STEAM Education in the View of the Bulgarian Teacher

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Abstract **– The reality we live in is constantly changing, modern technologies comprise all spheres of life, changing it irreversibly. These transformations require completely different knowledge, skills, and especially competencies with the modern human. To meet these needs adequately, the educational system is also changing - new approaches, methods, and technologies of teaching are being introduced. The purpose of the study, which found a place in this report, is to examine the teacher's position and opinion on the very popular STEAM training in the Republic of Bulgaria during the last two years.**

Keywords **– STEM, STEAM, teacher competencies, teacher opinion.**

1. Introduction

STEAM education in Bulgaria has gained wide popularity only in the last two years, with the introduction of a Ministry of Education and Science program, equipping school institutions with STEAM centers.

If we take a look back we shall understand that STEM education does not have a long history [1]. The abbreviation STEM was first proposed by the American scientist R. Colwell in the 90s and began being actively used at the dawn of the 20th century [2].

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Initiated in the United States, STEM training has spread to countries that have suffered from a lack of interest in STEM careers [3]. The credit for upgrading STEM to STEAM by introducing the arts into it goes to Georgette Yakman, an engineer and technology teacher who founded the STEAM educational framework in 2006 [4]. The introduction of new integrative approaches to STEM education over the last two decades is logical continuation of reform efforts [5].

In most developed countries - the USA, Israel, Australia, Britain, Japan, Canada, and others - the popularity of STEM education is constantly growing to date [2]. This interest reaches more than 450 million elements with a simple Google search, which includes the terms "STEM", "STEM education" or "STEM education research" [6]. Research in the field has increased significantly since 2010, and a large number of new publications in the field of STEM also suggests that they have received recognition from many different journals as a hot and important subject area [1]. There is currently global concern about the decline in high school students' interest in a science-oriented career [3]. And without specialists to manage modern robotic and mechanized technologies, constantly entering all industries and areas of business, global technological progress would be unthinkable.

In solving everyday problems people cannot distinguish between mathematical and other knowledge. Those issues cannot be solved without a set of knowledge because it is a combination of different aspects of knowledge. STEM combines several learning approaches that include science, technology, engineering and mathematics. The combination of these four aspects is a harmonious combination for dealing with problems that occur in everyday life [7]. STEM training aims to implement contemporary science topics in the classroom, aiming to include computers, robotics, programming, engineering, technology, design, virtual environment, applications, smartphones, games with a challenging creative and task-oriented approach. [3].

Traditional education cannot improve students' creative thinking skills. Therefore, an alternative is needed to improve students' skills. One alternative

learning activity that can be used as a means to increase the basic skills needed in this century is STEM learning [7]. Many studies show that STEM education contributes to students in different ways such as attitude, motivation and interest [6]. Mentoring is also considered to be one of the possible approaches to engaging and keeping more STEM students, and mentoring relationships can be particularly useful for improving STEM diversity among under-represented groups [8].

An interesting means to look at and justify building STEAM programs in schools is that this type of learning regime makes students more creative and empathetic. Creativity and empathy lead to happiness [9]. By incorporating art into STEM, students can use their analytical and creative minds to solve complex problems [4]. The participation of modern technologies could motivate students to participate more actively in the learning process.

However, STEM as an educational concept is problematic. There is no consensus on what this is, how it can be taught in schools, whether it should be taught as a separate subject or should be an approach to teaching components, what is the progression in STEM learning and how it can be assessed [10].

The important question arises regarding the desire and ability of teachers to work for all these educational changes to happen. A frequently discussed topic is the skills and competencies of teachers, including digital ones. Debates about the value of their training often revolve around technical interpretations of research, but the consequences are much greater [11].

There are many challenges facing the modern teacher - they include, not only mastering the specific skills for coping with all educational changes and innovations but also skills to motivate students to engage in various activities, often extracurricular. This was the reason that provoked us to conduct the study, which found a place in this report.

2. Implementation of the Study

Fifty-five primary school teachers from different settlements in the Republic of Bulgaria took part in the study. They completed a questionnaire containing 20 questions. Eight of them had open answers and the rest closed. The first four characterize the respondents' personalities and are related to their age, location, position, and professional experience. The other sixteen are directly related to their STEAM training.

