Participatory Educational Research (PER)
Special Issue 2016-III, pp., 161-169 November, 2016
Available online at http://www.partedres.com
ISSN: 2148-6123

Assessment Of Stem Applicatons In Terms of Students' Opinions[1]

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Abstract
The objective of this study is to find out how students will assess STEM (Science, Technology, Engineering, and Mathematics) applications prepared within the scope of Electrical Energy unit. To this end, the study was conducted with 26 7th graders studying in a secondary school in Samsun city center. Students' diaries, interview forms and field notes were used as data collection tool and the data obtained were assessed through qualitative analysis method. According to the results, it was found that students thought it was positive to conduct STEM applications in groups, however, they also thought that these applications sometimes caused confusion, thus it was concluded that they should be well planned. In addition, it was found that students adapted the view that STEM applications could be used for a great number of units since these applications are very useful and fun in terms of learning through doing and experiencing. It is thought that including similar group works more within the education process will give students more experience about peer learning based on cooperation and they will be very useful about turning information into daily life productions.

Key words: STEM education; students's opinions; science education

Introduction

The objective of 21st century contemporary education systems is to use information and turn information into life experience and to give scientific process skills rather than to reach information and accordingly important projects have been applied. Since educating individuals who can produce by using scientific process skills generally occurs technology-oriented, only science was found to be insufficient and thus it became widespread to include mathematics and engineering sciences, too. While STEM education defines the continuous and integrated association between the disciplines of science, technology, engineering and mathematics, the association between process and product is interesting. Within the 21st century, which is the technology age in which information increases incrementally, STEM

[1]This study was formed from a part of the doctoral thesis prepared by Samsun OMÜ Educational Sciences Institute Science Teaching doctoral student Fatma Taştan Akdağ. This study was presented as an oral presentation in 'International Dynamic, Explorative and Active Learning (IDEAL) Conference' held in Samsun between 1 -3 September 2016.

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education aims to give skills such as cooperation, creativity, communication, problem solving and analytic and algorithmic thinking (P21, 2015 ; Akgunduz, 2016).

STEM is an interdisciplinary education approach that aims to turn theoretical information into product by blending different disciplines while at the same time prioritizing the assessment of the process. While STEM education gives students interdisciplinary thinking skills and presents them with experiences about working in cooperation to solve real life problems, it also provides them with experiences that will provide them a basis to develop solutions about life (Dugger, 2010). With organizations in the education system, students are asked to use another discipline while explaining a discipline. For example, in studies, it can be seen that in school curriculums groups are asked to teach some subjects by cooperating with science-mathematic teachers at the same time and thus to make interdisciplinary connections. So far, students have been expected to use mathematics in science and technology in science when necessary while learning the disciplines of science, technology, engineering and mathematics separately from each other. However, students cannot see the association between science and mathematics and they try to solve problems by focusing on either only mathematics or only on science (Akaygun & A.Tutak, 2016). The important thing in STEM education is to make the students realize that these four disciplines should be considered together while solving life-oriented problems of our day and that these disciplines are in an inseparable association. While looking for a solution to their problems, students should be able to include their proficiencies in science-technology-engineering and mathematics as necessary. In addition, since the aesthetic side of the resulting product is important, the artistic dimension of STEM applications were also taken into consideration and thus, especially recently, it has begun to be used as STEM+A(Art). Since aesthetic should be taken into consideration at the stage of planning and designing in all products, it is seen that it is not much necessary to express this as STEM+A in STEM applications.

While students present their original ideas by making various designs with STEM education, they develop self-confidence and dream for more, which leave a positive effect on their future career plans. Young et al. (2011) define one of the objectives of STEM education as directing students to STEM occupations. The starting point of STEM educations is the need felt for the production society to carry countries to higher levels in terms of economy in 21st century. Due to workload under risk as a result of economic crises, it is more important than ever to educate individuals who are expected to be the scientists and engineers of the future as technology literate (Miaoulis, 2009).

Since the common point of daily life problems and work problems requires using many disciplines together, it is thought that the skills necessary for interdisciplinary solutions of future problems can be given through STEM education approach (Corlu & Aydın, 2016). In order to increase the quality of education, STEM education has been put into action in America in addition to existing education approaches (Bybee, 2010; Çorlu, 2014). In 2013, STEM Education 5-year strategic plan was announced in America and National Science Education standards were introduced. National Science Education standards were designed to apply in every level of education with the significance of using innovative Technologies in order to increase production and provide sustainable economic growth and to present a vision for education with approaches that include engineering skills and applications that make students active (Next Generation Science Standards, 2013).

