STEM POLICY'S INTEGRATION INTO THE GREEK EDUCATIONAL TEACHER TRAINING SYSTEM

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Abstract
Lately, there has been a global growing demand for STEM learning, an innovative, educational policy that combines four disciplines: Science, Technology, Engineering and Mathematics. It is a fact that developed countries such as the US, China, Belgium, Germany, etc. annually spend a large amount of government funding to this specific educational policy, as research has shown that through it, the economic development of a country is achieved. The purpose of this paper is the study of the policy's integration into the Greek educational teacher training system of the one-year Pedagogical Training Program of ASPETE (School of Pedagogical and Technological Education). Study findings reveal the true dynamics of this policy. Stem helps learners to understand courses more easily and quickly in relation to traditional teacher-centered teaching. Educators they are willing to use it in their educational process.

Key words: *STEM, educational policy, innovative learning methods, teacher training*
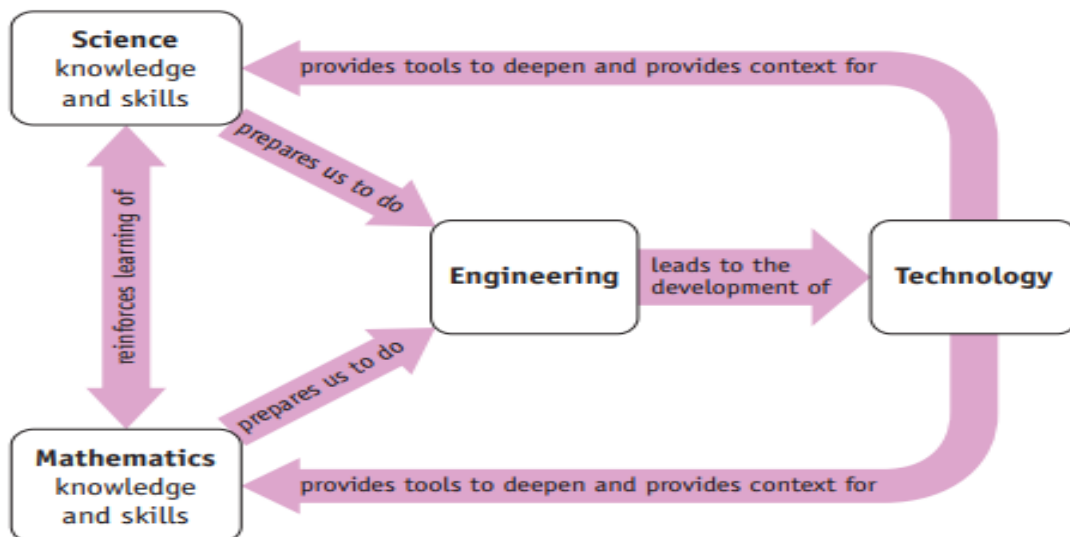
1 INTRODUCTION

The term STEM is, in fact, an acronym derived from the English words "Science", "Technology", "Engineering" and "Mathematics", and its main aim is to turn countries towards a modern and innovative educational policy concerning the exact sciences that include these four fields (Kuenzi, 2008).

The ultimate purpose of this shift includes two crucial issues. The first one, which is more direct, relates to the way students learn and tries, through teaching Science and Mathematics, to lead them to understand how the universe works and to improve the way they are using Technology, which along with Engineering, consist their means of interacting with the universe (Christenson, 2011). The second crucial issue, which could be described as long-term, consists in making students able to become "citizens of the world". The term describes people who, with the appropriate knowledge and education, can cope with a globalized society and be able to decide on vital issues such as their personal health, national security or energy dependency (Psycharis, Kalovrektis, Sakellaridi, Korres & Mastorodimos, 2017). The education provided to them is holistic and aims mainly to their critical competence and understanding that all modern problems are complex and multidimensional and that their solution is not based on a single field, on a single science, but interdisciplinarity is required. This results in the formation of citizens able to cope, in a global society, under any circumstances that might be called upon to work or to live. As Psycharis (2016) states, this policy aims to teach all four specialties in order to make students capable in resolving real problems and able to design objects using their knowledge of Science, Mathematics, Technology and Engineering (Psycharis, 2016).

