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Primary school students' views about science, technology and engineering

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Some of the main goals of science education are to increase students' knowledge about the technology and engineering design process, and to train students as scientifically and technologically literate individuals. The main purpose of this study is to find out primary students' views about science, technology and engineering. For this aim and in order to increase students' knowledge and understanding of science, technology and engineering, a module named "Engineering and Technology Lessons for Children" developed by the Museum of Science was applied to 88 students who were in 4, 5 and 6th grades. The science topic was 'balance and forces', and the engineering field was 'civil engineering'. The module took five days and consisted of interactive teaching techniques such as experiments, science trips, observations, creative drama and designing. Out of these 88, 23 students took part in interviews to find out their views about science, technology, and engineering in detail. The students were attending a comprehensive primary school in an urban district of Izmir, which is the third biggest city in Turkey. Specifically, this school was chosen since it was a sister school to the university which means the university and the school had an agreement on benefiting from each other's competences and facilities. Since the school was a sister school it was a convenience sample and this was the main reason for choosing these students. This study is a case study survey type of research and is also a simple descriptive design. As an instrument, a semi-structured interview was used. According to the results of the analysis of the data, after implementing the module, students' awareness in terms of science, technology and engineering increased.

Key words: Engineering design process, understanding of science, understanding of technology, understanding of engineering.

INTRODUCTION

In the context of the National Center for Technological Literacy (NCTL), 'Engineering is Elementary' (EiE) prepared an education module called 'Engineering and Technology Lessons for Children' to teach science, engineering, design and the connection between these terms to develop children's natural sense of wonder (http://www.eie.org/). One of the main aims of this module is to make children technologically literate individuals

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(Roehrig et al., 2012). Some of the reasons why this is important are summarised as follows on the EIE website: Students need to be aware that if they design anything they should be working like engineers. This causes them to develop positive attitudes towards science, technology and engineering. Engineering needs the integration of other disciplines such as maths and science in order to solve problems. Design-technology-engineering applications develop the skills of awareness of problems, solving problems and producing alternative solutions. Design-technology-engineering applications should be a part of project-based learning and promote hands-on learning. This curriculum relates to life skills everyone needs to use.

In this regard, the purpose of this study is to find out whether primary (4, 5, and 6th graders) students' views of science, technology and the engineering design process developed or not after the implementation of the EIE curriculum module.

The conceptual framework

In the last decade, the science curriculum committee in Turkey has included some basic skills in the curriculum: scientific process skills and life skills such as analytical thinking, decision making and creative thinking (MEB, 2005, 2006, 2013, 2017). The emphasis was also on raising scientifically and technologically literate individuals so that children would understand science (Dindar and Taneri, 2011). The current science curriculum (MEB, 2017) emphasises other skills that are called 'engineering and design skills'. The explanation of these skills is as follows: 'students need to think and use science, maths, technology and engineering in a holistic way; with the interdisciplinary point of view, students can solve problems in an innovative way; they should learn strategies to make and develop products'. It is explained that the reason for putting this new field in the curriculum is that students' experiences of science and engineering are important in terms of increasing the capacity for the development of scientific research, technology, socio-economic status and competitiveness of the country. It is now clear that there is a necessity for finding ways to improve student understanding of the terms, technology and engineering design process.

In this study, a module titled 'Engineering and Technology Lessons for Children', developed by the National Center for Technological Literacy led by the Museum of Science in Boston (www.mos.org/engineering-curriculum), was used. The museum was founded in 1830 in Boston. It was the first museum to embrace all the sciences under one roof and the first science and technology center in the USA.

