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Examining Students' Opinions about STEAM Activities*

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Abstract

The purpose of this study is to determine the opinions of students about STEAM activities. This qualitative study was conducted on the with 7th grade students (n=37) who are studying at a public school in Istanbul. A purposeful sampling was used in this study. Nine STEAM activities were used while teaching Force and Energy unit. An evaluation form which is composed of open-ended questions was used as a data collection instrument at the end of the teaching process. The responses provided by students for the evaluation form were analysed qualitatively to determine the opinions of students about the activities. The study was structured as qualitative research and content analysis technique was used to evaluate the obtained data. The findings revealed that a relatively positive attitude about STEAM activities and the contribution that the approach had on students. It was therefore concluded that students have few negative opinions about STEAM activities.

Keywords: STEM, STEAM, STEAM activities, science education, force and energy

1. Introduction

Many countries have carried out various studies to implement STEM education for improving their students' achievements for a long time (Scott, 2012). STEM education received considerable official and institutional support in United States and European Union (Çorlu & Aydin, 2016). In recent years the importance of STEM education has also increased in Turkey. Akgündüz and others created awareness with their reports about STEM education in Turkey which was published in 2015 and exhibited the necessity of STEM education. Ministry of Education emphasized the importance for the necessity to integrate STEM education into education system in its report which was published in 2016. A report which is called as 'The Necessity of STEM in Turkey through 2023' was published by TUSIAD (Turkish Industry and Business Association) in 2017. The key importance of STEM subject areas was discussed and the need for the workforce who has STEM abilities in the future economy was explained in this published report. These reports display the necessity of STEM education in Turkey.

In recent years science, technology, engineering and mathematics (STEM) education has attracted considerable attention (Bybee, 2010). STEM as an educational approach explores teaching and learning between/among any two or more of the STEM subject areas and/or between a STEM subject and one or more other school subjects (Sanders, 2009). Moore et al., (2014) defined STEM education as an effort to convert a whole or a part of science, technology, engineering or mathematics disciplines into a class, unit or a course which is based on correlations between real life problems and subject areas (p. 38). STEM includes knowledge, skills and beliefs created at the intersection of one or more STEM subject areas (Çorlu, Capraro & Capraro, 2014).

STEM education seeks to achieve two objectives. Firstly, it increases the number of students who will prefer professions in these disciplines at the university level. Secondly, it enables students to find creative solutions to the real life problems about STEM disciplines by increasing the basic knowledge of students in science, technology, engineering and mathematics (Thomasian, 2011).

Developing a conceptual framework for STEM education requires a deep understanding of the learning complexities especially when it comes to teaching and learning the STEM content (Kelley & Knowles, 2016). Guzey, Harwell, Moreno, Peralta and Moore (2014) identify three key roles of the STEM integration. Firstly, it deepens the STEM students' understanding and conceptualisation of STEM concepts. Secondly, it enables the students to implement the

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STEM concepts within their specific and compatible socio-cultural contexts. Thirdly, it increases the students' interest to STEM disciplines for enhancing their perspectives on STEM. The integrated approach of science, technology, engineering and mathematical practices will enable significant gains to the students.

Bybee (2010) stated that STEM education has three essential features which are: improving students' understanding of how things operate, increasing the use of technology, and integrating engineering principles into students' education.

STEM education aims that teach individuals how to analyze problems with an interdisciplinary perspective and to improve their knowledge and skills. It enables students to prepare themselves for the developments of the 21st century and to have the skills of the 21st century is important in terms of giving opportunities to students at all levels to advance in Science, Technology, Engineering and Mathematics disciplines (Meyrick, 2011).

The need for the studies about this topic continuously constantly in recent years when the theoretical foundation of STEM education, you need to understand it as a whole, has just constructed (Akgündüz et al., 2015). STEAM is based on STEM education, which grew out of the need of art component. Korea's Ministry of Education, Science, and Technology [MEST] named their new model as STEAM by adding the fifth discipline art to the English acronym STEM (science, technology, engineering, art and mathematics). STEAM education is a newly developed program which was included in 2011. The main purpose of the STEAM education is to improve students' problem solving skill and to make them more interested in science and technology (Jeong & Kim, 2014). STEAM encourages students' motivation for learning and education to improve their skills about solving multidisciplinary (Oh, Lee & Kim, 2013, p. 494).