The following figure illustrates schematically the four themes that form the STEM acronym and their interdependence (Watson, & Watson, 2013). We observe that, although for the most part, these four lessons are taught individually, great emphasis is placed on the link between them. The pioneering, with the STEM study, is that it considers these areas as a single set, a totality and not separate lessons. The real meaning of the concepts is provided, since, for example, in the real world, science is based on technology, engineering and mathematics, while engineering is based on the achievements of physics and mathematics and is implemented with the use of technology. It could be characterized as a circle whose individual elements are in constant interdependence. Students benefit by using concepts from all four sciences and are able to design and to conduct scientific research, using computational methods and algorithms, and recognizing alternative explanations (Psycharis, 2015).

Figure 1 - Interdependence of STEM

Figure 1: Relationship Model of the STEM Initiative

Source: Watson, & Watson, 2013, Transitioning STEM to STEAM: Reformation of engineering education

Educational politics

STEM learning provides the groundbreaking fact that learners acquire general knowledge, useful for their later life, working as members of a team who are obligated to co-operate and to work together well and smoothly with each other.

By learning STEM, teacher-centered teaching is abandoned and student-centered teaching is promoted. More specifically, the central role in teaching has been given to students and to relationships they develop within the school environment. The aim of STEM learning is the collaborative, expansive-exploratory learning, in which students are required to work in teams from an early age in order to solve issues that arise, which requires their immediate involvement. This method provides the development of student's cognitive, social, moral autonomy, as well as the quest for knowledge first and foremost by themselves and not just the controlled transfer of knowledge from the

teacher (Matsagouras, 2000 & Chaniotakis, 2007). It has been proven that engaging students in teaching is vital, as it activates them. According to Wesson, the deeper knowledge comes from the activation of our entire brain (Wesson, 2012), while Morrison states that the most effective way for students to learn is experience, speech, discussion, and even confrontation, as it enables them to search and prove what they support (Morrison, 2006).

In addition, the general assumption is that STEM trainees have in common the 8 following features:

> ➤ They resolve problems - They are able to solve problems, such as puzzles, to understand them and to apply their conclusions to new situations
> ➤ They are innovative - They are able to use initial research in the design process
> ➤ They are inventors - They are able to recognize the needs of the world and to apply creative designing and solutions
> ➤ They are self-sufficient - They are able to develop and be self-confident and to work within defined timeframes
> ➤ They are reasonable thinkers - They are able to use reasonable thinking processes
> ➤ They are technologically educated - They are able to understand the nature of Technology and to have the skills that they need in order to use it correctly
> ➤ They participate in the STEM dictionary – They support the bridging between STEM training and the workplace
> ➤ They associate - They are able to relate their culture and history with education (Morrison, 2006).

Lately, efforts have been made in Greece in order to integrate STEM into education. The featured decision of the Institute of Educational Policy (hereinafter referred to as IEP) in 2015, states that: *"Incorporating STEM into the educational process is proposed by those who design curriculum, both because it better serves learning through holistic problem-solving, and because it consists a bridging to the gap between science and its applications. Therefore, a framework for teaching these sciences through an integration model can be considered more effective for the preparation of workers in the field of technology and science of the 21st century" (Stavropoulos, 2017)*, while two years later, in 2017, the IEP has sent the call for expressions of interest to school participation in project H2020 entitled "OPEN SCHOOLS FOR OPEN COOPERATIONS - OSOS" whose main objective was the creation of an open and innovative school, which based on natural sciences and objects of STEM, will be actively involved in issues of the local community (Fermeli, 2017).
A major contribution to the easier integration of STEM into education is the integration of ICT in schools, which enables educators to create digital teaching scenarios that reflect the designing of the teaching process in relation to a specific subject matter and a specific module of it, having defined content, clear objectives, specific teaching method and activities (Tsalagiorgou, Valsamidou & Melliou, 2016). Digital teaching scenarios constitute an innovative way of learning and can be designed with the assistance of interactive digital platform tools such as "Photodentro" and "Aesop".

Finally, it is worth noting that STEM learning consists a new "post-science" teaching area, which includes activities concerning all learning levels, from pre-school to post-

doctoral level, and can be applied both to formal structures, such as school, and to extra-curricular classes (Gonzalez & Kuenzi, 2012 & Morrison, 2006).