The 'Engineering is Elementary' (EiE) Project (eie.org/eie-curriculum) is one of the projects developed by the Museum of Science in 2003, for children in grades 1 to 5, and they state that 'it is the nation's leading engineering curriculum for grades 1 to 5'. Cunningham and Lachapelle (2016) stated that since 2003, in the USA, approximately 10 million children have been taught with the curriculum and 110,000 teachers have used the materials. The EiE curriculum consists of three components for all units: a teacher guide, story book and material kit. All the EiE units complement the science topics that teachers teach and each unit has an engineering field. The components, except for the material kit, were bought from the Museum of Science, USA. The EiE curriculum created a simple Engineering Design Process (EDP) to guide students through engineering design challenges. This EDP has just five steps and uses terms that children can understand:

'ASK: What is the problem? How have others approached it? What are your constraints?
IMAGINE: What are some solutions? Brainstorm ideas. Choose the best one.
PLAN: Draw a diagram. Make lists of materials you will need.
CREATE: Follow your plan and create something. Test it out!
IMPROVE: What works? What doesn't? What could work better? Modify your designs to make it better. Test it out!' (http://www.eie.org/eie-curriculum/engineering-design-process).
Detailed information about the module is given in the methodology section in this paper.

RELATED RESEARCH IN THE LITERATURE

The literature illustrates that some of the research was conducted with students to find out their understanding or to find out the effectiveness of the activities which were carried out in the context of technology and engineering. On the other hand, some of it was carried out with teachers to find out their teaching abilities and their development of teaching the subject.

Cunningham and Lachapelle (2010) carried out a research with a huge sample (experimental group of students n=5139 and control group n=1827) to find out the effectiveness of the EIE curriculum. They found significant differences between the experimental and control groups in that the experimental group of students had a better understanding of engineering and science. Another study (Lachapelle et al., 2013) was done to find out primary students' (n=789) views about technology. They used a "what is technology (WT)?" instrument for pre- and post-test. According to the results, most of the students relate technology to electronics. After teaching technology, although students' misconceptions decreased, some of the students still had misconceptions about technology.

In the same research the researchers also stated that post-test results showed that EIE materials had a positive effect on students' interest in being engineers. Similarly, students were more interested in engineering subjects and science.

The EIE curriculum's effectiveness was proved once again in another study (Lachapelle et al., 2011). They also tested students' scientific content knowledge and the students' achievement was higher than that of the control group students. Lachapelle et al. (2011) results were similar to those of the other research about the effectiveness of the EIE curriculum. Similarly, Lachapelle et al. (2017) assessed the effects of EiE intervention for elementary school students and they found that intervention students showed great improvement in science content outcomes.

Cunningham et al. (2005) asked students to draw an engineer. It was understood that most of the students had limited or wrong knowledge about what an engineer did. Lachapelle et al. (2012) developed a scale which measured students' knowledge about what engineers do. The results revealed that students believed that engineers repaired cars, computers, televisions, etc. However, they did not believe that engineers worked with non-electronic objects.

Karahan et al. (2015) investigated the effect of science, technology, engineering and mathematics integrated media design processes on 8th grade students' attitudes towards science classes. During media design processes learners design digital media artifacts. The result shows that learning STEM affected students' attitudes towards science class as EiE stated.

Other research was conducted with teachers. For example, Cunningham et al. (2006) aimed to find out teachers' knowledge and attitudes towards engineering and technology. They found that teachers had some difficulties when teaching engineering and technology. When they taught with the EIE curriculum, their tendency to use the engineering concept during classroom activities increased. Another developed program was "Pre-College Engineering for Teachers" (PCET) (Lachapelle et al., 2008). The researchers found that when teachers used PCET with their students, the students learned science, engineering and technology better. McKay et al. (2008) organised a project to educate teachers in order to increase their engineering content knowledge. At the end of the project it was proved that teachers' understanding of the engineering design process and science content were increased.

It is believed that it is important to develop an understanding of the engineering design process as Cunningham and Kelly (2017) stated that this could help to teach science and that 'engineering offers ways of knowing that it can be educative beyond just servicing science learning' (p.498). Hertel et al. (2017) have done research to find out the effect of notebooks on students' learning through engineering design activities. As a conclusion, they suggested that since notebooks play important roles and engineering is becoming a more common discipline in elementary classrooms, teachers should gain better understanding of the engineering design process and of implementing it in classroom activities.

