World Journal on Educational Technology: Current Issues

Volume 14, Issue 4, (2022) 1197-1204

www.wj-et.eu

Training teachers in science subjects through STEAM technologies

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Suggested Citation:

Zholymbayev, O., Zhumykbayeva, A., Dinar, O., Bibekov, K., Aigul, S. & Gulzhan, P. (2022). Training teachers in science subjects through STEAM technologies. *World Journal on Educational Technology: Current Issues*. *14*(4), 1197-1204. https://doi.org/10.18844/wjet.v14i4.7707

Received from January 16, 2020; revised from May 25, 2022; accepted from July 16, 2022.

Selection and peer review under responsibility of Prof. Dr. Servet Bayram, Yeditepe University, Turkey.

Abstract

The trainings given to produce from learning methods and techniques to problem-solving provide permanence in learning. There is a need for regulations so that they can develop the necessary knowledge and skills regarding science, technology, engineering, arts and mathematics (STEAM) education and increase the STEAM workforce in the country. In order for the education to be supported by technology, the teachers who provide education should have the qualification for these technologies. In this study, it is aimed to determine the opinions of prospective teachers studying in the science department, who are important stakeholders of the learning–teaching process, about STEAM education, which attracts great attention in the world. It is a prerequisite for this study for them to have taken the STEAM application in their courses. It is thought that this study, which deals with an up-to-date teaching approach, will be important for programme developers and science educators and to determine the opinions of prospective teachers who will give education in the future about this technology. The study is a case study from the qualitative research method design. For the research data, open-ended questions were prepared by the researchers, after obtaining expert opinions. The study group of the research consisted of 45 senior students studying science teaching at a private university. As a result of the research, it was concluded that the STEAM application was effective in teaching. It was stated that positive gains were achieved in students with the inclusion of art in the science, technology, engineering and mathematic activity. It was concluded that some preparations should be made before and during the implementation of the STEAM activity.

Keywords: Technology, STEAM education, science, pre-service teacher, teaching;

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1. Introduction

There must be a person who knows everything, and a cover is that the oil that underlies this promise must be something better than an ordinary individual. All the problems that are lost today will never come together. In a decoupling line, what is always important individually is a lot of competition in the field of science, technology and engineering, and with the insights and gebruik, anything can happen. Individually, one can understand what is happening here and solve problems. Here is this iron pot with 21st-century vaardighede; this kind of thing turned out to be the best practitioner for new and resourceful programmes with an empty process. 21st-century vaardighede is a new word (Ananiadou & Claro, 2009; Rotherham & Willingham, 2010). Regarding geletterdheid, mediageletterdheid, communicasie and tegnologie, the geletterdheid programme evolved into ideas and insights into the programmes held in 2005 and 2013. Dheid the wet hatter. If the agenda is an obstacle, then schools (Roberts et al., 2018) know the use of the integration of science, technology, engineering and mathematic (STEM).

Understanding the knowledge and applications of science and mathematics, as well as technological and engineering applications, has become a priority for national educational programmes around the world (Kelley & Knowles, 2016). The US Next Generation Science Standards primarily cover engineering design and applications, as well as elements of science education (Gess, 2017). Leaders and organisations from business, politics and education around the world have called for STEM-oriented teaching to increase academic rigor and prepare students for the workplace (Tytler, Osborne, Llogliams, Tytler, & Cripps Clark, 2008).

STEM are currently recognised. STEM is often used as a meta-discipline that builds bridges between de-coherent disciplines. STEMs as a whole should be included in each in order to create knowledge through applications or processes (Patil et al., 2020). STEM is a pedagogical approach that is included in courses from preschool education to higher education. Science, technology, engineering, arts and mathematics (STEAM) and STEM, as well as learning arts disciplines, especially between digital technology and new media production business, establish a connection. However, STEAM's pedagogy and nickname have sometimes been used in a way that does not fully take into account the epistemological or pedagogical potential of the deep integration of STEM and art (Bartlett & Bos, 2018; Conradty & Bogner, 2018; Hunter-Doniger, 2018).

