems and their knowledge and skills, instilling a sense of optimism and hope for the future.

STEM education has been found to contribute significantly to career awareness in students and enable them to learn while having fun. This results in practical, lasting, collaborative, and student-centered learning by providing active participation and relevance of course content to everyday life. More importantly, STEM education has the potential to empower and inspire students, as it helps them realize real-life problems and their knowledge and skills.

The purpose of an earlier survey conducted in America (Coppola et al., 2015), in the context of efforts to disseminate a new curriculum, was to record the opinions of secondary school teachers and educators about the obstacles they face in implementing STEM education in their classrooms. In particular, the experience of the teachers, their opinion on the appropriate age for the implementation of engineering curricula, and the obstacles to teaching engineering in primary school and secondary education were investigated. The research sample consisted of 70 teachers. The teachers stated they were interested in teaching more engineering while citing time and lack of support as barriers to implementing engineering. These are essential issues to consider when developing new curricula.

On the other hand, another study by Annawati et al. (2022) investigated whether there was a significant difference between the perceived attitude, knowledge, and application of STEM before and after the implementation of STEM training by a group of 77 kindergarten teachers in Indonesia, who already had experience applying STEM in the classroom. These kindergarten teachers participated in a professional development program consisting of a one-day introductory seminar, a two-month online course, and a one-day final seminar. This study's findings revealed no significant differences in teachers' attitudes before and after the online professional development program, as teachers in Indonesia already had high attitudes toward STEM education before participating in the specific professional development program. A high correlation was also observed between attitudes towards STEM and knowledge regarding it.

Papadakis et al. (2019) found that more experienced teachers are more concerned and have a negative attitude regarding using educational robotics in the formal curriculum. On the other hand, younger teachers believe that incorporating robotics into preschool education improves student learning outcomes.

Finally, when prospective teachers' knowledge of STEM was examined (Zdybel et al., 2019), it appeared that teachers' understanding of the essence and subject of STEM education needed to be more superficial and not based on scientific knowledge. Although most respondents stated they knew the term STEM, they associated it with a broadly understood holistic education rather than a problem-solving strategy or scientific thinking.

Some research indicates no correlation between the education of teachers in STEM and their attitude toward this education (Martynenko et al., 2023).

RESEARCH AND RESULTS

This paper aims to decipher the characteristics of primary education teachers in Greece (demographic data and education) concerning their attitude towards STEM. The research was carried out from August 2023 to November 2023. To ensure the reliability of the

research, questionnaires were sent via e-mail to the e-mail addresses of elementary schools and kindergartens in many regions of Greece and posted in teacher groups on social media. The research sample consisted of 203 active primary education teachers.

There will be no correlation between gender and teachers' attitudes towards STEM, as similar studies on teachers, in their majority, do not report differences between the two genders. Furthermore, internships or STEM training increased the STEM attitudes of university students. Furthermore, pre-university STEM programs positively influence attitudes toward STEM (Martynenko et al., 2023). On the other hand, a study has demonstrated a more negative view of female teachers in general towards STEM education than their male colleagues (Park et al., 2016).

The research hypotheses are the following:

1. Younger teachers will have a more positive attitude towards robotics and its classroom implementation than older teachers. Similarly, a study found that more experienced teachers are more concerned and have a rather negative feeling and attitude towards using educational robotics in the formal curriculum. On the other hand, younger teachers believe that integrating robotics in early childhood education improves students' learning outcomes (Papadakis et al., 2019).
2. Teachers who have been trained in STEM or have taught it in their basic course of study at university will implement STEM programs in their classroom more than those who have not been trained. This hypothesis is consistent with the results from the botSTEM project that show the benefit of supported long-term professional development for teaching STEM and robotics in early childhood education (Fridberg et al., 2023). Another study also showed that internships or STEM education increased the STEM attitudes of university students. In addition, pre-university STEM programs positively influence attitudes toward STEM (Martynenko et al., 2023).