Looking at what many scholars and mathematicians have done in the past, it is clearly seen that the borders between art and science or music and mathematics are more intertwined than conventional learning paradigms (Root-Bernstein, 1999). In this sense, STEAM is a basic paradigm enriched in terms of art and creativity in STEM disciplines (Henriksen, 2014).

STEAM education is used for improving the structural understanding between science, technology, engineering, art and mathematics areas. STEAM leans on STEM education where emphasis is on the necessity for more students to understand the system and connections (Yakman, 2008). Similarly, STEAM education was designed with a frame which can be very suitable for every level and type of education which encapsulates 'Creative Design' and 'Emotional Learning' (Yakman & Lee, 2012).

There is more recent literature on STEM (e.g., Akaygun & Aslan Tutak, 2016; Avery, 2009; Ayar, 2015; Banning & Folestad, 2012; Baran et al., 2016; Bash, 2015; Beard Turner, 2013; Bingolbali, Monaghan & Roper, 2007; Carter, 2013; Ceylan, 2014; Cinar, Pirasa & Sadoglu, 2016; Çorlu, 2012; Dewaters, 2006; Erdoğan, Çorlu & Capraro, 2013; Fadzil & Saat, 2014; Han, 2016; Sümen & Çalışıcı, 2016). Some of these studies are about STEAM education (e.g., Jeong & Kim, 2015; Kim & Park, 2012; Yakman & Lee, 2012). The results of these studies demonstrate the importance of STEM and STEAM education.

Although there are more than 150 universities in Turkey, especially in Istanbul, just a few of them have STEM centers or laboratories. STEM centers/laboratories educate pre- and/or in- service teachers and introduce STEM for the students. These institutions aim to provide the development of STEM fields. Unfortunately, each individual does not receive STEM education from these institutions. For this reason, STEM implementations made in schools gain importance.

The purpose of this study is to determine the opinions of students about STEAM activities. The perceptions of students about STEM activities are crucial because if we evaluate the design, content and the scope of these activities, we will be able to improve these fields (Baran et al., 2016). If we determine the opinions of students about these activities, it is believed that we can prepare activities which can contribute a lot to the students about STEAM education. In this context, this study was designed to answer the following research question: how are students' opinions on STEAM activities?

2. Method

A case study using qualitative research methods was used in this study. The case study is an in-depth description and analysis of a bounded system (Merriam, 2009, p.43). A qualitative study design was preferred because of the fact that it provides us discovering the suggestions of students about this topic and obtaining their opinions about STEAM implementation in details by moving from the experiences of students studying where this study is carried out (Creswell, 2007). The opinions of students about the activities employed in this study were taken.

Data collected with the activity evaluation form. There were four questions in the final version of the activity evaluation form. These questions are: "What do you like about the activity that we did today? Why?", "Write the difficult parts of the activity that you did today. Why?" The students were asked to write answers to these questions.

2.1 Participants

This study was carried out with 7th grade students studying at a middle school in Istanbul. 37 students, 16 female and 21 male, participated in this study. The sample is composed of students who receive STEAM education. Purposeful sampling method is used in this study. When selecting the individuals, the main concern is whether they are directly related with the research topic rather than whether they represent the universe or not (Neuman, 2012, p. 320). Purposeful sampling gives us chances to study cases which are believed to have abundant information (Yıldırım & Şimşek, 2008, p. 107). The purpose of this study is to analyze the opinions of participants in this study.

The study was carried out through teaching 'Force and Energy' Unit in 7th grade Science lessons in 2006-2007 academic years. The purpose of this unit is to acquire knowledge and skills about mass and weight, relationship between force and solid press, factors affecting solid press, relationship between force and work, energy types and energy transformations. There are 9 learning outputs targeted to be excavated in this unit. The application was conducted in 9 weeks period. The activities was carried out in 9 weeks and right after finishing each activity an activity evaluation form including open – ended questions was conducted.