METHODOLOGY

This study is a case study survey type of research, which is described as follows "it is a research design in which a survey is administered to a case, either a small sample or an entire population of individuals, to describe an aspect or characteristic of that population. Researchers ask individuals in the population questions to examine individual self-reports of opinions, behaviors, abilities, beliefs, or knowledge. The responses are analyzed to describe population trends or to test questions or hypothesis" (Mills et al., 2010). Mills et al. (2010) also stated that simple descriptive design is one of the designs of case study research. This study is also a simple descriptive design which "is a one-time-only survey that is used to describe the characteristics of a sample case at one point in time" (Mills et al., 2010). As an instrument, a semi-structured interview was used for data collection.

The sample of the study was made up of 4th (n=28), 5th (n=30) and 6th (n= 30) grade students in a primary school. The ages of the students were 9, 10 and 11, respectively. The school is a comprehensive school in a rural area in a big city. Specifically, this school was chosen since it was a sister school to the university which means the university and the school had an agreement on benefiting from each other's competences and facilities. For instance, the school students were given the opportunity to visit the university and had some free courses from the academic staff, or teachers from the school could be involved in the in-service teacher training programme. Since the school was a sister school, it was a convenience sample, and this was the main reason for choosing these students. To increase primary students' understanding of science, technology and engineering, a module named "Engineering and Technology Lessons for Children" developed by the Museum of Science was applied to the 88 students. However, among them only 23 students took part in the interviews. Table 1 shows the distribution of the sample in terms of their gender and grade.

Before collecting data from the students, permission was received from the parents and the management of the school. Separately, each group in the sample was instructed about the module, which was about science, technology and engineering. The details of the module have been given earlier in this paper and can also be found at http://www.eie.org. As Lachapelle et al. (2017) stated during the application of the module, students read a story which includes a design challenge. In this research, the unit titled 'To Get to the Other Side: Designing Bridges' was used. The science topic was 'balance and forces' and the engineering field was 'civil engineering'. The module took five days and consisted of interactive teaching techniques such as experiments, science trips, observations, creative drama and designing. The story was about trying to find a solution for reaching the other side of a river. After reading the story students were encouraged to find a solution by making a secured bridge. They also visited the department of civil engineering and the laboratories, and they were introduced to some civil engineers. They learned about the types of bridges and how to work as engineers with the engineering design process. Table 2 shows the content of the intervention.

Before and after the module, two instruments titled 'What is Technology' and 'What is Engineering', were applied as pre- and post-tests to all 88 students. At the end, in order to find out the effectiveness of the module and the level of their knowledge about

Table 1. The distribution of the sample in terms of their gender and grade.

Grade	Female (n)	Male (n)	Total (n)	Interviewed (n)
4th grade	14	14	28	10
5th grade	24	6	30	5
6th grade	21	9	30	8
Total (n)	59	29	88	23

Table 2. The content of the module.

The activity	Content
Preparation	Revealing students' ideas about engineering and the engineering design process. Drama
An Engineering Story	Reading the story Types of bridges Civil engineering Civil engineering department visit Design process
Science Topic	Pull and push forces Experiments Balancing the forces and civil engineering
Design challenge and data collection	Making and introducing three types of bridges Testing which type of bridges carry the most weight Observing the effect of different weight amounts on the bridges. Drama
Designing continues	Designing a bridge with basic materials by using the engineering design process. Developing their design.

technology, engineering and science in detail, interviews were conducted with 23 students. Although only the interview results will be presented, the results will also be related to the answers to the two instruments stated earlier.