Analytical the research questions of this study are the following:

- What is the profile of primary education teachers regarding the use of ICT and STEM?
- Is there a correlation between teachers' gender and attitudes towards STEM?
- Is there a correlation between teachers' education level and the implementation of STEM activities?
- Is there a correlation between the age of teachers and the implementation of STEM activities?
- Is there a correlation between teachers' years of service and the implementation of STEM activities?
- Is there a correlation between the type of school (kindergarten and elementary) and the implementation of STEM activities?
- Is there a correlation between the workplace and the implementation of STEM actions?
- Is there a correlation between teacher training in STEM and the implementation of corresponding actions in the school they serve?
- Did the university curriculum from which the primary education teachers graduated contain courses related to STEM? If so, what are these courses?

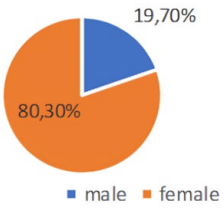

Figure 1. Distribution of teachers by gender (Source: Authors' own elaboration)

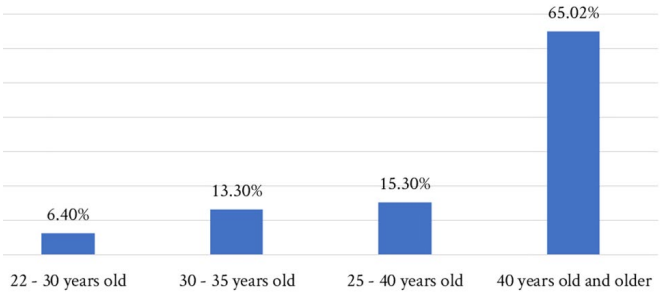

Figure 2. Distribution of teachers by age (Source: Authors' own elaboration)

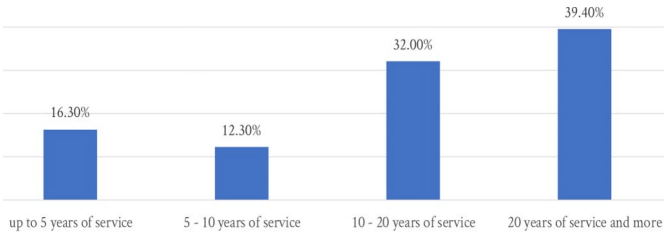

Figure 3. Distribution of teachers in terms of years of service (Source: Authors' own elaboration)

- In what other ways are primary education teachers trained in STEM?

Of the survey participants, 163 (80.3%) were female, while 40 (19.7%) were male. This analogy is almost identical to the Greek reality in primary schools (**Figure 1**).

From the age of the participants, it follows that 132 (65%) belonged to the age group of 40 and above, 31 (15.3%) belonged to the age group of 25-40, 27 (13.3%) belonged to the age group of 30-35, while 6.4% belonged to the age group of 22-30 (**Figure 2**).

Regarding years of service, 80 teachers (39.4%) had 20 years of service or more, 65 teachers (32%) had 10-20 years of service, 33 teachers (16.3%) had up to 5 years of service and 25 teachers (12.3 %) had 5-10 years of service (**Figure 3**).

Of the teachers who participated in the survey, 60% stated that they had a university degree, 1 teacher indicated that they had, in addition to the university degree, about half (92) stated that they had a master's degree (45, 3%) and 9 PhD (4.4%) (**Figure 4**).

Regarding the type of school the teachers serve, 102 participants stated that they serve in a public kindergarten (50.2%), while 101 stated that they serve in a public elementary school (49.8%) (**Figure 5**).

For their place of work, 110 teachers (54.2%) stated that they serve in a public school in an urban area, while 93 teachers stated that they serve in a school in a semi-urban or rural area (45.8%) (**Figure 6**).

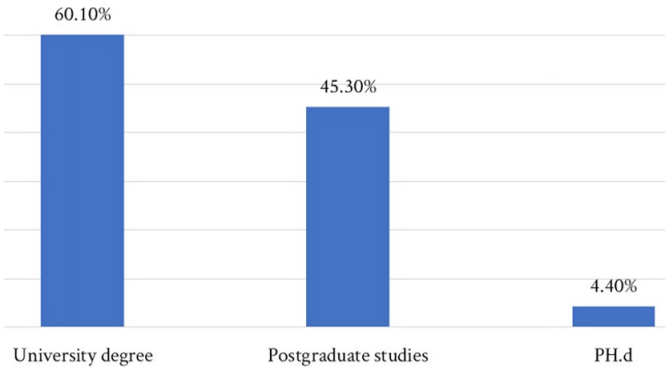

Figure 4. Distribution of teachers according to studies (Source: Authors' own elaboration)