Figure 1 shows the age distribution of the respondents. Unfortunately, we can note that the lowest percentage of participants is between 25 and 30, as well as 31 and 35 years. In total, participants under the age of 35 are only one-tenth of all respondents who completed the questionnaire. The largest group of teachers is aged between 46 and 50, namely 27%.

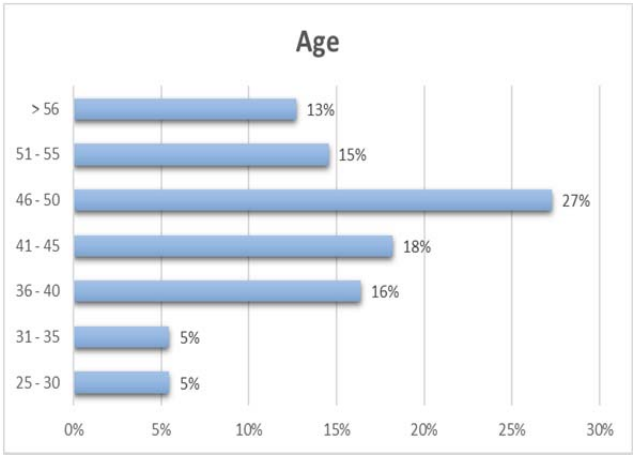

Figure 1. Age distribution of respondents

Figure 2 shows the distribution of respondents according to their professional experience as teachers. As seen, the highest percentage of participants with experience over 25 years, followed by those with experience between 20 and 25 years. In total, more than half of the respondents have significant experience (more than 20 years), which speaks of their professionalism and representativeness of the answers they gave.

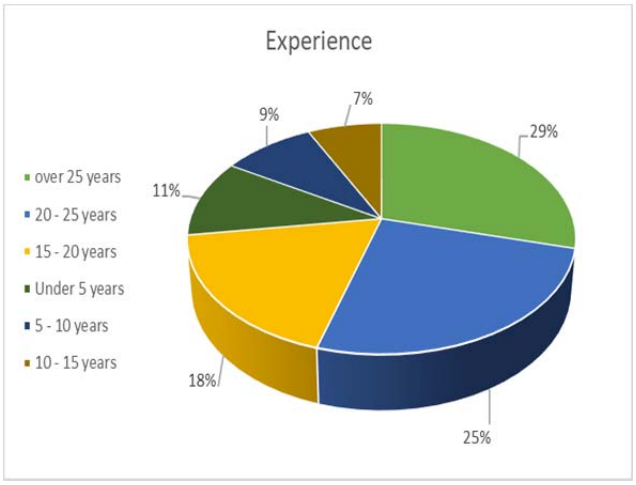

Figure 2. Distribution of respondents according to their professional experience

Figure 3 shows the distribution of respondents according to the settlement where they work. Here the values are relatively close, with the smallest share of teachers working in the capital of the Republic of Bulgaria - 20%, the largest is the number of participants practicing the teaching profession in a medium-sized city, followed by a slight difference from the representatives of large settlements. This diversity will contribute to the study of the views of people from different sizes of settlements and will allow us to compare the situation in them..

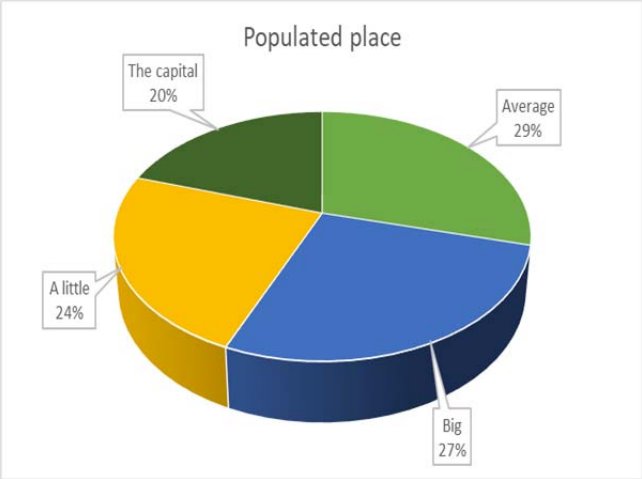

Figure 3. Settlement type where the participants teach

Figure 4 shows the distribution of respondents according to their position. The percentage of teachers is the highest - more than half, followed by the number of senior teachers - 38%. The representatives of the principals and the deputy principals are 2% each.