2 Methodology and Sample Features

The purpose of this article is to explore educators' points of view, as far as it concerns the role and use of STEM in their teaching. In order for this research to be conducted, the following individual research objectives were drafted:

- First objective: To explore educators' points of view on using STEM in the educational process
- Second objective: To explore educators' points of view on how much STEM helps students and
- Third objective: To explore educators' points of view on the integration of STEM into the Greek school reality and whether schools dispose the appropriate equipment for using it

Whereas, in order to achieve the above research objectives, the following research questions were formulated:

- ➢ Research Question 1: Do you think educators are willing to use STEM in their teaching?
- ➢ Research Question 2: Do you think that STEM helps students to understand subjects more easily and quickly than the classical teacher-centered teaching?
- ➢ Research Question 3: What do you think of STEM as a training tool in our country and is there the adequate school equipment for its use?

In order to conduct the survey and gather the required data, a questionnaire was used as a well-structured and well-formed instrument, based on previous published surveys (Dimakopoulos & Panagiotakopoulos, 2011 & Nemoto & Beglar 2014). The questionnaire included 17 questions pertaining to the personal data of respondents such as age, gender, studies etc. and questions that mentioned the studying of STEM as a means of teaching,and the necessary preconditions for its inclusion in schools, and for methodological objectives these questions were grouped into four categories:
- ❖ The personal information of the educators
- ❖ The aspect of educators on using STEM in their teaching
- ❖ The aspect of educators on the role of STEM in students' learning
- ❖ The aspect of educators on school equipment regarding the use of STEM

The questionnaire was answered by both active and potential educators within 5 minutes, as it contained closed-type questions, which means "multiple choice" and "multiple answer" answers (Petropoulou & Kasimati & Retalis, 2015). What is positive about this kind of questions is that: a) it is easier and quicker for the trainee to answer b) more questions can be answered in less time, as answers do not require development and c) questions are more specific and do not require development of critical thinking. On the other hand, however, such questions pose the risk that the respondent: a) is obligated to choose between specific alternatives he may have not thought of, b) might not be given the opportunity to develop their creativity and personal

ideas and views and c) requiring specific skills in order to choose the correct answer, which they may not have in their disposal (Siniscalco & Auriat, 2005).

Besides creating the questionnaire, the representative sample was also necessary, in order to be lead to a valid result. For this reason, this questionnaire was answered by the students of ASPETE Patras and by educators of various specialties. The questionnaire was created using **Google Docs Forms or Google Drive**, and thereafter was sent by email and communicated to the Facebook page created by students, as well as to the Facebook page of English Literature Teachers'.

3 Research results

Our aggregate sample consists of 60 educators, active and potentially, of different specialties, who, as shown by their specialties, teach or will teach at primary and secondary education.

The first grouping of responses includes **Table 1,** showing the general characteristics of the sample surveyed, which means their age, gender, education and current occupational status.

Studying this table, we observe that the majority of respondents belong to the 22-32 age group (53.3%), while the second age group (33-43 years) has the second highest percentage (30%). This is followed by the age group 44-54 with 15%, while there is a single answer (1.7%) at the age of 55 years and over. Concerning the second question and the sex of the sample, it is noted that the overwhelming majority of the participants are women, with 75%, while men follow with 25%. Moreover, 58% of the respondents stated that they hold a higher education degree (university level education), while others, with a small difference, also hold a postgraduate degree with a 41,7%. Finally, more than half of respondents (33 responses) state that they are potential educators with 55%, while active educators follow with 45%. Percentages in the occupational situation, where most of the sample participants being potential educators and women, may have been affected by the fact that the questionnaire was shared through the pages of ASPAITE and English Literature on Facebook. Finally, it is worth mentioning that most of the respondents are school teachers, with 13.3% and a total of 8 answers, followed by English Language Teachers with a total of 7 answers. The following are the specialties of Informatics with 6 overall answers and the specialties of Economists and Nurses with 4 answers each. Other specialties present fewer responses.
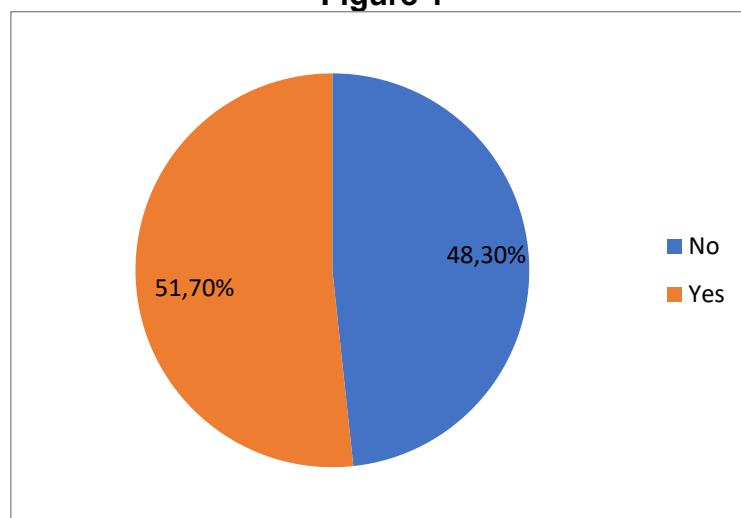
Table 1 - General Sample Features