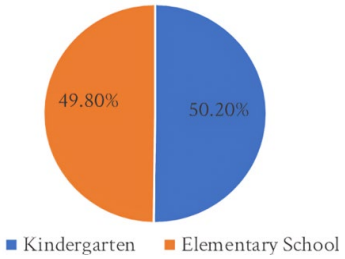

Figure 5. Distribution of teachers according to the type of school they serve (Source: Authors' own elaboration)

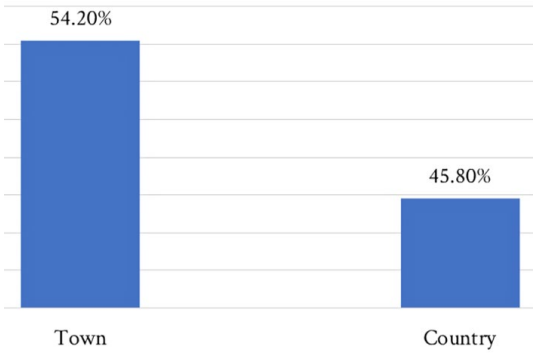

Figure 6. Distribution of teachers according to the place where the school they serve is located (Source: Authors' own elaboration)

When asked whether the curriculum at the university they graduated from contained STEM courses, most participants answered negatively (184 teachers out of 203, 90.6%), while very few teachers responded positively (19 teachers, 9.4%).

The STEM-related courses that teachers reported attending at the university are, as follows:

- apps that kids can use to get familiar with numbers, letters, colors, story making, etc.,
- teaching mathematics and literacy in natural sciences,
- didactic STEM,
- introduction to STEM,
- mathematics,
- physics,
- artistically,
- information technology,
- internship at the university,
- classroom practice,
- robotics, and
- chemistry.

When asked whether teachers have participated in any STEM-related training, only 32% answered positively, while most teachers answered negatively (68%).

Those teachers who responded that they had been trained in STEM indicated the following as their training providers:

- e-twinning,
- directorates of primary education/in-school education,
- universities,
- associations of teachers (EEPEK), and
- Ministry of Education (ICT level B).

Regarding the training time, most teachers answered that it ranged from 2-14 hours, while very few teachers answered that they participated in relevant training lasting 120-300 hours.

In the non-mandatory question on whether the institution that implemented the STEM training was public or private, out of 70 responses, 53 teachers answered that the institution that implemented their training was public (91.6%). In contrast, 17 teachers responded that it was a private body (8.37%).

When asked how participants learn about STEM, 15% said they learn from colleagues, 17% from related groups on social media, and 20% from personal reading. There were also combined responses, where 14% answered that they are informed by relevant groups in social networks and individual reading, and 10% responded that they are told by colleagues and from relevant social networks (**Figure 7**).