It was stated that by conducting interviews, in-depth data can be collected about students' views (Cohen and Manion, 1994; Drever, 1995; Mertens, 1998). During interviews, the data can be collected more qualitatively by asking probing questions such as 'why?', 'what do you mean by saying that?' (Drever, 1995), and also the questions are narrowing of the central questions and subquestions in the research (Creswell, 2013). This was the reason why the semi-structured interviewing technique was used.

Before conducting the interviews, the participants were informed about the details of their interviewing process. During the interviews, the researcher used prompts, probes and follow-up questions to encourage the interviewees to clarify their answers. Because of the responsibility of being respectful to the participants in terms of not making them feel that they were being judged, there were no direct questions such as 'what is technology', 'what is engineering'. Instead the questions were in the 'what do you think?' format. A comfortable environment was created for the participants.

Each interview was recorded and then transcribed for more detailed examination. The interview questions were as follows:

(1) What do you understand when they say 'technology'?
(2) How would you understand if an object is a technological product or not?
(3) Do you think technology is harmful?
(4) What do you think that engineers do? What kind of people do you think we call engineers?
(5) What do you understand when they say science?
(6) Science, technology and engineering: is there any relationship?
(7) What would you say about the engineering design process?
(8) After the module, what did you learn that you did not know before?
(9) Would you like to take part in that kind of learning again?

The instrument called "What is Technology" included pictures of some objects (16 objects) and the participants were asked to choose the objects that they thought were technological products. The objects were: shoes, subway, dandelions, cellular phone, oak tree, bridge, television, cup, bird, factory, bandage, house, power wires, bicycle, lightning and books (the objects that are written in bold are the correct answers). Finally, the participants were also asked “How would you understand if an object is a technological product or not?” This instrument was first developed by Cunningham et al. (2005), and was used to determine students’ knowledge and understanding about technology. It was then applied to 550 students (3rd, 4th and 5th grade students) as pre- and post-test (Lachapelle and Cunningham, 2007). They gave 1 point for each correct answer and 0 points for each wrong answer. Total score was calculated and internal reliability coefficients were found to have a Cronbach’s α of 0.853 (n=479).

The other instrument, called “What is Engineering?”, also included pictures of some types of work (16 types of work) and the participants were asked to choose the types of work that they thought engineers do for their jobs. The types of work were: improve bandages, develop better bubble gum, design ways to clean water, construct buildings, drive machines, arrange flowers, read about inventions, figure out how to track luggage, work as a team, create warmer kinds of jackets, install wiring, sell food, repair cars, design tunnels, clean chimneys and write computer programs (the jobs that are written in bold are the correct answers). The last question asked to the students was ‘If a friend of yours asked you what an engineer is what you would say to your friend?’ This instrument was used to determine students’ knowledge and understanding about engineers (Cunningham et al., 2005). When tested for internal reliability, this scale produced a Cronbach’s α of 0.881 (n=863).

RESULTS

According to the results of the ‘What is Technology?’ instrument the module had an effect on developing students’ understanding of technology. The statistical difference showed that the module was more effective on 4 and 6th graders than on 5th grade students. The results of the ‘What is Engineering?’ instrument showed that the module was not effective on 4th grade students but that there was a difference regarding 5 and 6th grade students’ understanding in a positive way. The module was more effective for 5th grade students than for 6th grade students. In this research the focus will be on the result of the interviews.

Results from the interviews

The qualitative data were manually analysed by the researcher by categorising the answers. Cohen and Manion (1994) suggested that there should be an acceptable level of agreement between people as to how to describe data. Accordingly, after transcribing the recorded interviews the transcriptions were analysed by another researcher who was working on similar projects. A high degree of agreement was achieved. First, long statements were compressed into briefer statements in which the main sense of what was said was rephrased in a few words. These were then grouped into simple categories, which made it possible to present the large amount of data in a few tables. The results will be given in detail as the following.

