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Research Article

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Pedagogical approaches and materials used by kindergarten and elementary school teachers in Greece to implement STEM education

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ABSTRACT

This paper attempts to record the perceptions of primary school teachers in Greece, kindergarten teachers, and elementary school teachers regarding science, technology, engineering, and mathematics (STEM). The research was conducted using questionnaires sent via e-mail to the email addresses of primary schools and kindergartens in various regions of Greece. The findings of the research show that the majority of teachers suggest preschool education as the most appropriate starting point for STEM education for various reasons, such as the availability of time in kindergarten, the flexibility of the curriculum, and the consideration of preschool education as the fundamental stage for preparing students for the next school stage. Regarding pedagogical approaches to implementing STEM, most teachers responded that they apply teaching with experiments and learning based on synthetic tasks (projects)/problems. In contrast, only a small percentage of the participating teachers responded that they apply direct traditional teaching. Regarding materials, there seems to be a tendency for teachers who apply the two dominant pedagogical approaches to utilize more modern materials– media, such as robots, software, etc. in their classrooms.

Keywords: STEM, pedagogical approaches, primary education

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INTRODUCTION

The term science, technology, engineering, and mathematics (STEM) was first used by the National Science Foundation in 1998 to reflect the interconnectedness of the fields of science, technology, engineering, and mathematics (Berger & Sireci, 2001). The necessity of STEM in shaping future professions was supported in the UK. The USA argued that for students to acquire STEM skills, it is needed the existence of STEM educational specialties for the teaching of relevant subjects (Wang, 2012).

In the last decade, research has been conducted in Greece examining STEM education in education (Kalogiannakis et al., 2018; Samara & Kotsis, 2023b, 2025a), to systematically introduce STEM education from preschool education onwards and upgrade the quality of STEM currently provided in schools.

The purpose of this paper is to enrich the bibliographic research with data concerning teachers' perceptions of the starting level of STEM education and the recording of the pedagogical approaches and materials they use, with the ultimate goal of monitoring the development of STEM education in our time, with the adoption of more modern methods and means and with the ultimate goal of improving the quality of STEM education.

Initially, a literature review presents research on STEM introductory level and STEM pedagogical approaches and materials. This is followed by the research part, which presents the purpose, sample, description of the research, research questions, and research hypotheses. Then, the research results are analyzed, and the conclusions of the research, its limitations, and proposals for its expansion are presented.

LITERATURE REVIEW

STEM Starter Education Level

STEM education is not only important but also a one-way street in our time, as it equips students–tomorrow's citizens–with the necessary skills to develop into successful professionals in the future (Samara & Kotsis, 2023a).

Various studies have been conducted on students' starting grades for STEM education. In many of these studies, it has been suggested that STEM education should start in kindergarten, as the foundations

for engineering education are laid in early childhood. Children act as natural scientists and engineers: They like to constantly ask questions and engage in problem-solving (McClure, 2017).

However, while early childhood is appropriate for initiating the implementation of STEM education, research has shown that this initiation is not qualitative due to teachers' lack of appropriate STEM training (Blackley & Howell, 2015).

On the other hand, research has shown that appropriate teacher training in STEM is insufficient to significantly enhance teachers' confidence and effectiveness in implementing STEM education in their classrooms. However, ongoing support for teachers after their training in various ways (continuous professional development, technical assistance, collaborative networks, and regular feedback mechanisms) is necessary (Samara & Kotsis, 2025b).

In a qualitative study by Wang (2020) on STEM, in which 65 kindergarten teachers serving in public and private kindergartens participated, it appeared that although a very large proportion of teachers had not even heard of STEM education, after being informed, they believed that STEM could be included in kindergartens.

STEM Pedagogical Approaches

Over time, various pedagogical approaches have been applied to implement the subject of STEM in education. From the evaluation of these approaches, after the end of the educational interventions, it emerged that some approaches were more effective and some less effective.