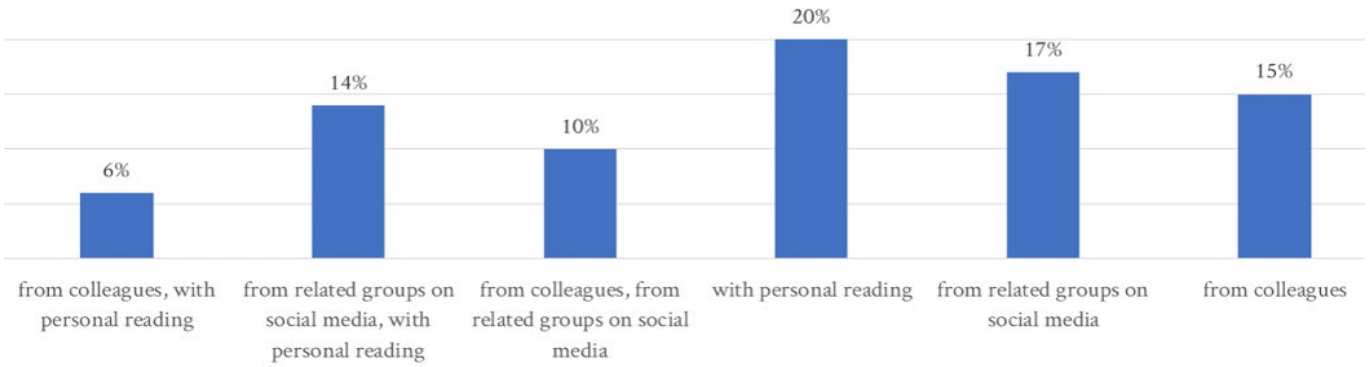

Figure 7. The answers to the question: In what other ways do you learn about STEM? (Source: Authors' own elaboration)

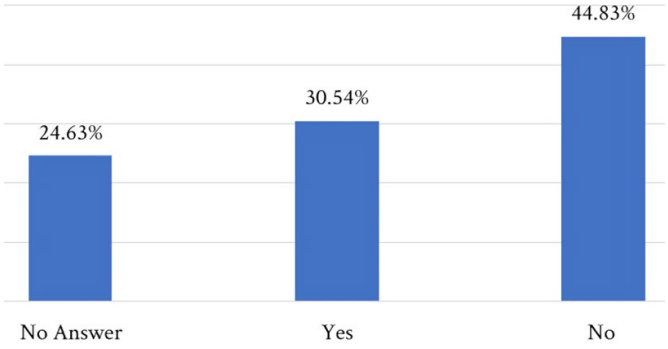

Figure 8. The answers to the question: Did your STEM training or university studies lead you to implement STEM programs in your classroom? (Source: Authors' own elaboration)

Table 1. Correlation between teachers' gender and STEM activities

		Did your STEM training or university studies lead you to implement STEM programs in your classroom?		Total
		Yes	No	
Gender	Male	17	8	15	40
	Female	33	54	76	163
Total		50	62	91	203

Table 2. Correlation between teachers' age, their STEM training, and the implementation of STEM programs in their classroom

		Did your STEM training or university studies lead you to implement STEM programs in your classroom?		Total
		Yes	No	
Age	22-30 years old	3	4	6	13
	30-35 years old	7	8	12	27
	25-40 years old	10	11	10	31
	40 years old and above	30	39	63	132
Total		50	62	91	203

One hundred fifty-three teachers responded to the non-required question of whether teachers' STEM training or studies triggered the implementation of STEM programs in their classrooms. Most teachers answered the question negatively (90 teachers, percentage: 44.83%), while a rate of 31% responded positively (**Figure 8**).

ANALYSIS OF RESULTS

The correlation of gender and the implementation of STEM activities shows that 34.8% of men and 42.3% of women have a positive attitude towards STEM (**Table 1**).

The correlation between the teachers' age and their training in STEM and the implementation of corresponding programs in their classroom showed that 52.4% of the teachers aged 25-40's training in STEM or their studies at the university were the trigger for implementing STEM programs in their classroom, compared to 40% of teachers aged 22-30 and 30-35, as well as 38% aged 40 and over (**Table 2**).

The correlation between the length of service of STEM-educated teachers and the implementation of corresponding programs in their classroom showed that 47.1% of teachers with 5-10 years of experience who were trained in STEM implemented STEM programs in their classroom, compared to 44.7% who had 10-20 years of service, 38.5% who had 20 years or more of service and 37.5% who had up to 5 years of service (**Table 3**).

Table 3. Correlation between teachers' tenure and STEM activities

		Did your STEM training or university studies lead you to implement STEM programs in your classroom?		Total
		Yes	No	
Years of service	Up to 5 years	9	9	15	33
	5 - 10 years	8	8	9	25
	10 - 20 years	18	20	27	65
	20 years and above	15	25	40	80
Total		50	62	91	203

Table 4. Correlation of type of schoolteachers serve, their STEM training, and implementation of respective programs

		Did your STEM training or university studies lead you to implement STEM programs in your classroom?		Total
		Yes	No	
Type of school	Kindergarten	21	40	41	102
	Elementary	29	22	50	101
Total		50	62	91	203

Table 5. Correlation of teachers' place of work, their STEM training, and the implementation of STEM programs

		Did your STEM training or university studies lead you to implement STEM programs in your classroom?		Total
		Yes	No	
Place of school	Town	25	42	43	110
	Region	25	20	48	93
Total		50	62	91	203

Regarding the type of school the participants served and the implementation of STEM activities in their school, 49.4% of the kindergarten teachers and 30% of the primary school teachers answered positively (**Table 4**).