General Sample Features		Percentage
Age	22-32	53,3%
	33-43	30%
	44-54	15%
	≥55	1,7%
gender	male	25%
	female	75%
Level of Education	University degree	58,3%
	Msc	41,7%
	Phd	0%
Professional situation	Active	45%
	Potential	55%

In the second set of questions, educators were asked to answer questions about the main topic of the research, STEM, and thus, STEM in their teaching. The questions they had to answer were related to whether they had heard of the term, whether they knew what STEM is about, whether they were using it or whether they were willing to use it. The results of the answers are illustrated in Figures 1-5.
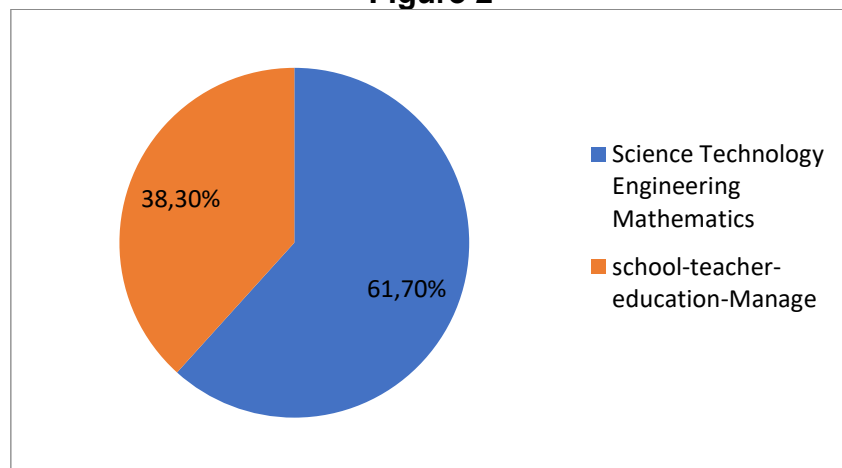
In **Figure 1**, educators were asked whether they had heard of this term again, and the majority of the sample, with 51.7%, responded positively that they do have had heard the term STEM and this is confirmed by both Figure 2, illustrating the sample's answer to "What do you think that STEM means", and Figure 3, which illustrates what the educators themselves believe STEM to be.

Figure 1

In **Figure 2**, 61.7% of respondents replied that STEM is an acronym derived from the English words of the four courses studying, which is Science, Technology, Engineering and Mathematics, while 38.3% answered that is an acronym derived from the English words School, Teacher, Education and Management, and perhaps it is the Teachers who had not heard of the term and belong to 48.3% of Figure 1 or perhaps they have indeed heard of it but are not aware of its origins.