Studies have shown that experiential-practical pedagogical approaches are the most effective for implementing STEM starting in elementary school. Also, an inquiry-based approach from a very young age can help students discover their interests, find solutions to real-world problems, and thus gain confidence in their problem-solving abilities (Ammar et al., 2023).

Furthermore, an equally effective pedagogical approach to STEM is the pedagogical approach that uses digital tools (digital escape rooms, different technological applications), as it leads to increased student participation and creative thinking and problem-solving abilities (Khalid et al., 2025).

Also, Karanikola et al. (2022) and Triana et al. (2019) propose for teachers the following teaching-learning models in STEM teaching:

(a) the "project-based learning" (PBL) model, which promotes the construction of knowledge through the active involvement of students in activities with a realistic approach to learning and

(b) the "PBL" model, which is based on the implementation of authentic problem-solving activities.

RESEARCH

Purpose of the Research

The purpose of this paper is to enrich the bibliographic research with data concerning teachers' perceptions of the initial stage of STEM education, record teaching approaches and materials as they are used, and monitor the development of STEM education in our time with the adoption of more modern methods and materials.

Research Sample

Two hundred three serving primary education teachers (teachers and kindergarten teachers) responded to the questionnaire via electronic questionnaires (Google Forms).

Description of the Survey

This survey was implemented electronically. From August to November 2023, questionnaires were sent to the email addresses of primary schools and kindergartens in many different regions of Greece.

Research Questions

The research questions of this study are as follows:

1. At what grade do teachers believe that STEM education should begin and why?
2. What pedagogical approaches do teachers use when teaching STEM subjects?
3. What kind of materials do teachers use when teaching in their classroom?
4. Is there a correlation between teachers' pedagogical approaches when teaching STEM subjects in their classroom and the materials they use?

Research Hypotheses

The research hypotheses of this paper are as follows:

1. Many teachers consider primary school an appropriate grade for starting STEM education. This aligns with a study conducted in Poland and Ukraine among in-service teachers and future teachers. This study showed that more than 50.0% of respondents understand the important role of STEM education and the necessity of introducing it in primary school with workshops and other activities (Smyrnova-Trybulska et al., 2016). On the other hand, some studies indicate that preschool education is the most appropriate grade for starting STEM implementation (Ültay & Ültay, 2020).
2. Due to their greater familiarity with new technologies, today's teachers and students are expected to use them more in STEM education. However, due to the lack of appropriate teacher training in STEM (Blackley & Howell, 2015), both teachers and students will use technologies mainly reproductively (searching for information on the Internet) and less productively as creators of knowledge (Birzina & Pigozne, 2020).
3. Teachers will tend to use other pedagogical approaches in applying STEM in their classrooms beyond traditional direct teaching, such as inquiry, student-centered learning, authentic experiences, or learning through problem-solving and modeling (Deehan et al., 2024).
4. Teachers who apply modern pedagogical methods will use more technologically advanced means in their classroom, such as the pedagogical approach, which uses digital tools (Khalid et al., 2025).
5. There is no expected correlation between the pedagogical approach and the tools used by teachers in implementing STEM, perhaps due to the existence of obstacles that teachers face in implementing STEM in the classroom, such as the insufficient number of computers and interactive whiteboards (Bal et al., 2021), their lack of adequate STEM training and their

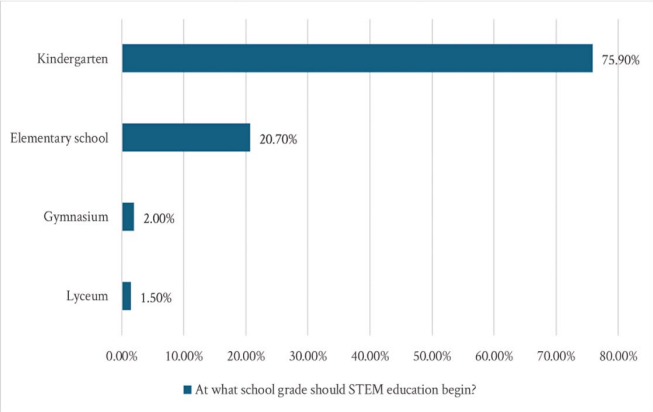

Figure 1. Educational grade where STEM education should begin (Figure created by the authors)