Teachers serving in a city school answered positively regarding implementing STEM activities at a rate of 50.6%, compared to 29.4% of teachers serving in the district (**Table 5**).

41.3% of teachers with a master's degree and 50% with a doctoral degree implemented STEM in their classrooms. Of the teachers who said they had only an essential degree, 38% implemented STEM in their classrooms (**Table 6**).

DISCUSSION

Regarding the demographics of this research's sample, most of the sample were women who were 40 years of age or older and had 20 years of service or more. Also, the sample consisted of an almost equal number of kindergarten teachers and teachers. The findings suggest that while training is essential, its effectiveness can vary based on several factors, including the teachers' prior experiences and the nature of the training.

One significant observation from the study is that teachers who participated in STEM training programs did not show a marked improvement in their attitudes toward STEM education. This is particularly interesting because many of these teachers already had a positive attitude toward STEM before the training began. The study

Table 6. Correlation between teachers' Studies, their STEM training, and the implementation of corresponding programs

		Did your STEM training or university studies lead you to implement STEM programs in your classroom?			Total
			Yes	No	
Studies	University degree	29	27	44	100
	10	1	0	0	1
	11	1	0	0	1
	University technological direction degree	0	1	0	1
	Postgraduate	13	27	38	78
	PhD	2	2	2	6
	7	3	3	7	13
	8	0	1	0	1
	9	1	1	0	2
Total		50	62	91	203

indicates that the teachers in Greece, regardless of their years of service or training, implemented only a small percentage of STEM programs in their classrooms, suggesting that training alone may not change attitudes or behavior significantly.

The research highlights that teachers with many years of service who received STEM training were still reluctant to implement STEM activities. This finding aligns with other studies that suggest experienced teachers may have entrenched views that are resistant to change, even with professional development (Park et al., 2016). Therefore, while training is a critical component, it may need to be complemented by ongoing support and resources to encourage the practical application of STEM concepts in the classroom.

Additionally, the study points out that teachers who had not received STEM training during their undergraduate education expressed a desire for in-service training. This indicates a recognition of the importance of training in shaping attitudes towards STEM, as these teachers are actively seeking opportunities to improve their skills and knowledge in this area.

Female teachers seem to outperform male teachers by a small percentage regarding the implementation of STEM activities, which contradicts research that has suggested the opposite. A study has shown that female teachers generally have a more negative view of STEM education than their male colleagues (Park et al., 2016).

Specific teachers aged 25-40's STEM training or university studies triggered the implementation of STEM programs in their classrooms to a greater extent than their colleagues aged 22-30, 30-35, and 40 and over. Very few early-career STEM-educated teachers implemented corresponding STEM programs. More specifically, teachers who had up to 5 years of experience and had been trained in STEM, as well as those with 20 years of experience or more, showed the lowest percentages of implementing STEM programs in their classrooms compared to teachers who had 5-10 years of experience and 10-20 years old. This result contradicts research showing that younger teachers more easily implement STEM programs because they believe integrating robotics into preschool education improves student learning outcomes (Papadakis et al., 2019).

Teachers with many years of service and were trained in STEM implemented a very small proportion of STEM programs. This is consistent with other research showing that more experienced teachers are more concerned and have a rather negative feeling and attitude regarding using STEM educational robotics in the formal curriculum (Papadakis et al., 2019).

Most of the research participants worked in urban schools. The survey results showed that teachers in urban schools implement STEM activities more than their colleagues in the district.

Regarding the education of the teachers who participated in the research, most held a master's degree in addition to the basic title of Studies. In contrast, a few teachers held a doctoral degree and a university degree in technology.