According to National Academies Report, it is important for students to have skills such as complex communication, social skills, non-routine problem solving, self-management

and systematic thinking to be able to compete in modern economy. One of the important approaches that can be used in giving these characteristics is STEM applications. Bybee (2010) suggests that with STEM applications, it is possible to give students 21st century skills to a certain extent with group works, laboratory activities and projects and they can even have a global perspective by becoming conscious of subjects such as personal health, being a better citizen, energy efficiency, environment quality, using resources and national security.

Method

The study was conducted within the scope of 7th grade Electric Energy unit. Within the process of 8-week-long STEM applications conducted with the developed lesson plan, students' diaries, open ended interview form and field notes were used. The data obtained were assessed. In order to decrease the rate of error, different data collection tools were used in the study. The data obtained during the application were recorded (Marshall and Rossman, 1995) and later analyzed.

Results

The data collection tools used during the study were assessed separately and each were differentiated in its own right and presented.

A-Results from students' diaries:

1-Group work based on cooperation;

It can be seen that students had different views about group work during STEM applications.

'We love to work and get on with the group'.(Student 1)

'I think group work is a bit difficult but also a bit fun. It is difficult to decide with friends'. (Student 4)

'Group work is very helpful and effective while doing this activity. Cooperation, fun and having good time in the group helps us to understand better. With group work, we repeat the subject that we did not understand by telling each other. A difficult aspect of group work is being undecided about which of the different ideas to choose from while making a decision.(Student 5)

'Since I generally love to study alone, I think it is better to study alone'.(Student 6)

'Group work is good but it is a bit bad to be dependent all the time because you are dependent on everyone in the group, you can't just go along on your own'.(Student 8)

'It is bad to be a group, some don't study'. (Student 11)

'our group worked well but it was a bit difficult group. Since I am a quick tempered person, it was difficult for me to get on with my friends. I believe that I did good things in the group, it is more difficult when you can't even agree with your best friends. We were very happy when we finished the activity as the first group, group work is difficult, but it is very good if there are people that you like in the group and if you are smart'. (Student 12)

'Even if such activities seem difficult individually, they are more difficult as a group. Still, it is good for a few people to try for a Project. A work that ends in a longer period individually will end in a shorter time as a group".(Student 17)
'Since we work as a group in such activities, we have difficulties even if one person does not show up. The good aspect is that it is good to reproduce an idea'.(Student 18)
'The difficult sides of group work are disagreements. The easy side is it is fast because of work distribution, there is cooperation'. (Student 19)
'Group work is difficult; however, we could do it. It is a problem even when only one person doesn't show up. We take everyone's ideas in the group and assess these ideas. We move according to majority opinion. Sometimes everyone says something different, but we find a solution eventually'. (Student 22)
'When there are absentees in the group, there is no one to screw things. The group can be the best of the week. It will be a lot of fun if everyone does equal amount of work'.(Student 24)
'It was both easy and difficult to work as a group. The difficult side is to gather everyone and to make them pay attention. The easy part is to take everyone's ideas and do something together, you think for five minutes instead of 10'. (Student 26).

2-Assessments about the functioning of the application process;

Students made different assessments about the comprehension of STEM applications during the teaching of the lesson and classroom management, their assessments were about the application being instructive or fun.

'There is too much noise in the classroom, it is difficult to do something'.(Student 1)
'I think it is more fun to learn through experimenting. We learn better through experiments'. (Student 4)
'It is fun to do activities about the subject and it helps us to understand. I think we should do such activities, not every class hour, though. It will also help the teacher to tell the subject in an easier way. As a conclusion, how can we understand a subject or an event if it is not permanent in the human brain'. (Student 5)
'It is more fun and informing to teach a lesson with such activities. I learned better because I learned through experimenting'. (Student 6)
'Working with such activities is better than smart board'.(Student 8)
'It is good and fun. It develops our culture and us'. (Student 11)
'I think such things should not be done because there is a lot of noise and you get bored some time later. It is better to learn by listening to lesson, yes we learn new things, but such works are difficult and troublesome'. (Student 26)
'I think these activities should be done in each lesson. I think that we understand the subjects better. These activities should be done even in mathematics, Turkish and social lessons. They are fun, but they are also difficult. You won't find them difficult if you beleive like I do, you just have to think hard'. (Student 12)
'It is both very fun and a bit difficult to learn with such activities. Batteries and tapes are like enemies".(Student 19)
'It is permanent, it is fun. I think it should not be done all the time, it can be a bit boring'. (Student 22)

B-Results from design interview form consisting of open ended questions.