insufficient technical support (Coppola et al., 2015), the insufficient number of computers with an Internet connection (Bal et al., 2021), insufficient bandwidth or insufficient Internet speed (Bal et al., 2021), the insufficient number of laptops and outdated computers in the school that need repair (Bal et al., 2021).

RESULTS

At What School Level Do You Think STEM Education Should Start?

When asked at what school grade they think STEM education should start, 154 teachers (75.9%) responded that it should start in kindergarten, 42 teachers (20.7%) responded in elementary school, 4 teachers responded in gymnasium (2.0%), and 3 teachers (1.5%) responded in high lyceum (**Figure 1**).

Justification of participants' answers for the school level from which STEM should start

The answers given by teachers by education level are as follows:

1. STEM education should start from kindergarten because
   - "the earlier, the better."
   - "development of skills of cooperation, teamwork, exploration, problem-solving, critical thinking, and project management."
   - "there is time to develop such projects."
   - "children become familiar with the scientific approach, observation, experimentation, and calculation."
   - "they acquire technological knowledge."
   - "they discover their talents and acquire the necessary skills for the future."
   - "it helps in the organization and flexibility of thinking, creativity, and the use of ICT in a creative way."
   - "it helps children improve their perception of themselves and those around them."
   - "it helps in the way of thinking."
   - "of consolidation."
   - "of familiarization of children from an early age."
   - "to prepare children for the next levels."
   - "STEM has a playful form, which is completely consistent with the nature of toddlers."
   - "toddlers can do it since they have computational thinking."
   - "children can program robots according to their age, and it is a subject that excites them."
   - "children at this age can better assimilate knowledge of this level."
   - "STEM is included in the new curriculum for kindergarten."
   - "building and experientially acquiring knowledge through discovery."
   - "it is an attractive way of teaching for children."
   - "through STEM, they learn how to learn."
   - "of the readiness of the students."
   - "these are things we do in kindergarten: experiments, constructions with wooden building materials, constructions with waste materials, and Beebot robots."
   - "helps in brain development."
   - "it is important for children's socio-emotional development and the demands of the modern era."
   - "combines learning with play."
   - "promotes children's motivation."
   - "contributes to the transformation of schools into creative hives of knowledge and innovation."
   - "algorithmic thinking must be cultivated from an early age."
   - "the innate curiosity of toddlers plays an important role in STEM education."
   - "the evolution of technology requires children to be familiar with STEM."
   - "the conquest of space and routines are the first algorithms."
   - "activates and increases children's interest in science."
   - "STEM promotes an interdisciplinary approach to knowledge and learning."
   - "there is appropriate software."
2. STEM education should start in primary school due to
   - "immaturity in preschoolers."
   - "demand of the time."
   - "gaining comfort."
   - "familiarizing students from an early age."
   - "to acquire the appropriate skills."
   - "to prepare students to handle digital tools and systems."
   - "beginning the cultivation of computational thinking."
   - "broadening children's view of technology beyond mobile phones and gaming machines."
   - "it will have an effect at older ages."
   - "it is difficult for young kindergarten children to understand."
   - "STEM can be supported by an IT teacher."