Figure 2

In **Figure 3**, which depicts what the respondents think that STEM is, 78.3% responded that it is an innovative education policy, as opposed to 21.7% of the sample, that responded that STEM is a course plan.
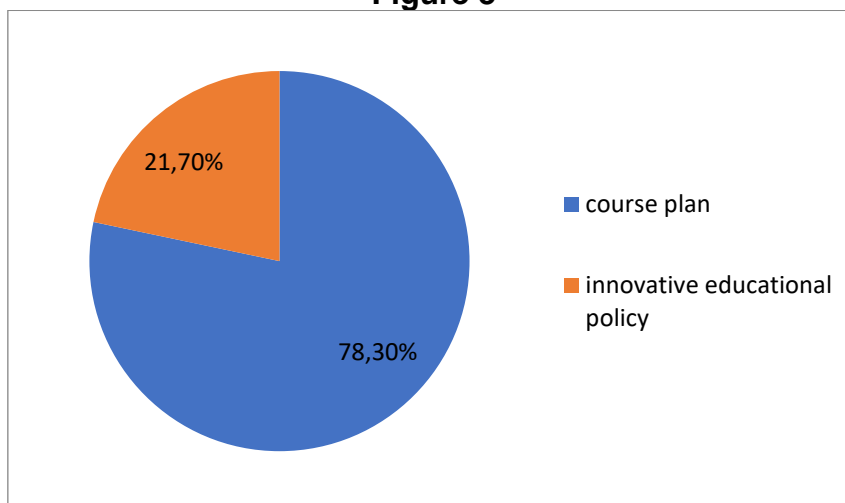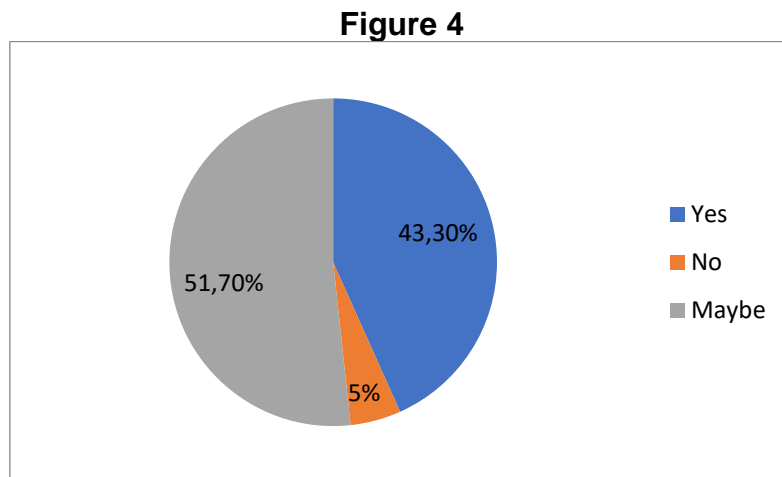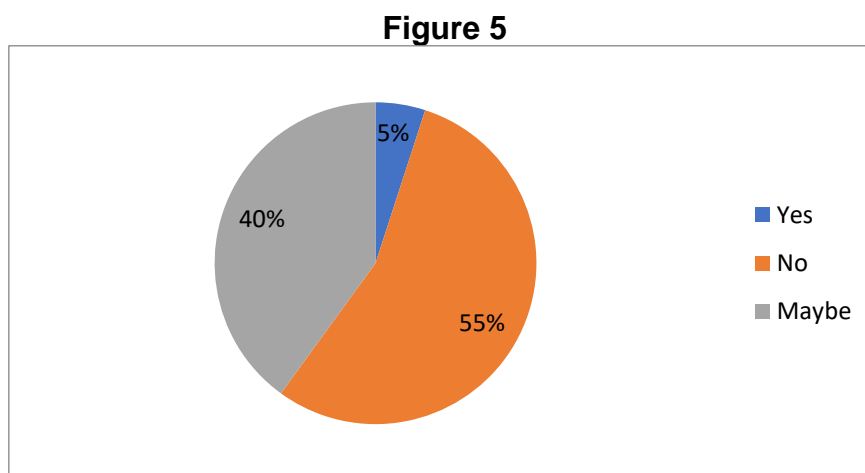
Figure 3

Figure 4 refers to whether educators would apply this policy to their teaching. 51.7% of the sample responded that they might use STEM during their teaching, while 43.3% were more positive and responded that they would be willing to apply it during the course. There were also 3 respondents (5%) who were rather negative about using it and for that, they stated that they were unwilling to incorporate it in their teaching.

Figure 4

Finally, in **Figure 5** the respondents were asked to answer whether using the STEM policy would have to be established as an obligation by the Ministry of Education. 55% of the respondents replied that it should not be mandatory from an institution, in particular the Ministry of Education, to integrate STEM into teaching, while 24 persons (40% of the sample), replied that it should be mandatory. Finally, as in Figure 4, there was also a 5%, that is, 3 persons, who stated that they would use it only if it was compulsory from the Ministry.