2.2 Activity Evaluation Form

The activity evaluation form was developed in order to determine the opinions of students about the STEAM activities employed in this study. Open ended questions were prepared to analyze the opinions of students in details. Open ended questions provided flexibility to the researcher to obtain detailed information about the topic (Yıldırım & Şimşek, 2005).

After writing the items of the form, four lecturers who are experts in science education and two other science teachers checked them. The form was finalized based on the results of the opinions of the experts. 337 evaluation forms were conducted to the students for 9 activities.

2.3 STEAM Activities

There are nine objectives in 'Force and Energy' Unit in the teaching program of 7th grade science lesson. In this study, an activity was developed for each objective stated in the teaching program. It was aimed that the contribution of students to the lesson was high.

The distribution of STEAM activities according to the objectives stated in the teaching program was given in Table 1.

Table 1. The distribution of STEAM activities according to the objectives

The name of the Activity	**Objective**
1. Robot Making Task	1. S/he defines the weight as a force and measures its magnitude with a dynamometer by describing the gravitational force acting on the mass as weight.
2. Naughty Cat	2. S/he makes a comparison between the concepts of mass and weight.
3. Smart Cubes	3. S/he discovers variables affecting solid pressure by doing an experiment and analyses the correlation between these variables.
4. How can I do?	4. S/he discovers variables affecting fluid pressure by doing an experiment and analyses the correlation between these variables.
5. It has flown	5. S/he gives examples from the applications of solid, fluid and vapour pressure features in daily life and technology.
6. I am doing my car	6. S/he understands that a physical work is directly proportional with applied force and covered distance and indicates its unit.
7. Mission is to design	7. S/he correlates energy with concept of work and classifies kinaesthetic and potential energy.
8. It is time to prove energy transformation	8. S/he explains that kinaesthetic and potential energy can be transformed to each other with examples and concludes that energy is saved.
9. Let's discover frictional force	9. S/he explains the effect of frictional force on the kinaesthetic energy with examples.

Tools and instruments used in the activities can easily be found and used. While doing the activities, classroom discussions were conducted to increase students' contribution to the activities. The teacher only guided the students.

2.4 Data Analysis

The responses provided for the open-ended evaluation form were analyzed by the first researcher by using content analysis to determine the opinions of students about STEAM activities in a detailed way. The codes created during descriptive content analysis were first transformed into categories then combined with themes. The themes and categories created from the responses were reviewed by the two researchers together and then tables were created.

3. Results

The findings regarding the opinions of students about STEAM activities were presented in this section. Themes obtained as a result of data analyses were given in tables. For each code, examples from students' responses were provided. It is seen that three different themes emerged when the answers of the students were examined.

Students have many positive opinions about STEAM events. Table 2 presents the categories which opinions directly about the activity itself, opinions about teaching and opinions about job orientations.

Table 2. The Positive Opinions about the STEAM Activities

Categories	Codes	f	Examples of Comments
Opinions directly about the activity itself	Being fun	162	I did not understand how the lesson ended. I really had fun.
	Being interesting	152	The lessons were so different; we have not had such lessons before.
	Presenting different point of views	124	I really liked the part that we produce ideas with our friends. I found the most reasonable one among many different ideas.
	Resulting with a product	95	Designing something made me incredibly happy.
	Being exciting	93	I was very excited as I was really curious about how the products that we designed would be.
	Supporting cooperation	76	We tried to follow the right way altogether.
	The result is successful	64	We felt the sweat smell of success after the things we made worked properly.
	Teaching new things	53	We learnt new things, for this reason I liked these lessons a lot.
	Enabling students to produce solutions	32	The questions that our teacher asked were like puzzles. We tried to find the solution.
	Doing things on your own	31	Doing everything on our own was great.
Opinions about teaching	Learning concepts like weight, mass and gravity	32	I thought weight and mass was the same things but I understood the difference.
	Learning fluid pressure and the working principles of hydraulic system	25	We understood and designed the hydraulic system.
	Understanding the correlation between energy and work	25	From now on, I love energy subject more.
	Understanding gas pressure	14	I did not know about gas pressure, I learnt.
	Understanding solid pressure	14	We learnt the background of solid pressure.
	Energy transformations and saving energy	10	We proved energy transformation with our work.
	Understanding frictional force	9	Designing by using frictional force made me think about the topic.
Opinions about job orientations	Wanting to be a scientist	87	Being a scientist will be my most important goal in this life.
	Wanting to be an engineer	71	I learnt what an engineer does and now I want to be an engineer.
	Wanting to be an artist	71	I like colouring our products, in the future I can be an artist.
	Wanting to deal with mathematics	25	I was good at doing operations at the activities. I want to be a maths teacher.
	Wanting to deal with technology	18	Nothing happens without technology. I will invent something about this topic in the future.