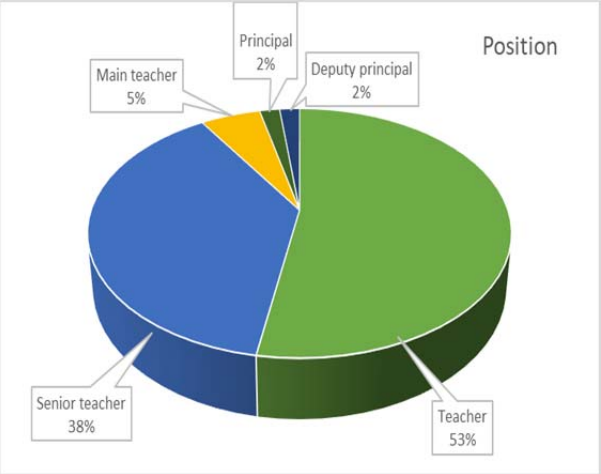

Figure 4. Distribution of participants according to their occupation

The first in the questions series dedicated to STEAM education is the one related to the types of pedagogical approaches whose respondents apply in this type of training. They can combine several pedagogical approaches in their work, so they can indicate more than one answer. Therefore, the Graph 5 shows the number of indications of the different answers, not their percentage distribution. The largest number of teachers use project-based learning. Close to the maximum result are the game approach and teaching with the application of experiments. We can attribute these results to the fact that these approaches are closest to the everyday life of modern children and, logically, they are accepted well by them. Interactive display, online demo of examples, and station learning are applied by only one teacher.

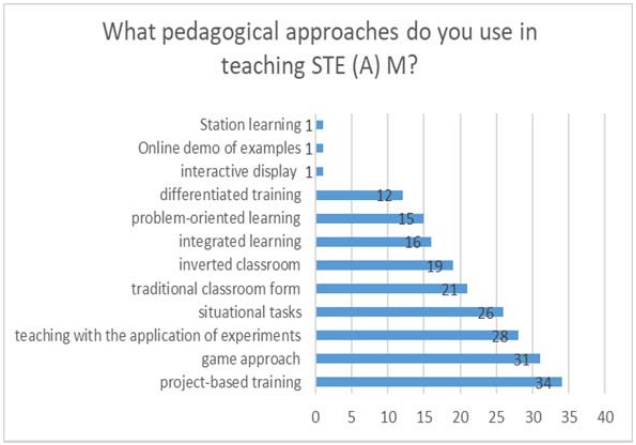

Figure 5. Pedagogical approaches applied by the respondents

Question 6 considers the resources/teaching materials used by teachers. The top three places are occupied by video materials, presentations, and online learning resources (Figure 6). They are listed by 40 to 46 respondents. These results do not surprise us, as these are probably the most accessible resources that teachers could find pre-developed and published on the Internet. Only one teacher indicated that he developed the necessary resource materials himself.

Figure 6. Resources and teaching materials used by teachers

The next question aims to explore the sources of information for teachers about STEAM training. Thirty-seven of them state they mainly receive information from social networks, twenty-three share that they have participated in training on the topic, and twenty-two draw experience from their colleagues. University professors and the media have almost equal numbers, 12 and 11, respectively. It turns out that only 3 teachers have consulted their principals, the principals of school institutions, for information. We are not surprised by the respondents who use social networks as their main source of

information, as we know how many self-help groups created by teachers – only exist for teachers, for example, on the social network Facebook. There are many of them, which were created specifically to discuss STEAM training, to share opportunities, ideas, and last but not least good practices and personal experience. The Covid-19 pandemic has provoked several researchers and scientists to organize a large number of webinars and online training on a variety of topics, including modern teaching methods. Most of the teacher trainings in the country are also conducted online to ensure the safety of all participants, both trainers and trainees.

The issue of providing teachers with the necessary devices to apply modern teaching methods was also important to us. Therefore, the next question was: "Do you use a computer when teaching STEAM?". Figure 7 presents the answers obtained. Unfortunately, we can note that despite the constant efforts of the Ministry of Education and Science to provide technical support for school institutions, only 62% of teachers indicate that they have an office computer at their disposal. 31% have a personal computer that they use for business purposes. Seven percent of respondents still do not have any device, and 2% of these are teachers who say they do not need one. Probably these are people who still prefer to work with older methods and techniques.