Each question was assessed separately in the form and students' views were presented based on the questions.

Question 1: What do you think about design based STEM based activities you conducted about the unit of electrical energy?

They were quite fun, I like doing something and learning new things (Students 1, 4,6, 7, 8, 9, 10, 11, 17, 19, 25,26)

I learned a lot of new things thanks to these activities, I touched things I had never seen. I saw and touched and understood better (Students 5, 12, 15, 18, 21, 22, 23, 25)

I think that I was successful in the activities (Students 2, 3, 7, 16,17, 19)

I was sometimes bored, I don't think much about them (Students 17, 20, 24)

Question 2: Which parts of STEM activities did you like the most?

Making designs in the computer, creating products and seeing them work (1, 2, 3, 4, 6, 7, 8, 9,10,11, 12, 16, 17, 18,19, 20,21, 22, 23, 24, 25, 26)

It is boring to write on the students' assessment guide which consists of directions and open ended questions (5,15, 17)

Question 3: When you assess the activities, What kind of changes would cause you to learn better?

I would have learned better if I knew how to do at the beginning of each activity (11,18, 19, 21)

If I had been careful, if I had not made mistakes in design (7, 8, 20,25)

If the materials had been more different (2, 17,25)

I think they are enough, there is no need for changes (1, 3,4, 6, 9, 10, 16, 23, 24, 26)

If the group members had been better (5, 12, 15,22)

Question 4: What did you gain by STEM activities?

My hand skills developed (2, 3, 4, 7, 12, 16, 17, 18, 19, 22, 23, 26)

my interest in doing Project increased (2, 17, 19)

I had more information (1, 3, 4, 5, 6, 8, 9, 11, 15, 16, 19,20, 21, 22, 25)

I learned what to pay attention to while making a design (10, 23, 24)

My self confidence increased (10, 17)

C- Data recorded during the application.

In this part, the data recorded based on the observations at every stage of the 8-week application process from the start of the application to the creation of the product were assessed integrally.

1-Data obtained about group works

In group works, it was found that in groups, in which students were more participative and open to cooperation, works were completed in time and more successful designs were put forward. There were also students who avoided participation or sharing knowledge. It was observed that most of the students adapted to group work during the process. Some students were observed to insist on behaving individually and they were found to decrease the group performance. In addition, competition and successful designs were observed between groups. When a general assessment was made, it was found that students had difficulties in group works based on their groups; however, in some of the applications they were found to be more willing to group work. While male students in groups showed dominant behaviors such as taking control, when their cooperative characteristics were revealed later on, the situation was balanced.

2-Students' motivation during the application process

Most of the students stated that they took pleasure from working in the laboratory, touching the materials and working actively all the time. In addition, they reported positive situations such as the happiness of making their own designs as they liked. Some of the students who wanted to make new designs in their holidays tried to learn where they could get materials and stated that it would be very pleasant to have such activities in other lessons. Some students stated that creating a product and working with computer during this process made them feel like engineers. It was found that although female students were willing in associations with engineering, they acted cautiously thinking that engineering is more aimed at male students and they were found to express this view.

3- Problems faced during the application process

Incoordination occurred in groups sometimes due to gender and sometimes because of feelings of responsibility. When the general situation was considered, it was found that students showed negative attitudes to each other especially at the beginning when there was noise and disorder. In terms of students' learning situations, it was found that as well as positive observations such as peer learning, mislearning was seen to expand to everyone in class. It was observed that there were important problems about organization and distribution of work during group work and members of groups were observed to quarrel about who would do what. For example, since each group was given a computer instead of giving each person a computer, in-groups quarrels as well as intergroup were observed within the students

who were not used to group work about who would use the keyboard and about material selection. As a result of these negative things, some of the groups were found to experience loss of time and not be able to complete their designs. The fact that applications were limited to lesson time was also an important problem in terms of time. It was found that students quarreled and experienced problems about noting down the ideas of group members in parts of the design guide where they were expected to fill in.