The views of students about technology

One of the aims of the study is to find out students’ views about technology. Table 3 presents their views about technology. In Table 3, the students’ answers are given in brief sentences. This was done before categorising. It is preferred to give Table 3 because it is thought that it is wise to give the idea of how to analyse data to the readers.

Following Table 3, Table 4 was constructed by making a classification according to the answers earlier mentioned.

The first and second category could be in the same category since the computer, television, etc., are all electronic devices. Most of the students (18 out of 23) thought of electronic equipment when technology was mentioned.

As stated earlier, for the ‘What is Technology’ scale, the students were given the names of 16 items and asked which of these were technological products. These items are: (1) shoes, (2) subway, (3) dandelion, (4) cellular phone, (5) oak tree, (6) bridge, (7) television, (8) cup, (9) bird, (10) factory, (11) bandage, (12) house, (13) power wires, (14) bicycle, (15) lightning, and (16) books. The items numbered 1, 2, 4, 6, 7, 8, 10, 11, 12, 13, 14, and 16 are the correct items. The maximum number of points that could be obtained from the instrument is 12 since 12 items are correct. Table 5 shows the average points that all the groups obtained out of 100. This table represents the result statistically.

While the 4th grades did not indicate items that were wrong answers before or after the training, only one person in the 5th grade gave the wrong answer, ‘oak tree’, as a technological product after the training. Surprisingly, from the 6th grades, 4 students indicated the dandelion flower and 2 indicated lightening as technological products following the training. Qualitatively the researcher would like to point out that subway, cellular phone, television and power wires were mostly mentioned both before and after the intervention. It is quite pleasing that while no one marked shoes, cup, bandage or books in the pre-test, the number of marks for these items was increased in post-test. This proves the effectiveness of the module.

During the interview, before the module and also after the module the participants were asked how they would understand whether an object is a technological product or not. The categories are stated in Table 6.

From the interviews, it was found out that there are some similar answers. For example, “it helps us” or “it makes our lives easier” or “it fulfils our needs” could all be in the same category: “Technological products fulfil our needs”. The categories obtained from this part of the interviews are listed as follows:

(1) Technological products fulfil our needs.
(2) They are electronic.
(3) They can be improved.
(4) They have mechanisms.

Except for 6 students they all answered correctly when

Table 3. Students' views on 'What is Technology?

Grade/No.	Answers
4/1	When it is dark we put the lights on, we use the oven in the kitchen. They are technology.
4/2	Telephone, computer.
4/3	Electricity, bulb, oven in my home.
4/4	Telephone, iron, computer, etc., electrical things.
4/5	Telephone, computer, television.
4/6	Objects that fulfil the needs or desires of humans such as computer, table, blackboard, mug.
4/7	Electronic or non-electronic objects that fulfil our needs.
4/8	Technological products. Technological products should be improved, and should help us.
4/9	Scientists, computers, technological devices, money case, electronic devices.
4/10	Electronic devices.
5/11	Objects that work with electricity, computer, television, electricity wires.
5/12	Making devices to fulfil the needs of humans. Telephone, television, computer, etc.
5/13	Dish washer, telephone, and computer.
5/14	Useful devices for us.
5/15	Telephone, we use it in an emergency, that is, why it is a very important need.
6/16	Computer and electronic devices.
6/17	Computer, projector.
6/18	Media devices that scientists invent, computers, telephones.
6/19	I think of radiation, the harm to the world comes to my mind.
6/20	Internet, television, telephone.
6/21	The devices that fulfil our needs.
6/22	-
6/23	-

Table 4. 'What is Technology?' categorisation.

Categories	Numbers of students			
	4th grade	5th grade	6th grade	Total
Computer, television, telephone, internet, etc.	4	2	4	10
Electronic devices.	6	1	1	8
Devices that fulfil our needs.	4	2	1	7
Improved products.	1	-	-	1
Scientists.	1	-	-	1
Harm to the world such as radiation.	-	-	1	1

Table 5. Interview participants' average points from the "What is Technology?" instrument.