The main benefits of STEM education are as follows:

1. Develops problem-solving skills;
2. Contributes to the development of the characteristics of creativity in the field of engineering using the basic knowledge and skills of people;
3. Contributes to logical thinking;
4. Instils an element of trust in people;
5. Ensures that technology is explained and understood (Morrison, 2006).

As a result of the research conducted, there seem to be studies related to the application of STEAM. Figliano (2007) identified three broad categories of STEM integration in his monograph titled 'STEM content integration strategies: an empirical case study'. He divided them into planning, implementation and evaluation, and came to the conclusion that they are directly related to the overall teaching processes. Another researcher, Schoettler (2015), in 'the German Foreign Language L2 in the Classroom Pays Special Attention to the STEAM Education Class', was in a foreign language teaching and research programme that explored social and national requirements as a result of having carried out the research, STEAM, and proposed methods incorporating elements and principles of a foreign language. Eroglu and Bektash (2016) took a closer look at the STEM-based course for science teachers who previously studied STEM education and teachers who studied the perspectives, activities and research activities in the field of physics. Through these activities, they found that it was problematic in terms of time and materials as science courses dismantled the relationship between technology, engineering and mathematics. In this study, they proposed to radically increase education and expand its content. Another study conducted with teachers aimed at attracting interest in STEM education comprehensively, where it is taught in a combination of collaborative and interdisciplinary connection areas. Technology is used in projects, experiments and modelling approaches as well as in teaching,

and is defined by time, material resources, curriculum changes, sample source materials and exchange of experience. However, the problems were stated as lack of information and training to participate (Aslan-Tutak, Akaygün, & Tezsezen, 2017).

Yamak, Bulut, and Dündar (2014), in their research on fifth-grade students, examined the effect of STEM activities on scientific process skills and undergraduate students' attitudes towards STEM. As a result of their research, they observed an improvement in the scientific process skills of students. Huanmin (2021) used the STEAM teaching model in his study and concluded that it is effective for teaching English. In 2020, the park focused on STEM education in advanced countries such as the United States and the United Kingdom. In South Korea, STEAM education is emphasised by adding art. The purpose of STEAM education is to strengthen students' interest and motivation, focus on experience, research, experimentation, convergent thinking and solving real-world problems, rather than hindering the method of teaching and memorisation. This work defines a teaching design for unified English, the official language and science of the world, present in almost all disciplines. Based on the PBL model with the development of the industrial revolution, students voluntarily attend classes in problem-solving skills. The instruction design based on the ADDIE model consists of five procedures, i.e., analysis, design, development, implementation and evaluation. The goal of encouraging talented people with national economic impact is also important, and teachers in education should recognise the importance of STEAM training, and appropriate teaching design should be constantly studied. Firdaus and Rahayu (2019), in their study, aimed to improve students' cognitive learning outcomes at the elementary school level. This research was conducted using a single group design before and after the experiment and the pre-experiment method. The courses were conducted using STEM-based learning, while the learning approach was directed to the engineering design process. The steps consist of creating a scope of the problem, generating ideas, designing and building, evaluating and redesigning the design. As an example, 30 students in fourth-grade elementary school from the city of Cimahi took part in the study. The data were collected by observation and analysed by quantitative descriptive analysis. The results of the research showed that there are differences in learning outcomes in the cognitive area. It has been concluded that STEM-based learning will improve the cognitive abilities of elementary school students.

1.1. Purpose of the study

The general purpose of this research is to determine the opinions of pre-service science teachers studying at university on the STEAM application. In order to achieve this general aim, answers to the following questions were sought. Science teacher candidates were asked to answer the following open-ended questions:

1. What are the positive and negative aspects of using technological tools (STEAM) in the classroom?
2. How does art affect STEM?
3. What should be considered during the STEAM implementation process?