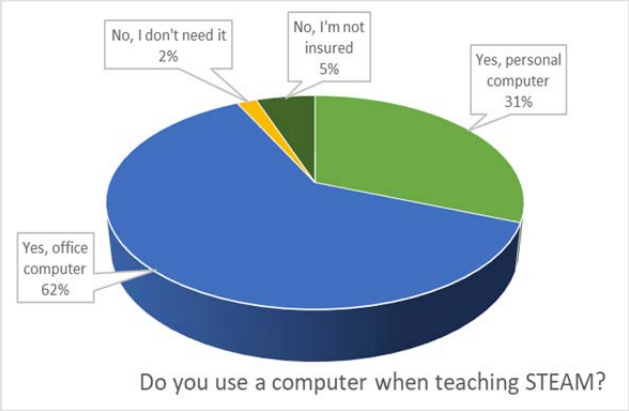

Figure 7. Application of computers during STEAM education

Due to the existence of a large number of different types of devices, we asked the respondents if they use another type of SMART device during this training. Here the results are similar (Figure 8), as the most significant difference is with the teachers, who share that they do not need any additional device - 9%. Again, we have respondents (5%) who categorically state that such a device is not provided to them, which means that they probably need it, but at the moment their institution cannot provide it. We can only hope that soon this situation will change for the better and there will be no teachers who suffer from the lack of modern technologies, because without them it would be difficult to be adequate to the constant technological field of education.

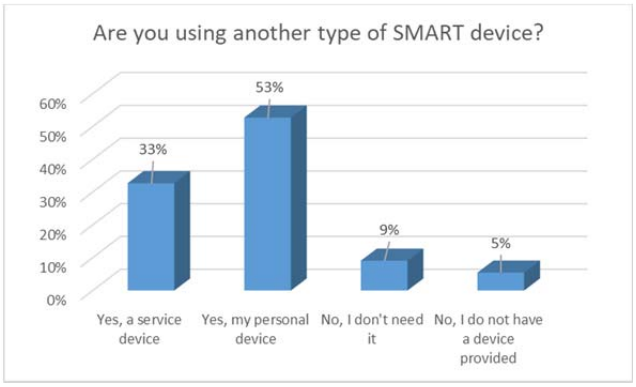

Figure 8. Application of additional SMART devices

In the last two years in Bulgaria a large number of STEM centers are being established in school institutions. Due to this fact, it was important for us to check what percentage of respondents already have access to such laboratories. Figure 9 presents the answers received to the question "Is there a specialized STEAM center in your school? When was it created?" Here, the largest number of teachers indicated that they have not yet established a center, but its establishment is imminent (42%). A total of 27% indicated that a similar center has already been built in their school.

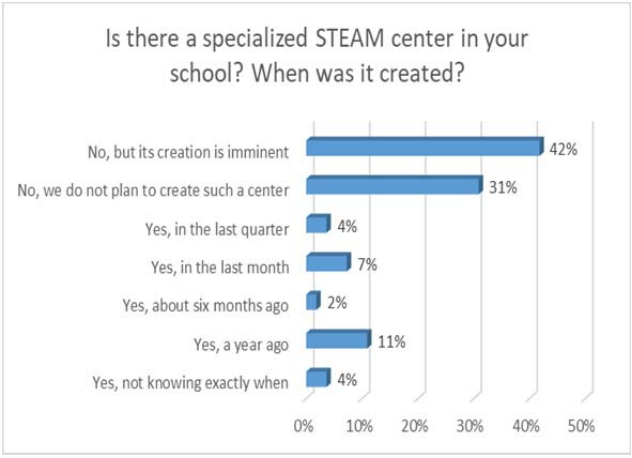

Figure 9. Existing STEAM centers

The next question was to find out what the funding of the centers and laboratories in question was. Almost half of the respondents (who answered positively to the previous question) state that they are not familiar. The next answer, which received 24% of the references, states that the centers were set up with the help of a European project, 7% were equipped thanks to a national program for STEAM schools. Only 5% were created with funds provided entirely by the school. 2% are relying on sponsorship from individuals and companies.

In addition to the technological provision of these centers, it is of great importance to provide staff training that is sufficiently qualified to successfully cope with the use of modern technologies with which STEAM centers are equipped. Extremely worrying is the fact that only 31% of the respondents say that similar training has been provided in their school. As we have already mentioned, the digital competencies possessed by teachers are extremely important for the proper conduct of this type of modern education. The results obtained were confirmed by the fact that only 27% answered in the affirmative to the question of whether they use this center. When asked whether they have been trained to apply STEAM approaches, 29% answered in the affirmative.