4th grade		5th grade		6th grade	
Pre-test score	Post-test score	Pre-test score	Post-test score	Pre-test score	Post-test score
35	86	28	73	37	98
Total (4, 5, and 6th grade)		Pre-test: 34		Post-test: 87	

they talked about the property of a technological product as fulfilling humans' needs. The increasing number of students that realised the meaning of technology can be seen. However, 4 students added that the products should be electronic. This was the belief of most of the students before the module. There was another interesting view; "It helps us, for example a plant, if it is a cure for our health then it is a technological product.

Table 6. How they would understand if an object is a technological product or not.

Grade		Before the intervention (What is technology instrument)	After the intervention (What is technology instrument)	Interview
4th grade	1		Technological products fulfil our needs	Technological products fulfil our needs They are electronic
	2	-	They are made by an engineer	-
	3	They have wires	Technological products fulfil our needs. They are electronic	-
	4	-	Technological products fulfil our need	Technological products fulfil our needs
	5	Technological products fulfil our needs	-	Technological products fulfil our needs
	6	They have wires, they have volume or screen	Technological products fulfil our needs	Technological products fulfil our needs
	7	They are electronic	-	Technological products fulfil our needs
	8	Technological products fulfil our needs	Technological products fulfil our needs	Technological products fulfil our needs They have to be improved
	9	-	-	Technological products fulfil our needs They are electronic They have a mechanism
	10	-	Technological products fulfil our needs	Technological products fulfil our needs
5th grade	11	Technological products fulfil our needs	Technological products fulfil our needs	Technological products fulfil our needs They are electronic
	12	-	Technological products fulfil our needs	Technological products fulfil our needs
	13	They are electronic	Technological products fulfil our needs	Technological products fulfil our needs
	14	-	-	-
	15	Technological products fulfil our needs	-	Technological products fulfil our needs
6th grade	16	Technological products fulfil our needs They are electronic They work with petrol	Technological products fulfil our needs	Technological products fulfil our needs They are electronic
	17	They have to be designed, drawn or planned	Technological products fulfil our needs	Technological products fulfil our needs
	18	-	Technological products fulfil our needs	Technological products fulfil our needs
	19	They have to be improved They are new models	Technological products fulfil our needs	Technological products fulfil our needs

Table 6. Contd.

20	They are electronic	Technological products fulfil our needs	Technological products fulfil our needs
21	-	Technological products fulfil our needs	-
22	They are electronic	-	-
23	-	Technological products fulfil our needs	-

Water, we need it, and then it is a technological product".

Quite a few participants stated that simple objects in everyday use such as a tray, pencil, glass, table, shoes, sunglasses, bandages, chair, ruler, bicycle, and notebook are not technological products, or if an object is simple, not complicated like the computer then it is not technology. One student from 5th grade stated that the horse is technology because horses are used for transportation.

The views of students about the harmful effects of technology

When students were asked about the harmful effects of technology they thought that there would be harmful effects in terms of health and social life. Regarding health, for example, students were aware of the radiation from computers, televisions and cellular phones, the harmful effect of television for our eyes, and the harmful effect of cellular phones for our ears. One participant stated that young people could find unsuitable friends by using the internet and another stated that excessive use of cellular phones could cause communication and economic problems in the family. Another view mentioned the problem of spending too much time by using the internet and watching television, which would cause them not to spend enough time for studying. The other problems stated were traffic accidents and watching too much television.

The views of students about engineering

As stated in the methodology of this paper, students were asked to choose what an engineer does. There were 16 types of work presented to the students and 10 of them were correct. Table 7 shows the average points all the groups obtained out of 100. This table represents the result statistically.

Secondly, they were asked to write their description of an engineer. Ten students described engineers as people who construct or design buildings. The reason why they first thought about civil engineering was asked during the interviews and it was found out that in the areas where the participants lived, most of their fathers were working as construction foremen. When they described an engineer, none of them used the words "designing" or "drawing a project" before the intervention. One student described engineers as scientists and two students stated that an engineer was a person who helps people.