1.2. Importance of the research

Along with the fact that technological tools affect every area of life every day, the variety of technological tools used in educational processes has also increased. Currently, research on the integration of technology and education it is quite valuable. While education constitutes one of the important building blocks of human existence, technology also has an important place that cannot be considered separately from this. With this topic, each related research has studies on the integration of technology and education it will serve as a guide for improving the quality and efficiency of educational institutions. The Department of Science Teaching is very important for students to determine their opinions, needs and suggestions about STEAM.

2. Methods

In order to achieve the purpose of this study, a qualitative research method was applied. A qualitative research method was used in case studies. A sample event, a single or several events in-depth studies of social events in a time period are presented (Yildiz, Gündoğmuş, Yener Aydın, & Atalay, 2020).

2.1. Universe and sampling

The study group of this study was selected from a purposeful sampling method chosen by the researcher in order to provide data on an event or phenomenon (Ary, Jacobs, Irvine, & Walker, 2014). The criteria were determined by the sampling method. The criteria can be prepared by the researcher or a pre-prepared list of criteria can be used (Kiral, 2020). The criteria determined for sampling in this study are that the teacher candidates studying in the science department participating in the study use STEAM applications. Again, it was ensured that the students selected in the same way were final year students. In this context, the sample of the study consists of 45 prospective teachers working in primary education.

Table 1. Demographic characteristics of the study group

Variable	Properties	*N*
Gender		
	Female	25
	Male	20

2.2. Collection and analysis of the data

Semi-structured interviews were conducted with university students in the study group included in the study. In the interview questions, one question was about demographic information and three questions were open-ended. Open-ended interview questions were on the reliability and validity of the form; measurement and evaluation of opinions; and academicians from the field of computer science. Two questions were removed with the clarity of the pre-application reviewed by three students. As a result of expert opinions and preliminary application, the necessary arrangements were made on the questions and the interview forms were made ready for the application. The questions in the interview form are as follows:

1. What are the positive and negative aspects of using technological tools (STEAM) in your classroom?
2. How does art affect STEM?
3. What should be considered during the STEAM implementation process?

The open-ended questions asked within the scope of the research questions were analysed by the content analysis method, which is one of the qualitative data analysis methods. Audio recordings of face-to-face interviews with final-year teacher candidates studying at the faculty of natural and applied sciences were obtained. After recording with the voice recorder, it was transferred to paper. The audio recordings written in the paper were then checked by pre-service teachers. In terms of the reliability of the study, participant approval was applied (Tekindal & Şerife, 2020). Then, related data were detected and coding was performed. The data were also analysed by an independent field expert and a reliability calculation was performed on the codes obtained using the formula proposed by Yanardağ (2020).

3. Results

3.1. Positive and negative aspects of using technological (STEAM) in the classroom

Table 2. Positive and negative aspects of using technological tools in the classroom

N	*f*
Diversity in learning	30

Positive	45	Alternative learning environment	10
		Fun lesson learning	10
		Keeping up with the digital age	8
		Easy measurement and evaluation	4
		Costly	23
Negative	45		
		Difficult to apply	17
		Connection lost	10

In order to determine the opinions of the students studying science teaching at the university about STEAM, which is a technological tool, firstly, a question was asked to get their views on the advantages and disadvantages of technology in education. All teacher candidates were asked to answer this question on their positive and negative aspects. On the positive side, there are 30 teachers who say that they provide learning with different techniques, 10 teachers who say that they offer alternative learning opportunities, 10 who say that they provide fun lesson learning, 8 teachers who see it as keeping up with the digital age and 4 teacher candidates who say that they provide easy measurement and evaluation. As a negative opinion, there are 23 teacher candidates who say that the use of technology is costly, 17 teacher candidates who say that it is difficult to apply and 10 teacher candidates who say that there may be technological negativities, such as Internet interruption.