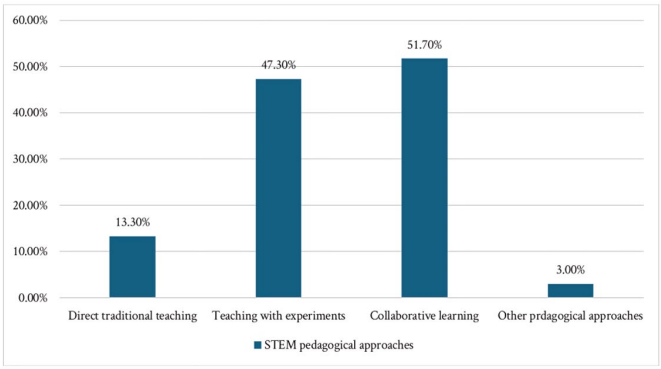

Figure 2. STEM pedagogical approaches (Figure created by the authors)

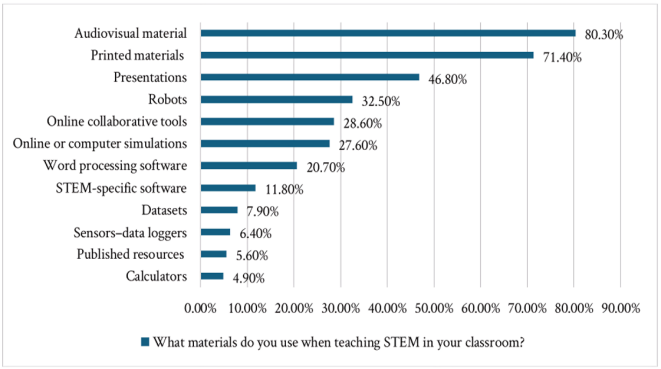

Figure 3. What materials do you use when teaching STEM in your classroom? (Figure created by the authors)

Table 1. Correlation of traditional direct teaching–Audiovisual material

What pedagogical approaches do you use when teaching STEM subjects in your classroom? Traditional direct teaching * What materials do you use when teaching in your classroom?–Audiovisual material crosstabulation

			What materials do you use when teaching in your classroom?–Audiovisual material		Total
			Yes	No	
What pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	Yes	Count	22	5	27
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	81.5%	18.5%	100%
	No	Count	141	35	176
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	80.1%	19.9%	100%
Total		Count	163	40	203
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	80.3%	19.7%	100%

- "children can better understand some commands."
- "children are more mature in age."
- "in the last grades of primary school."
- "to correlate mathematics, natural sciences, and ICT."
- "children have higher analytical thinking and assembly skills."
- "it takes a long time to get used to."

3. STEM education should start in gymnasium because
   - "STEM requires students to master complex skills, which is only possible at this age."
   - "of the students' higher abstract thinking."
   - "students can cope effectively."
   - "children have higher synthetic and abstract thinking."
4. STEM education should start in lyceum because of
   - "the students' mental maturity."
   - "age."

What Pedagogical Approaches Do You Use When Teaching STEM Subjects in Your Classroom?

Regarding the pedagogical approaches used by teachers in their classroom when teaching STEM subjects, 13.3% responded that they apply direct traditional teaching, 47.3% teaching with experiments, 51.7% learning based on synthetic tasks (project)/problems, while 3.0% responded that they apply other pedagogical approaches than the aforementioned ones (**Figure 2**).

The other pedagogical approaches mentioned by teachers were as follows:

1. experiential approach,
2. inquiry learning,
3. theatrical play and puppetry, and
4. simple robot presentation

What Materials Do You Use When Teaching in Your Classroom?

When asked what materials teachers use in their classroom when teaching, 4.9% mentioned calculators, 5.6% mentioned published resources from private companies active in the STEM fields, 6.4% mentioned sensors–data loggers, 7.9% mentioned datasets, 11.8% mentioned STEM-specific software, 20.7% mentioned word processing software, 27.6% mentioned online or computer simulations, 28.6% mentioned online collaborative tools, 32.5% mentioned robots, 46.8% mentioned presentations, 71.4% mentioned printed materials and 80.3% mentioned audiovisual material (**Figure 3**).