Figure 5

The Figures below (6-8) refer to the third grouping of questions, which concerns students and the role of STEM in their education. **Figure 6** outlines educators' aspects on whether STEM helps students to better understand the cognitive object in relation to the traditional form of teaching. 66.7% of educators were positive about this question and responded that they agreed it helped a lot, while 20% strongly felt that STEM

helped them a lot. Finally, 8 (13.3%) responded that they felt that they were of little help, while none of the respondents were negative about the help provided to students.
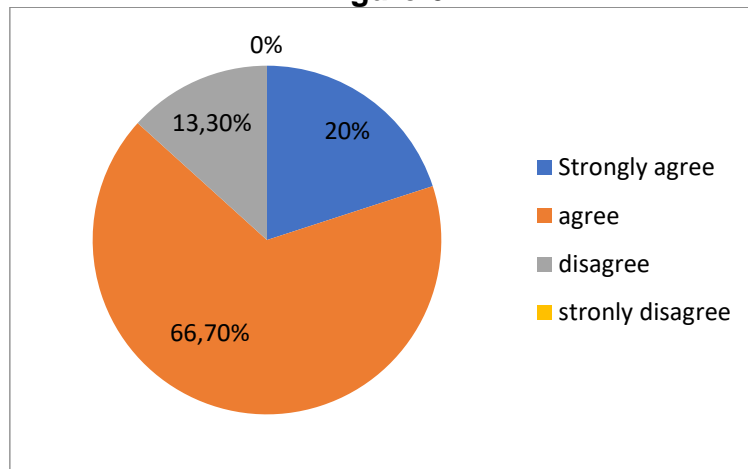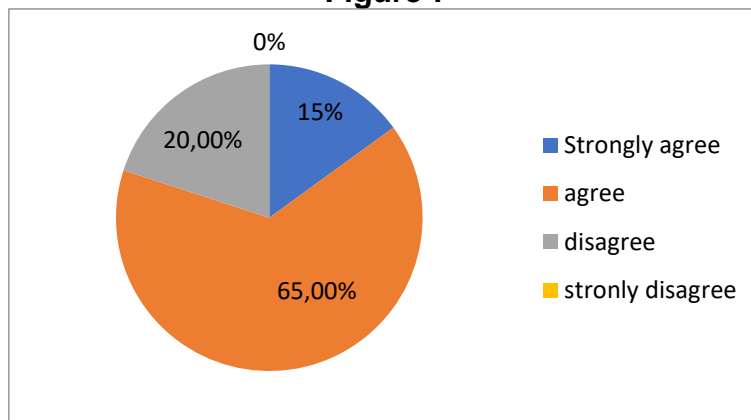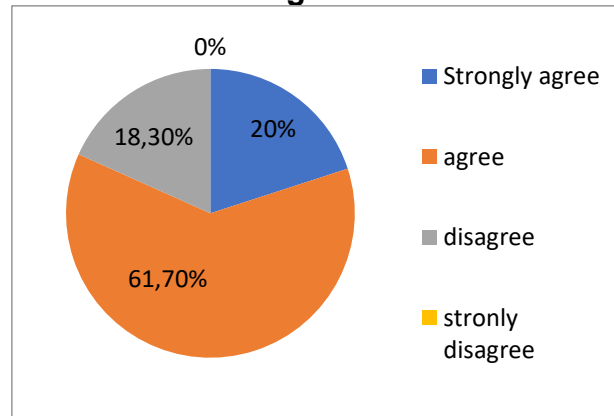
Figure 6

Figure 7 lists the views of educators on whether STEM helps students in their socialization. 65% of educators responded that they think that students through STEM are socialized enough, 15% stated that it helps them a lot, while 15% felt that STEM as a means of socializing contributes little.

Figure 7

Finally, **Figure 8** illustrates the aspects of educators on whether through STEM collaboration between students is achieved better. In this question as well, the educators were positive and 61.7% answered that through STEM the cooperation is achieved enough, 20% think it contributes greatly while 18.3% think that the results regarding the cooperation are minimal.
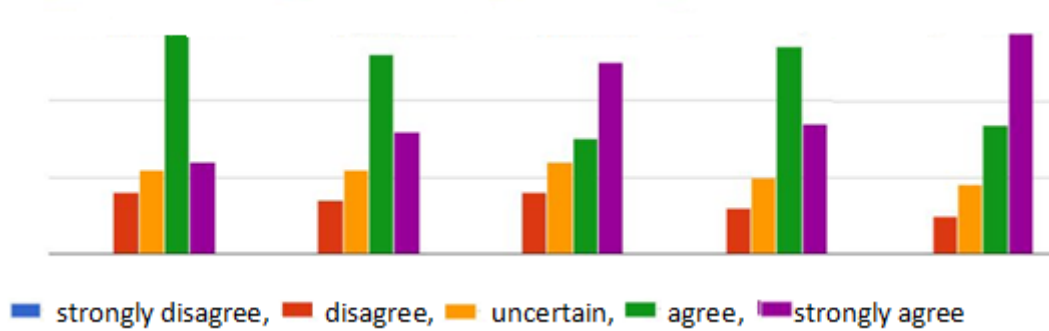
Figure 8