The findings in Table 2, show that the lessons in which STEAM activities were used were enjoyable and interesting for most of the students. Besides, positive opinions were taken from student about job orientation. Students liked creating something at the end of the activities, therefore designing something freely may get them agitated. It can be said that students have positive opinions about acquiring the objectives stated in the teaching program. Any negative opinions did not received about this issue.

In Table 3, students' negative opinions about STEAM activities were given. The difficulties that they encountered in activities were discussed in another question to have more detailed answers. The difficult parts of the activities for the

students were grouped under their negative opinions as a different category in data analysis.

Table 3. Negative Opinions about STEAM Activities

Categories	Codes	f	Examples of Comments
The Opinions about the activity	No attracting interest	27	To me, doing an activity is very boring, it causes a lot of work.
	Requiring to think	16	It is very bad to think constantly and search to do the activity.
	Using too many materials	12	There were too many materials and I needed to think carefully about which one to use.
Opinions about teaching	Finding the first giving information part boring	9	It would be better to start the activity immediately rather than giving information beforehand.
	Finding answering the questions in the worksheet boring	9	Answering puzzle like questions was difficult.
Opinions about the difficulties encountered in the activity	Having difficulty in the parts requiring hand skills El (cutting and pasting etc.)	13	The pasting part in our modelling work was very difficult.
	Needing more time	12	If the lesson had been longer, I could have done better.
	Having difficulties in producing solutions	10	There was time when I could not find the solution; we did it together with my friend.
	Having difficulties in working in a group	10	Some of friends in the group were really stubborn and they were not listening to us.
	Not imaging the product	9	When we were asked to imagine, I could not think from the beginning.
	Not being able to get the desired outcome	7	The result was not like the one I wanted.
	Needing teacher's assistance	6	I could not do it without a teacher.

As it can be seen from the findings in table three, only a few of the students had negative opinions about the activities. Some students thought that lessons carried out with these activities were boring. The ratio of this in the evaluation form is 8.1 %. The students who provided this answer were the same for each activity. It can be said that a few students think that STEAM activities are boring. These students are also the ones who do not like producing solution together with others.

There are three different categories of opinions about the benefits of STEAM activities, which are individual development, learning process and contribution to the future when looking at Table 4.

Table 4. The Opinions about the Benefits of STEAM Activities

Categories	Codes	f	Examples of Comments
Individual Development	Enabling achievement experience	170	To me, the most important thing is to accomplish our objective that is to make our rocket fly.
	Enabling creativity-flexible thinking	150	Colouring and decorating as we wish made me understand that I am creative.
	Enabling cooperation skills	89	I learnt to cooperate and think together with others. If scientists and engineers study together, they will become more successful.
	Guiding thinking	70	I learnt about thinking so that I can easily find the solution.
	Teaching abstract thinking-Imaging	38	We imagined and we did what we dreamed. If we dream before doing anything, we can work in an organized way.
	Enabling practical thinking	32	We had to think fast in given time. I learnt in this lesson that I need to think fast.
	Enabling problem solving skills	24	I started to think about how I need to solve the given problem.
	Improving psychomotor skills	11	I learnt to balance what I did in this activity.
	Understanding the importance of technology a	4	We could not create the car without doing the research from the tablet in this activity.
	Enabling time management skills	4	I learnt the necessity that we had to start the activity in a more organized way. Our group had difficulties to finish our work on time.
Learning Process	Enables concrete learning	76	I had chances to observe fluid pressure which I did not understand before.
	Developing positive attitudes in science lessons	75	If we had had our science lessons in this way, I would have loved the lesson a lot.
	Increasing achievement in science lessons	24	I think in the written exam I can solve the questions about the energy topic that we learnt in this lesson.
	Having an active role in the learning process	24	Our teacher let us free in this activity and we discovered ourselves.
	Developing skills for finding solution	14	We can find a solution by doing research and discussing.
	Developing skills for creating products	9	I learnt that I could also make inventions.
Contribution to the Future	Job orientation	104	I learnt may things about engineering thanks to this activity. Maybe, I can be an engineer.
	Having a scientific point of view	46	I learnt to think like a scientist.
	Correlating to daily life problems	43	I learnt how to lift cars. We can explain many other things like this with science.
	Teaching engineering skills	42	I learnt to think and to design like an engineer.
	Enabling social development	19	This activity taught me to be able to work with others.