When Tables 5 and 7 were compared, it is clear that the increase in students' understanding of technology was higher than the increase in their understanding of engineering. Most of them had difficulty in accepting that constructing buildings, driving machines, installing wiring and repairing cars were not engineers' jobs. During the interview, participants were asked about their views of engineers: what kind of work they do and who they are. Sixteen students mentioned that engineers draw and design projects. Three of them stated that engineers construct buildings, bridges or computers, while two of them said that engineers make inventions. "Engineers teach workers how to use machines", "they produce knowledge" and "they do research" were the other ideas.

Before receiving the module they only knew about civil engineering but after the module they also stated the other engineering fields: computer engineering, electronic engineering, environmental engineering, mechanical engineering, food engineering and textile engineering. Their awareness had increased. However, the participants did not talk about EDP.

Students' understanding of the engineering design process

Seventeen students did not remember the engineering design process. They simply did not state the steps of the process as *ask, imagine, plan, create and improve.* They could not give any examples.

At the end, they stated that they agreed to participate in that kind of training again. The things that they did not know before the module are listed as follows:

(1) Knowledge about engineering such as

Table 7. Interview participants' average points from the "What is Engineering?" instrument.

4th grade		5th grade		6th grade	
Pre-test score	Post-test score	Pre-test score	Post-test score	Pre-test score	Post-test score
34	46	22	49	31	56
Total (4, 5, and 6th grade)		Pre-test: 30		Post-test: 50	

different types of engineering and the work that engineers do.
(2) Technology and technological products: one student stated that "I have learned that technological products are not only electronic devices but that any man-made devices that help humans or make contributions to human life are technological products".
(3) Differences and common points between scientists and engineers.

Participants' views of science

Students' views about science and the relationship between science and engineering and technology were examined. When they heard the word 'science' most of them thought of scientists, while two of them said that it was a kind of profession in which you had to work hard. One student stated that science is everything and one of them remembered astronauts and space. When they were asked to give some scientists' names, while 8 students could not give any names the others gave examples such as Edison, Einstein, Alexander Graham Bell and Ali Kuscu (a mathematician and astronomer who lived in the 15th century during the Ottoman Empire).

"What kind of work do scientists do?" was another question. The responses are categorised as follows: they develop technology, design projects, do research, make inventions, use technology, work in a laboratory, produce devices that make our lives easier, and are clever and inventors.

When they were asked about the relationship between science, technology and engineering, most of them did believe that there was a relationship. According to them, a scientist takes advantage of technology. For example, a scientist can use machines to produce knowledge. They also emphasised that a scientist produces knowledge and that an engineer uses that knowledge. Another view is that a scientist and an engineer improve technology, such as improving cellular phones.

DISCUSSION

Although the raising of technologically-literate individuals, which is widely accepted as one of the basic aims of science education, that is to say, science-technology-engineering-mathematics (STEM) integration, was included in the Turkish science teaching curriculum in 2017, this need had already been recognised by science educators and studies and research related with STEM had already begun (Corlu et al., 2014; Corlu, 2013). Akgunduz et al. (2015) stated the importance of adding this field in the curriculum. They believed that "it will not be possible to compete in the global economic system that will enter a more challenging course in the 21st century without forming an educational culture and without raising a generation that has gained an understanding of science, mathematics, engineering". One of the results of this research was the inclusion of this subject in the syllabus. This research, aimed at developing the knowledge and understanding of primary school students with regard to science, technology and engineering, was also one of the studies mentioned. One of the modules developed by EiE had already been used in the study, since the research related with these modules had been examined and it was shown that the modules applied to large samples were beneficial both for students and for teachers (Cunningham and Lachapelle, 2010; Lachapelle et al., 2013, 2011a, 2011b, 2017, 2008; McKay et al., 2008). Sixteen of these modules, which were developed with great care and which were proven to have positive effects, were purchased from EiE to be adapted and used in Turkish. It is believed that every module, along with the results obtained from this study, will contribute to STEM education and that this will be important for education policy. For this reason, the contribution made by the implementation and translation into Turkish of each model in turn is pleasing for me as a researcher. Just as valuable results have been obtained from the work carried out with each module, so have both anticipated and striking results have been obtained from this study. Since what students say is important, the data were collected through one-to-one interviews. The participants who took part in the interviews actually said very little. It seemed that they had a lack of self-expression. More meaningful results were obtained from instrument 1 than from the interviews. Their lack of self-expression or the fact that the instruments have pictures might explain that conflict. The results were collected under the headings of students' views about technology and technological products, their opinions about the harmful effects of technology, and their views about engineering and science. In this way, in short, an attempt was made to determine whether the views of students with regard to the STEM sub-headings of science, technology and engineering had developed after the module.