A small percentage of teachers responded that they had been trained in STEM methodology. Most of those who answered that they had been trained in STEM stated that they had covered the cost of their training with their resources, which agrees with other similar surveys (Batsios, 2021). As their training providers, they mentioned their participation in a relevant e-twinning program, the directorates of primary education/in-school education, universities, teachers' unions (EEPEK), and the Ministry of Education (ICT level).

Regarding their training time, most teachers answered that it ranged from 2-14 hours, while very few teachers answered that they participated in relevant training lasting 120-300 hours.

Teachers' STEM training or attendance in corresponding courses during their basic study cycle did not give them the impetus to implement STEM programs in their classrooms, as most teachers answered the question negatively. This result contrasts with other research showing that STEM internships or training increased college students' STEM attitudes.

Additionally, pre-university STEM programs have positively influenced attitudes toward STEM (Martynenko et al., 2023). Also, research related to results from the STEM project has demonstrated the benefit of supported long-term professional development for teaching STEM and robotics in early childhood education (Fridberg et al., 2023), a result that contradicts the related consequence of the present research. The most significant percentage of teachers answered that they are informed about STEM by personal reading and from associated groups on social media. At the same time, this is followed by information from colleagues and the combined ways of these.

In conclusion, while teacher training is vital for fostering positive attitudes towards STEM education, its impact can be limited by prior experience and the nature of the training provided. Continuous support and tailored professional development may be necessary to ensure that training translates into effective implementation of STEM programs in primary education settings.

CONCLUSION

The research on Greek primary education teachers highlights several key areas where ongoing support can significantly improve their ability to apply what they have learned.

Firstly, teachers require continuous professional development opportunities beyond initial training sessions. The study indicates that many teachers, despite having undergone training, still implement a minimal percentage of STEM programs. This suggests that additional training sessions, workshops, or seminars could help reinforce their skills and knowledge, allowing them to feel more confident applying STEM concepts in their teaching practices.

Secondly, technical support is crucial. Teachers often face challenges with resources, technology, and curriculum integration when implementing STEM activities. Providing access to technical assistance can help teachers troubleshoot issues and enhance their teaching methods. This support can come from mentorship programs, where experienced educators guide their peers in effectively integrating STEM into their classrooms.

Creating a collaborative environment among teachers can foster a culture of sharing best practices and resources. It can be beneficial to establish professional learning communities or networks where teachers can discuss their experiences, challenges, and successes in implementing STEM. This collaborative approach can help teachers feel less isolated and more supported in their efforts to innovate their teaching practices.

Lastly, ongoing evaluation and feedback mechanisms are essential. Teachers need constructive feedback on their STEM program implementation to identify areas for improvement. Regular assessments can help educators reflect on their practices and make necessary adjustments, ensuring they effectively engage students in STEM learning.

In the way it is implemented in Greece, STEM education does not contribute to teachers' implementation of corresponding programs. This may be due to the absence of its generalization to teachers at all school levels, the limited time offered, or its non-connection with the school practice due to its non-compulsory nature in the Greek Curriculum.

However, it is very important to make the necessary changes so that STEM education is offered systematically and free of charge to teachers, connected with corresponding practices in the school classroom so that it can be the trigger to overcome any insecurities on their part, which will be the trigger for viewing STEM as a valuable and necessary educational tool for our time.

This framework proposes cooperation between educators and policymakers to create the appropriate conditions for removing the abovementioned obstacles and implementing STEM in practice. The present study can contribute to achieving this goal by capturing the current profile of primary education teachers in Greece and their attitudes towards STEM. Policymakers, relying on similar research, can improve the conditions for the implementation of STEM by removing obstacles and with various trial applications (e.g., teacher training, technical support, mandatory implementation of STEM, and professional development) to achieve the best possible result.

In summary, ongoing support for teachers post-training should include continuous professional development, technical assistance, collaborative networks, and regular feedback mechanisms. These elements can significantly enhance teachers' confidence and effectiveness in implementing STEM education in their classrooms, ultimately benefiting their students' learning experiences.

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Ethics declaration: The authors stated the study did not require formal ethical approval. The authors further stated that the survey was anonymous; participants were all adults; anyone who did not want to participate verbally informed the researchers before receiving the questionnaire; and anyone who wished to stop participating during the research informed the researchers and stopped.

Declaration of interest: The authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

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