Some of the examples of the opinions of the student candidates are as follows:

'It is very enjoyable to use technological tools in the classroom. We learn while having fun. It is very enjoyable for both teachers and students'.

'I think that learning is permanent thanks to the new methods used in learning. There is almost always a new technological product emerging. As digital natives, we ensure permanence in our learning with the inclusion of these products in learning'.

3.2. How art impacts STEM?

Table 3. How art impacts STEM?

Theme	*f*
Their creativity increases	35
Develops critical thinking skills	21
Affective gains increase	12
Opportunity to work across disciplines	4

The effect of including art in the STEM activity in science education was asked (Table 3). In addition to these gains, when art is included in the STEM activities of the students of the science teaching department, they stated that their creativity increases, their critical thinking skills develop, their affective achievements increase and the opportunity for interdisciplinary work also increases.

Some of the examples of the opinions of the student candidates are as follows:

'The field of art is directly related to STEM. In this way, creativity develops. Likewise, it encourages probabilistic thinking about the existence of different solutions and improves problem solving skills'.

'With the aesthetics added by art, the skill development of students will be faster. Its design can contribute to marketing and entrepreneurship with an aesthetic product'.

3.3. What should be considered during the STEAM implementation process?

Table 4. What should be considered during the STEAM implementation process?

Theme	*F*
Before application of STEAM	45
Situation analysis of students	31
Curriculum	30
Tools to be used	23
During application of STEAM	45
Guiding duty	34
Duration	28
Task distribution	22

Students studying in the science department were asked what they should pay attention to during the implementation of the STEAM activity. Two themes were identified for this finding: before the application and during the application. It emerged that students' situation analysis, the content of the teaching plan and the tools to be used should be considered before the application.

The answers of the students studying in the science department to the finding about what should be paid attention to during the application of STEAM application stated that the teachers should act as a guide; the importance of the time should be specified; and they should perform the distribution of tasks correctly.

An example of the opinions of the candidates is as follows:

'It is very important to correctly distribute the tasks of the students. The distribution should be made according to the interests of the students. Likewise, another element is the duty of guidance. The teacher should guide otherwise'.

4. Discussion and Conclusion

In order to determine the views of the students who receive science teaching education at the university about STEAM, which is a technological tool, firstly, their views on the multiplicity of technology in education should be consulted. The advantages and disadvantages of STEAM application were asked to the pre-service teachers studying in the science department. Subsequently, it can be said that there is a lot of positive aspects. From the answers they gave to the positive side, it can be said that the use of multiple techniques is advantageous in learning, and the STEAM application provides this. SETAM activity offers alternative learning opportunities. Another result is that there are 10 teachers who say that the STEAM application provides fun lessons; 8 teachers who see it as keeping

up with the digital age; and 4 pre-service teachers who said that it facilitates measurement and evaluation. As a negative side, there are 23 pre-service teachers who say that the use of technology is costly, 17 pre-service teachers who say that it is difficult to implement and 10 pre-service teachers who say that there may be technological negativities, such as Internet interruption. In this case, it can be concluded that the positive aspects of STEAM activity are very high.

Another application of STEM is the inclusion of art. In this regard, it is important to determine what is the effect of art on STEAM and the inclusion of art in the STEM activity. In addition to these gains, when art is included in the STEM activities of the students of the science teaching department, they stated that their creativity would increase, their critical thinking skills would improve, their affective success would increase and their interdisciplinary working opportunities would also increase.

Students studying in the science department were asked what they should pay attention to before and during the implementation of the STEAM activity. It is very important what kind of preparations should be made during the STEAM implementation phase and before the implementation. It was revealed that the situation analysis of the students, the content of the teaching plan and the tools to be used should be determined before the application. It was concluded that the teachers should be guides, the importance of time should be specified and the distribution of tasks should be carried out correctly during the STEAM application.

This work was supported by the Ministry of Education and Science of Kazakhstan,
Grant AP 09260305

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