As it can be seen in Table 4, students think that STEAM activities contributed their personal development, their learning process and their future. When students are able to do what they planned, they gain achievement experience. Besides, students also stated that STEAM activities contributed their skills about imaging. Students think that these activities will help them to improve in this long.

4. Discussion

In this study, the opinions of students about STEAM activities carried out within the scope of this study were analyzed.

In this sense, there themes were appeared: positive opinions about the STEAM activities, negative opinions about the STEAM activities and opinions about the benefits of STEAM activities. When we looked at the frequencies of the findings obtained from the students' opinions, it was concluded that the number of positive opinions is more than the number of negative opinions and the number of negative opinions is very few. Students think that STEAM activities contributed to them. At the same time, they stated that these activities can have positive effects for their future life.

As a result of the study, it was seen that students perceived activities as enjoyable and interesting. For this reason, a more efficient teaching can be conducted by using STEM activities to make students be interested in the lessons. STEM teaching is effective in increasing students' knowledge and students' interest to the STEM areas (Weber, 2011). In addition to this, thanks to STEM teaching, students grow as individuals who can solve various problems, who are innovative, inventor, self-confident, who can think reasonably and who are technology literate (Morrison, 2006).

When we look at the findings of the study, it is seen that students think that STEM activities will contribute for their future lives. According to Sahin, Ayar and Adigüzel (2014) STEM activities are effective in students' future carriers as they have an important role in increasing STEM areas. The number of students who want to be a scientist or an engineer is more according to students' response rates in this study. As the activities is based on science topics students may have an idea like being a scientist and as they require design, they may think to be an engineer. It can be interpreted that students also wanted to experience art related professions as they made designs freely throughout the activities. The reason of the limited number of student responses regarding mathematics can be the fact that activities were not based on mathematics. Having less responses about technology can be interpreted as the activities are limited in terms of using technology.

The frequencies of the responses provided by students, it is seen that the number of negative responses is less. The students who developed negative opinions against STEAM activities are generally same students for all categories. The reason why these students gave negative responses can be the fact that they do not like working together with others, they do not want to do something requiring hand craft and they are not good at time management.

At the end of the study, it was seen that students think that STEAM activities contributed for them. When we looked at the frequencies of the responses provided by students, it was found that the number of students who think positively about this is quite a lot. Students think that activities can have an effect on their personal developments, learning process and their future. This finding can be interpreted as STEAM activities can have sophisticated and futuristic effects on students.

5. Conclusions

Activities providing students to use scientific, mathematical and technological concepts concretely help them to develop a perspective regarding engineering design applications (Baran et al., 2016). For this reason, it is thought that STEM teaching approach can be used for concretizing abstract concepts in science lessons.

It is seen that STEM activities are more common than STEAM activities in literature. Attitudes, habits and intellectual skills which students can have throughout their lives can be taught by using STEAM teaching approach (Yakman & Lee, 2012). For this reason, these activities should be used more commonly by adding art dimension to them.

It is thought by looking at the study results that using STEAM activities while teaching will contribute students positively. For this reason, it can be suggested for future studies to develop new activities about other topics to be used while teaching. Universities could contribute to the development of this area by doing projects about STEAM.

It is thought that making STEAM activities common at different levels will provide students to have information about STEAM areas from pre-school to university. It can be suggested to the teachers to focus more on STEAM areas, to use them while they are teaching and to follow all the new developments about this field closely.

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