Correlation of Pedagogical Approaches Used by Teachers When Teaching STEM Subjects in Their Classroom and Materials They Use

Direct traditional teaching

81.5% of teachers who apply direct traditional teaching use audiovisual (**Table 1**) and printed materials (**Table 2**) in their classroom, 37.0% presentations (**Table 3**), 29.6% robots (**Table 4**), 0.0% sensors–data loggers, calculators, and resources published by private companies active in the STEM fields.

Table 2. Correlation of traditional direct teaching–Printed material

What pedagogical approaches do you use when teaching STEM subjects in your classroom? Traditional direct teaching * What materials do you use when teaching in your classroom?–Printed material crosstabulation					
			What materials do you use when teaching in your classroom?–Printed material		Total
			Yes	No	
What pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	Yes	Count	22	5	27
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	81.5%	18.5%	100%
	No	Count	123	53	176
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	69.9%	30.1%	100%
Total		Count	145	58	203
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	71.4%	28.6%	100%

Table 3. Correlation of traditional direct teaching–Presentations

What pedagogical approaches do you use when teaching STEM subjects in your classroom? Traditional direct teaching * What materials do you use when teaching in your classroom?–Presentations (MS PowerPoint, Libre Office Impress, Sway, etc.) crosstabulation					
			What materials do you use when teaching in your classroom?–Presentations (MS PowerPoint, Libre Office Impress, Sway, etc.)		Total
			Yes	No	
What pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	Yes	Count	10	17	27
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	37.0%	63.0%	100%
	No	Count	85	91	176
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	48.3%	51.7%	100%
Total		Count	95	108	203
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	46.8%	53.2%	100%

Table 4. Correlation of traditional direct teaching–Robot

What pedagogical approaches do you use when teaching STEM subjects in your classroom? Traditional direct teaching * What materials do you use when teaching in your classroom?–Robot crosstabulation					
			What materials do you use when teaching in your classroom?–Robot		Total
			Yes	No	
What pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	Yes	Count	8	19	27
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	29.6%	70.4%	100%
	No	Count	58	118	176
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	33.0%	67.0%	100%
Total		Count	66	137	203
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	32.5%	67.5%	100%

Simulations via the Internet or computer are used by 18.5% (**Table 5**), special STEM software and datasets by 3.7%, word processing software by 14.8%, and online collaborative tools by 18.5%.

Teaching with experiments

70.8% of teachers who apply teaching with experiments use printed materials in their classroom, 80.2% audiovisual materials, 53.1% presentations (**Table 6**), 47.9% robots (**Table 7**), 10.4% sensors–data loggers, 5.2% calculators, 33.3% simulations via the Internet or computer, 18.8% special STEM software, 10.4% datasets, 24.0% word processing software and 33.3% online collaborative tools and 9.4% resources published by private companies active in the STEM fields.

Project-based learning

A percentage of 69.5% of teachers who apply PBL use in their classroom when teaching printed materials, 83.8% audiovisual materials, 61.9% presentations, 45.7% robots, 8.6% sensors, 3.8% computers, 38.1% simulations, 20.0% special STEM software (**Table 8**), 11.4% datasets, 41.0% online collaborative tools and 8.6% resources published by private companies.

CONCLUSIONS

Regarding the pedagogical approaches used by teachers when teaching STEM subjects in their classrooms, the majority of teachers responded that they use PBL/problem-based learning, and about half of them use experiment-based teaching.

Table 5. Correlation of traditional direct teaching–Online and computer simulations

What pedagogical approaches do you use when teaching STEM subjects in your classroom? Traditional direct teaching * What materials do you use when teaching in your classroom?–Online or computer simulations crosstabulation

			What materials do you use when teaching in your classroom?–Online or computer simulations		Total
			Yes	No	
What pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	Yes	Count	5	22	27
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	18.5%	81.5%	100%
	No	Count	51	125	176
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	29.0%	71.0%	100%
Total		Count	56	147	203
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	27.6%	72.4%	100%