Discussion

Besides learning the lesson content, the targets of STEM education are cooperation, communication and process assessment. In the study, students were given experiences in which they could develop their communication skills and hand skills and create products by using technology. When the process was assessed in general, it was observed that students gained many experiences during the applications they conducted for the first time. It was observed that creative ideas increased students' practices in front of computer increased and they became more successful within the process in presenting the products while designing products. These results are assessed as positive situations expected from STEM applications.

When students' diaries were assessed, one of the most interesting parts was the problems encountered during group work. It is expected for the students to have difficulties in sharing, cooperation, responsibility and respecting ideas since they have little experiences in these. In addition, students expressed group works as positive situations in terms of coming across different perspectives and peer learning. Negative aspects of group work were expressed as difficulty of acting dependent on group members and problems encountered in the absence of a group member. In addition, group work and cooperation are important for success in education process and later on in business life. Similarly, Ünlü and Aydıntan (2011) stated the importance of group work in the development of social skills in their study.

There are also views about the process in student diaries. Besides students who mentioned positive experiences about the process, there were also students who complained about the noise or those who mentioned the difficulty of the process since it required a lot of work. While it can be accepted as normal for students to have difficulties in experiences they lived for the first time, it can be assessed as positive for students to find this process as fun and informative.

In students' answers to open ended questions, there are expressions about STEM activities such as 'I touched things I had never seen, I had fun, I understood better'. In addition, students expressed the things they liked as making design in computer, creating products and seeing them work. There are also students who stated that their hand skills developed, their interests about doing projects increased, they had more information and learned what to pay attention to while making a design. Based on these expressions, we can say that STEM applications gave students positive experiences. There were also students who stated that they could have learned better if they knew what was going to happen at the beginning of the activity. This is thought to result from the tendency of taking the easy way out for students who are accustomed to ready information as a result of having difficulties during the works.

According to the data recorded during the application, there were students who were successful about sharing information and cooperation within the group, while there were also

students who adapted during the process. Most of the students were found to start to make more constructive communication; however, some students were, even though not much in number, were found to insist on working individually and they were found to decrease the group performance. This is thought to result from students' not being used to group work and as a result of students' individual differences. In their study K. Erdamar and Demirel (2010) gave similar positive and negative results. STEM applications were found to have an important role in cooperation, taking responsibility, sharing and development of communicative skills and this was found to be reflected in the duration of creating a product and the quality of the product. In their study, Şahin, Ayar and Adıgüzel (2014) found that group works had positive effects on STEM applications and skills development, which was in parallel with the results of our study.

Students were found to develop feelings of self confidence and success with reasons such as touching the materials and creating their own products, which influenced their motivation during the application process. Thus, students were found to become more willing and more creative in their products. We believe that the processes which will help students to be happy by having fun will increase their motivation and bring success. In addition, students' plans about working after lessons were accepted as an indication that STEM applications reached one of its most important goals. Similarly, Yıldırım and Altun (2015) suggested that STEM applications contributed to students' success and attitudes.

When the problems faced during the process of the application were analyzed, it was found that in order to be able to decrease the noise and chaos that occurred in the environment, some studies (determining the suitable number of groups, taking into consideration the number of students in the classroom, distribution of tasks, etc) had to be conducted before the application. Events such as group members' discussing within the same lesson and reaching new ideas, drawing with their common decision, making designs with the computer, choosing suitable material and creating prototypes with the materials cause the level of noise to rise. Thus, we believe that exposing students to such applications will cause a less noisy environment and also cause the students to be more planned and increase success. In their study, Altıparmak and Nakiboğlu (2005) stated that in time, students' success in group work increased.

In most of the developed countries, the importance placed on STEM education has increased in the last ten years and it has begun to be spread to many countries. In Turkey, recently Turkish Industry and Business Association (TÜSİAD) and various universities have begun to attract attention to STEM education and projects have begun to be developed about STEM education. Especially in private universities and private education institutions, studies on education have begun to gain speed with STEM associations or inter-institutional STEM applications. It has become inevitable for these applications to be used in state schools, too. STEM education 5-year strategic plan published in America in 2013 stated that in order to be able to reach the goals, entrepreneurs, officers, civil society and universities should be included in STEM education plans. Studies have been started on this subject in Turkey and teachers have begun to be educated in STEM, even though partly. These educations should be generalized and applied in all schools. We believe that instead of teachers' being educated later, it will be more useful to start these applications in education faculties where teachers are educated. Teachers should be able to apply new teaching approaches in every stage of education and they should educate individuals who have the scientific process skills which enable individuals to turn information into production.

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