Finally, the four following figures (9-12) illustrate the last grouping of questions concerning STEM and education. Questions included concern the conditions that are necessary for STEM integration in schools, whether educators already use a digital scenario, in what level would it be more useful to integrate STEM teaching, and finally whether they believe that there already exists a Greek STEM educational association.

Figure 9 below shows educators' responses concerning the necessary conditions for the inclusion of STEM in schools. The preconditions that were deemed necessary when creating the questionnaire were the school's infrastructure, the equipment at disposal or the equipment that should have been at disposal for STEM integration, the training of educators on this new and innovative teaching method, the appropriate educational calculus, as well as internet use during the course. Respondents had to rate each of these suggestions on a Likert scale (Nemoto & Beglar 2014).

Regarding the first option given to them, the infrastructure, 29 educators stated that they are very much in agreement with the fact that it is an important condition for the integration of STEM into school reality, 12 educators agreed very much, 11 agreed moderately and 8 agreed very little. Equipment was also considered a prerequisite and 26 educators strongly agreed, 16 agreed, 11 agreed moderately, 7 agreed very little. The third condition was to train the educators themselves regarding STEM and once again the sample responded positively. 25 of the respondents strongly agreed with their training, 15 agreed very much, 12 agreed moderately, and 8 agreed very little. The fourth condition was the use of the appropriate equipment to achieve STEM teaching. From the total number of participants, 27 stated that they were very much in agreement with the present proposal, 17 agreed very much, 10 agreed moderately, and 6 agreed, but very little. Finally, the last condition for the inclusion of STEM was the use of internet. 29 educators out of the 60 of our total sample responded strongly to this suggestion, 17 agreed very much, 9 agreed moderately, 5 respondents stated that they had little agreement. As can be seen from the attitude of the main actors involved in education, regarding the necessary conditions for using STEM in their teaching, the majority of educators have a positive attitude as long as there are appropriate preconditions that will work in a supportive way.

Figure 9

In **Figure 10**, educators were asked to answer if they themselves use some of the platforms of digital teaching scenarios either during the course or as a suggestion to students to implement activities or tasks. 53.4% stated that they did not use any repositories, 36.2% use Photodentro and only 10.3% use Aesop.
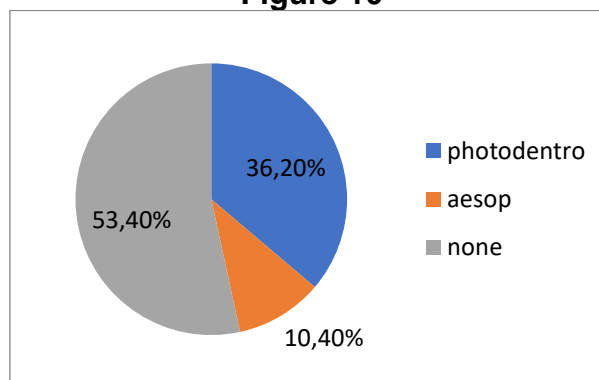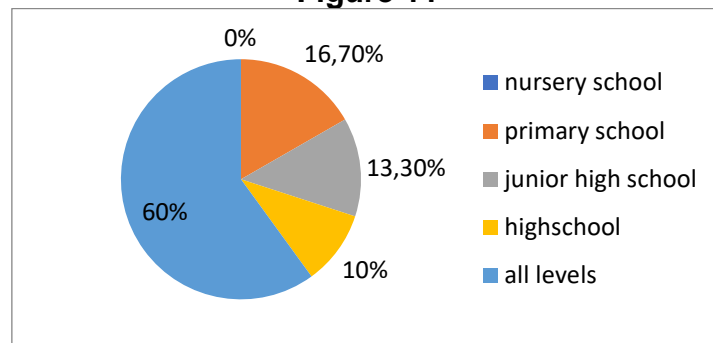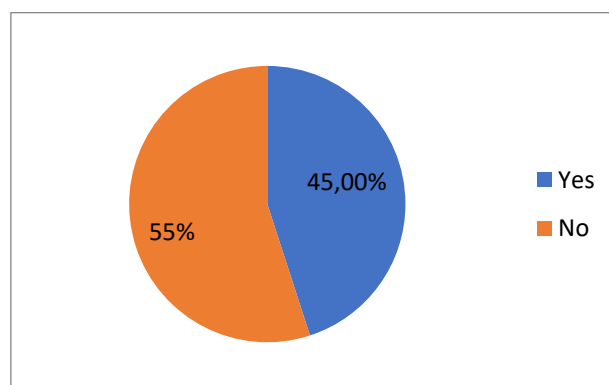
Figure 10