Table 6. Correlation of teaching with experiments–Presentations

What pedagogical approaches do you use when teaching STEM subjects in your classroom? Teaching with experiments * What materials do you use when teaching in your classroom?–Presentations (MS PowerPoint, Libre Office Impress, Sway, etc.) crosstabulation

			What materials do you use when teaching in your classroom?–Presentations (MS PowerPoint, Libre Office Impress, Sway, etc.) crosstabulation		Total
			Yes	No	
What pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	Yes	Count	51	45	96
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	53.1%	46.9%	100%
	No	Count	44	63	107
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	41.1%	58.9%	100%
Total		Count	95	108	203
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	46.8%	53.2%	100%

Table 7. Correlation of teaching with experiments–Robots

What pedagogical approaches do you use when teaching STEM subjects in your classroom? Teaching with experiments * What materials do you use when teaching in your classroom?–Robot crosstabulation

			What materials do you use when teaching in your classroom?–Robot		Total
			Yes	No	
What pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	Yes	Count	46	50	96
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	47.9%	52.1%	100%
	No	Count	20	87	176
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	18.7%	81.3%	100%
Total		Count	66	137	203
		% within what pedagogical approaches do you use when teaching STEM subjects in your classroom?–Traditional direct teaching	32.5%	67.5%	100%

Table 8. Correlation of synthetic task-based learning–STEM-specific software

What pedagogical approaches … of STEM subjects in your classroom? PBL/problem-based learning * What materials do you use when teaching in your classroom? Special software for STEM crosstabulation

			What materials do you use when teaching in your classroom?–Special software for STEM		Total
			Yes	No	
What pedagogical approaches … of STEM subjects in your classroom? PBL/problem-based learning	Yes	Count	21	84	105
		% within what pedagogical approaches … of STEM subjects in your classroom? PBL/problem-based learning	20.0%	80.0%	100%
	No	Count	3	95	176
		% within what pedagogical approaches … of STEM subjects in your classroom? PBL/problem-based learning	3.1%	96.9%	100%
Total		Count	24	179	203
		% within what pedagogical approaches … of STEM subjects in your classroom? PBL/problem-based learning	11.8%	88.2%	100%

In contrast, direct traditional teaching follows in a very small percentage. Most teachers who apply direct traditional teaching use mainly audiovisual and printed materials, presentations, robots, simulations via the Internet or computer, and online collaborative tools in their classrooms. They use word processing software, special STEM software, and datasets very little, while they do not use sensors–data loggers, calculators, and resources published by private companies active in the STEM fields at all.

Most teachers who implement experimental teaching use mainly printed and audiovisual materials, presentations, robots, online or computer simulations, online collaborative tools, and word-processing software in their classrooms. Less frequently, they use specific STEM software, sensors–data loggers, calculators, datasets, and resources published by private companies active in STEM fields.

Teachers who implement PBL use printed and audiovisual materials, presentations, robots, online collaborative tools, and simulations in their classrooms. Less frequently, they use sensors, computers, special STEM software, datasets, and resources published by private companies.

There is no correlation between the pedagogical method and the materials teachers use to implement STEM programs. More specifically, the most popular materials teachers use in their classrooms, regardless of the pedagogical method followed, are audiovisual materials, printed materials, presentations, robots, online collaborative tools, simulations, and word processing software via the Internet or computer. Very small percentages mentioned special STEM software, sensors–data loggers, published resources from private companies active in the STEM fields, and computers. However, there seems to be a tendency for teachers who apply the project pedagogical approach and the pedagogical approach with experiments to utilize more modern materials–media in their classrooms, such as robots, software, etc.

The majority of teachers believe that STEM education should start in kindergarten (75.9%) (Ültay & Ültay, 2020) and are followed by a smaller percentage (20.7%) who answered that it should start in primary school, while very few stated that the appropriate school level for starting STEM education is gymnasium (2.0%), and lyceum (1.5%).