The next question confirms the need for such training, according to the respondents. To the question "Do you think you need this kind of training"? 64% answered positively (Figure 10). The total percentage of teachers who do not think they need such training is 11.

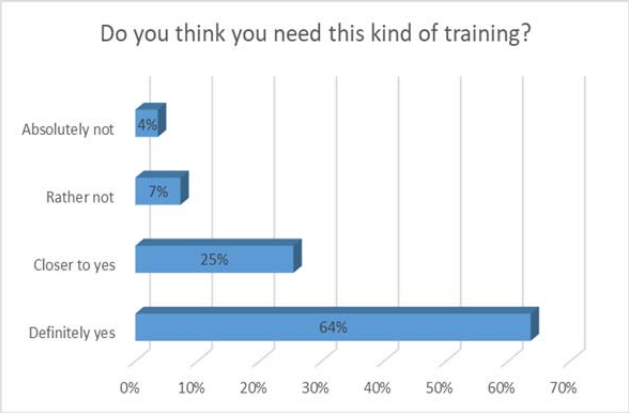

Figure 10. Need of training

After determining the technological security and the teachers' needs, it was time to study their opinion about the application of STEAM training. The first question in this series was when is the right age of starting this training. According to 42%, it is most appropriate for children to start STEAM between the ages of 7 and 10. Followed by 31% who believe that it would be more appropriate to introduce children to STEAM between 11 and 15 years. The lowest percentage of teachers who have chosen the age limit over 15 years - 7% (Figure 11).

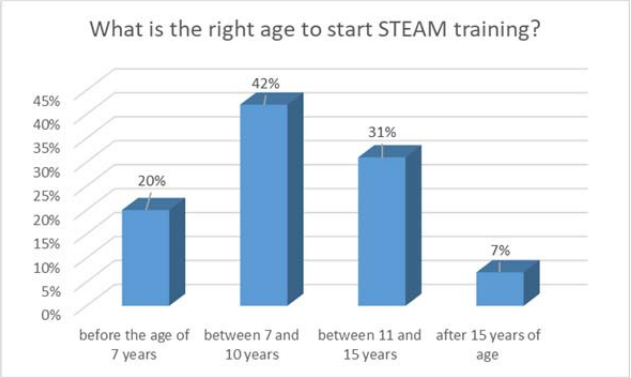

Figure 11. Suitable age to start STEAM training

On the question "What are the positive aspects of STEAM learning?", teachers most often point out: this type of learning activates students' interest, helps them to be easily engaged, combines visualization and experimental work, allows integration of learning content, students acquire knowledge imperceptibly, having fun, it is efficient and sustainable.

Concerning the negative aspects, the respondents indicate problems of organizing the training, rather than the characteristics of the training itself. For example, lack of material and technical base, lack of resources, the cost of equipment that is needed, as well as the possible harm of technology to children's health.

Asked whether they consider it necessary to create such a center in each school, less than 10% of respondents said no. According to them, the present and the future require it. It is also innovative and useful for students and the development of their life skills.

The question "What would you recommend to principals/teachers who are yet to learn about STEAM training?" we receive encouraging and motivating answers. For example: to invest in young and ambitious teachers who train competently so that they can achieve this type of training, to do everything possible to build STEM centers and provide the necessary training for teachers, to be curious and creative, and that they are not afraid of the new.

3. Conclusion

In conclusion, we shall formulate the following outcomes from the survey: in general, teachers hold positive opinion and attitude towards STEAM training. The main difficulties encountered in its implementation are rather organizational, which gives us hope that soon STEAM training will begin to work better in our country. One of the main problems that need to be solved at the national level is the organization of appropriate training dedicated to STEAM methods and approaches, as well as the safe work with technologies. Attention should be paid to teachers' opinions on the appropriate age for its introduction. The need for clearly defined curricula, including specific curricula for each class, is also important, as many teachers now apply these technologies mainly in extracurricular activities. When equipping STEAM centers, they have to be functional and practical, tailored to the age of the students who will use them, and above all safe for children's health. STEAM training can be extremely useful for developing students' thinking and competencies that are needed for their future successful realization in the modern labor market, as well as for life in general.

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