The categorisation made in terms of technology showed that electronic devices such as computers, television, and telephones came to the students' minds. Lachapelle et al. (2013) obtained the same result. They studied with primary students' (n=789) and used a "what is technology (WT)?" instrument for pre- and post-test. According to the results, most of the students relate technology to electronics. After teaching technology, although students' misconceptions decreased, some of the students still had misconceptions about technology. In both studies, too, it was shown that a few students could have misconceptions with regard to technology even after the intervention. It may also be concluded from this study that some of the sample students were confused in terms of their definition of technology. For example, one student, based on the definition, "technology means things which make our lives easier and are beneficial to us", defined the horse as a technological product since it makes transport easier for us, while another defined the lime flower as a technological product, since if we drink it when we are ill, it is beneficial to us. In that case, we must consider redefining the term technology. Is a technological product a natural object or is it made by people? The horse and the flower are each products of nature; therefore they are not technological products. Let us give a similar example for stone. Stone is a natural product and when it is found in nature it is not a technological product. Yet when we take it and use it to hit a nail, it becomes a technological product. This result of the study has created the idea that further research needs to be done on the subject of how the definition of technology should be given to students. For example, the sentence "things which meet the needs of people are technological products", given as an answer by students, could be the starting point for a study entitled "What is technology and how should it be taught?"

The change in the students' views with regard to engineering and technology was not easy. Just as in the studies by Cunningham et al. (2005) and Lachapelle et al. (2012), the results that appeared in this study revealed that students possessed the belief that the jobs to be done by technical staff were done by engineers. Yet the results of the questionnaire showed that following the module, the words 'engineering' and 'design' had begun to be used in association by students. The fact that the educational module was effective in this sphere had already been determined in previous studies (Cunningham and Lachapelle, 2010; Lachapelle et al., 2013; Cunningham et al., 2006). For instance Cunningham and Lachapelle's (2010) sample is very huge (experimental group of students n=5139 and control group n=1827) and they found significant differences between the experimental and control groups in that the experimental group of students had a better understanding of engineering and science. Yet it was observed that the module was not effective in teaching of the engineering design process. In fact, it was reported that this method was very important for students not only to learn science subjects but also to learn the ways of knowing them (Cunningham and Kelly, 2017). In this context, the teacher training and educational module development projects were initiated. Not only the module developments but also the developments of some scales, which determine the ideas of students about science, technology and engineering, are needed. For instance, Koyunlu Unlu et al. (2016) have adapted science, technology, engineering and mathematics career interest survey into Turkish and the scale can be used to find out middle school students' interest in the subject. Very few studies have been conducted in Turkey about the effectiveness of science, technology and engineering education (Sahin et al., 2014; Corlu et al., 2014; Akgunduz et al., 2015). This study will contribute the curriculum developments with the example of a module.

CONFLICT OF INTERESTS

The author has not declared any conflicts of interests.

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