Those who answered that kindergarten is the most appropriate level to start STEM education justified their answer by stating that "the earlier, the better" and "there is a development of skills in cooperation, teamwork, exploration, problem-solving, critical thinking, project management," "there is time to develop such projects," "children become familiar with the scientific approach, observation, experimentation, and calculation," "they acquire technological knowledge," "they discover their talents and acquire necessary skills for the future," STEM education "helps in the organization and flexibility of thinking, in creativity, in the use of ICT in a creative way, in improving children's perception of themselves and those around them and in their way of thinking." Also, STEM education is suitable at this age "for consolidation, for familiarization of children from an early age and to prepare children for the next levels."

Furthermore, "STEM has a playful form, which is completely consistent with the nature of toddlers" (Kanadli, 2019). In addition, "toddlers can do it since they have computational thinking and can program robots according to their age, and it is a subject that excites them." Also, children at this age "can better assimilate knowledge of this level, and it is included in the new curriculum for kindergarten." Moreover, "the structuring and acquisition of knowledge is done experientially, through discovery, and is an attractive way of teaching for children" (Kanadli, 2019). Also, "through STEM they learn how to learn and these are activities that take place in kindergarten, experiments, constructions with wooden building materials, constructions with waste materials, Beebot robot." Furthermore, "STEM education helps in brain development and is important for the socio-emotional development of children and for the demands of the modern era" (Kanadli, 2019). It also "combines learning with play, promotes children's motivation" and "contributes to the transformation of schools into creative hives of knowledge and innovation." Furthermore, "algorithmic thinking must be cultivated from an early age and the innate curiosity of toddlers plays an important role in STEM education." Furthermore, "the evolution of technology requires children to be familiar with STEM" and "the conquest of space and routines are the first algorithms." Finally, STEM "activates and increases children's interest in science," "promotes an interdisciplinary approach to knowledge and learning," and "appropriate software exists."

Those teachers who responded that STEM education should start in elementary school justified their answer by citing the "immaturity of preschoolers," "demand of the times," "to gain comfort and familiarity for students from an early age," "to have the appropriate skills," "to prepare them to handle digital tools and systems," "to begin cultivating computational thinking," "to broaden children's view of what Technology is, beyond mobile phones and gaming machines," "because it will have an effect at older ages," "because an IT teacher can support STEM education," and "children can better understand some commands, as they are more mature in age." Another response was that STEM education "can start in the last grades of primary school," "so that mathematics, natural sciences, and ICT are related," "children have higher analytical thinking and assembly skills," and "it takes a long time to get used to it."

Those teachers who answered that STEM education should start in high school justified their answer by saying that "STEM requires students to acquire complex skills, which is only possible at this age," "due to the higher abstract thinking of students," "students can cope effectively," and "children have higher synthetic and abstract thinking."

Few teachers responded that STEM education should start in high school, justifying their responses "due to the mental maturity of students" and "due to age."

Limitations and Research Extensions

There are some limitations in this research. The sample used is not large enough, but it is representative of the trends and perceptions of Greek educators since it was distributed electronically to primary education schools in Greece (kindergarten teachers and teachers), serving in various regions of the country, considering the geographical particularities of each. Also, the answers given by the educators contribute to enriching the research on their perceptions regarding the starting level of STEM education, in agreement with the bibliographic findings so far that this education, to be effective and substantial, should start very early, already from preschool age (Kalogiannakis et al., 2018; Samara & Kotsis, 2023a).

To expand the research, further specialized STEM Implementation Programs could be implemented in primary education schools, and these Programs could be evaluated, e.g., in terms of the use of pedagogical approaches and materials in the form of questionnaires, by teachers and students, as has already been done in other research

(Samara & Kotsis, 2025b). With this place, an important repository of good STEM Practices will be created, which will offer, on the one hand, security and ideas to new teachers, but also a trigger for innovative Practices for the more experienced, with the ultimate goal of the generalized and systematic implementation of STEM at all levels of education.

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AI statement: Grammarly was used to improve the English.

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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