Figure 11 illustrates the viewpoint of educators as to the degree to which they consider STEM to be more useful. 60% of respondents replied that they considered all grades, both primary and secondary, equally important for STEM teaching. The second main category, with large deviation from the first one, was 16.7%, which considers primary education to be the most important and in particular its teaching should be included in Primary School, followed by Junior High School with 13.3% and finally High School with 10%. It is impressive that 60% chose all grades and included nursery school and thus agreed with research that have shown that the inclusion of STEM in kindergarten and the contact of children with this subject from their pre-school age has many positive benefits for their subsequent development (Tsalagiorgou, Valsamidou, & Melliou, 2016).

Figure 11

The last figure of this paper, **Figure 12**, illustrates the viewpoint of educators about whether they know if a Greek STEM training association already exists. It could be said that this question was the only one that educators' responses did not accurately respond to reality, since the majority of the sample, with 55%, did not know that there was such an association, while 45% responded that they knew of it. The correct answer, as analyzed in this paper, is that such an association has existed since 2017 and its main objectives are the dissemination of methodology, the training of educators and students, and the creation of seminars and proposals to integrate STEM into all educational levels.

Figure 12

4 Conclusions

The first objective of this paper was to explore the aspects of educators on the use of STEM in the educational process. To make this feasible, educators would have to answer whether they had heard of that term, whether they really know what it is and whether they are already using it or are willing to do so in the near future. The results of the questionnaire could be described as encouraging, as the majority of the sample was informed about this particular educational policy. 61.7% of the respondents correctly answered that STEM is an acronym derived from the initials of the English words of the four courses that studies, Science, Technology, Engineering and Mathematics, while in addition to this question, we could point out that 78.3% of the sample responded that STEM is indeed an innovative educational policy rather than a course plan.

The second objective was related to the viewpoints of educators on the interaction of STEM and students. In particular, the first question that was posed to educators was whether STEM helped students to better understand the cognitive object compared to older methods. 66.7% of educators were positively related to this question and replied that it helped enough. Educators were also positive about the impact of STEM on socialization and student collaboration. It is worth stating that 65% of educators responded that they think that students through STEM are socializing enough while concerning cooperation, 61.7% answered that through STEM it is achieved enough. These responses are particularly important as they prove that STEM really does what it was intended for. STEM is a student-centered form of teaching that, in order to solve its problems, it is obligatory for students to cooperate with other members of the classroom.

Finally, the third and final objective was to explore the viewpoints of educators on the integration of STEM into Greek school reality and whether schools dispose the appropriate equipment for its use. Regarding the necessary prerequisites for the integration of STEM into education, it is worth noting that none of the participants disagreed with any of the choices given to them and their answers ranged through the Likert scale from I agree very much until I agree minimum. The conditions that were deemed necessary when creating the questionnaire were the school infrastructure, the equipment they disposed or should have disposed for STEM integration, the training of educators on this new and innovative teaching method, the appropriate educational calculus, as well as internet use during the course.

A positive impression also arises from the fact that the educators were also in agreement with the proposal for their own training so that they could then be able to use it. In addition, 60% of educators believe that the study of STEM is useful at all levels, although 53.4% of them do not use a digital repository. Finally, regarding the question of whether a Greek educational STEM association exists, 55% of the sample was not aware of it. This, of course, is due to its recent creation, although its work is already significant.

In conclusion, it could be said that learning STEM helps people to acquire critical thinking and to be able to find viable solutions both in simple daily and in the more complex problems they face. What is essentially allowed through STEM is that they become thinking people who have as their background a universal, humanistic and

general education based on multiple scientific domains, thus becoming active citizens with social and political concerns. In addition, through STEM, students learn complex concepts in an interactive way, without having to memorize terms that they often do not understand.

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