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The Perception of Engineers by Middle School Students through Drawings*

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ABSTRACT

Purpose: In 2017 and 2018, engineering applications and design process were given weight to with the updates carried out in the Physical Sciences Lesson Curriculum in Turkey. For the STEM education which is at the center of this update to reach its target, it is highly important that students accurately learn what engineers do, what their work field is, the characteristics they should carry and understand the nature of engineering. The present study aims to identify the perception of engineers of 5th, 6th and 7th grade middle school students through drawings.

Research Methods: The study group of this research which is a descriptive survey model consisted of 119 students from a city located in the East Anatolian region of Turkey who were 5th, 6th and 7th grade students. The "Draw an Engineer" form was used as the data collection tool and the drawings were evaluated with a checklist.

Findings: As a result of this study, it was determined that a majority of the students adopted the stereotyped idea that engineers are male. The findings showed that as the age increased, the rate of male engineers in the drawings increased as well and engineers creating designs were given more place to. In this study, it was concluded that in general the students mixed up what engineers do with the work construction workers or repairmen do and that they perceived engineers as individuals who work alone.

Implications for Research and Practice: To be able to develop students' perception of engineers in a positive manner, it is considered important for students' to experience STEM education applications. In this context, it is suggested to give place to 'Science, Engineering and Entrepreneurship Applications' in all grade levels both in school and outside school learning environments.

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Introduction

The advanced technologies and scientific developments brought by the 21st century have brought along international competition in many countries as well. The success of countries in this competition depends on producing creative individuals who can critically and analytically think, solve problems pertaining to daily life, make efficient decisions, conduct research and question. To be able to be successful in the global competition, countries' making some reforms in the educational policies has come into question. When we take a look at the achievements of the 'Science and Engineering Applications' unit, which is a part of the Physical Sciences Lesson Curriculum updated in 2017 in Turkey, it is possible to see that engineering applications and design process were given weight to (Ministry of National Education [MoNE], 2017). STEM education which is at the center of this reform is made up of the first letters of Science, Technology, Engineering and Mathematics areas and embodies knowledge, skills and beliefs which are formed with the intersection of more than one of these areas (Çorlu, Capraro, & Capraro, 2014).

The program, which was renewed by the MoNE in the middle of 2017 in line with the STEM approach, is a draft program which was prepared to receive the views, suggestions and criticism of the public. The program was applied as a pilot program to the 5th grade students in the 2017-2018 academic year. Regarding the implementation of the program, the Head Council of Education and Morality evaluated the opinions received from different institutions and people. In the workshop report of Aydın University titled "Integration of STEM education to the Academic Program," it was stated that it will not be possible to implement the STEM approach by merely adding an engineering unit to the program and that the STEM education needs to be integrated into the whole Science Academic Program (Akgündüz, 2018, pp. 16-17). As a result of the evaluation of the views received from Aydın University and other institutions, the program was revised and updated once again at the end of 2017 and the MoNE published the 2018 Science Lessons Academic program. In the 2017 program, the 'Science and Engineering Applications' unit appears as the eighth unit from the 4th grade to 8th grade and as nine hours for 4th grade students and 12 hours for the other grade levels. In the 2018 program, the 'Science and Engineering Applications' unit was removed and replaced with 'Science, Engineering and Entrepreneurship Applications' to cover all of the units. Within the scope of these implementations, the students are expected to create products to meet a need in daily life or as a solution to a problem by taking the subjects learned in the units as a reference and present these at the science festival to be organized at the end of the academic year. In this respect, nine hours for 4th grade students and 12 hours for the other grade levels were suggested for this science festival (MoNE, 2018).

The purpose of STEM education is to make it possible for students to form a relationship between engineering and the other three disciplines, understand interdisciplinary interaction and use the knowledge they acquire during the learning process in the lives. In order for STEM education to reach its target, it is considered that it is important for students to accurately understand what engineers do, what their study field is, the characteristics they should carry and the nature of engineering.

Although our daily lives are surrounded by the products of engineering, students mostly do not understand what engineers do (Gibbin & Davis, 2002; Frehill, 1997). According to the Turkish Language Society, an engineer is an individual who is specialized in public works, such as roads, bridges and buildings; nutrition, such as agriculture and diets; sciences, such as physics, chemistry, biology, electric and electronics and technical and social areas, such as planes, cars, motors and work machines which serve the purpose of meeting every needs of human beings, who received a specialized education (TLS, 2010). Engineering is defined as the accumulation of knowledge in the design and production of both human made products and the problem solving process (Katehi, Pearson, & Feder, 2009, p. 17).

Understanding what students' perception of engineers is and what they think about the work carried out by engineers seems important because these perceptions can influence the understanding of students about this profession, their beliefs and thoughts about doing this profession as a career (Knight & Cunningham, 2004). In the literature, the most commonly used method to identify the perception of students of engineers and engineering is the 'Draw an Engineer Test' (DAET). This test was created by taking the 'Draw a Scientist Test' (Chambers, 1983) developed with the purpose of identifying the perception of students on scientists as the basis. DAET, which was developed by the Boston Science Museum researchers, contains open-ended questions in addition to drawings (Knight & Cunningham, 2004). The researchers asked 384 3rd-12th grade students to draw an engineer and answer the question "What does an engineer do?" in written form. At the end of the research, what engineers do was identified as construction, repair works, creation and design.

The researchers, who developed a measurement took named "What is Engineering?" using the results they obtained from DAET, asked the students to choose the visuals which represent what engineers do. In this study, it was concluded that students think of engineers as car repairmen and construction workers (Cunningham, Lachapelle, & Lindgren-Streicher, 2005). In another study, primary school students perceived engineering as repairing and constructing things and doing these work, and that they depicted engineers as construction workers. In addition, students thought that engineers use plans, computers and objects, such as safety helmets as well (Oware, Capobianco, & Diefes-Dux, 2007). In another study in which DAET and interview method were used, the perception of students about engineers was separated into four categories, as follows: repairmen, construction workers, technicians and individuals who do designs. Only 17% of the students who participated in this study expressed that engineers do designs (Capobianco, Diefes-Dux, Mena, & Weller, 2011).

In another study in which DAET was used, the findings showed that second, 3rd and 4th grade students associated engineers with concepts, such as constructing buildings, repairing things and driving vehicles (Carr, Diefes-Dux, & Horstman, 2012). In another study in which students perceptions about engineering were identified, the researchers evaluated the drawings with a check-list they developed. In this study in which 744 students' drawings were evaluated, engineers were mostly depicted as human and male. The skin color of engineers was not indicated, and they were

depicted as individuals with construction worker clothes who wear glasses/protective glasses and laboratory coats. Some of the students gave place to other people as well in their drawings, and the most commonly seen objects were passenger vehicles, civilian buildings, architecture/construction tools, trains/railroads, furniture and computers. The engineers drawn by the students did construction/repair/manual work, operated/used machines/tools and did design work, and some of them did not do anything at all. It was observed that the work environments of engineers were mostly not indicated and open spaces were given more places to in comparison to closed areas. As a result, students depicted engineers as workers who used their hands rather than their minds and did heavy work in open areas (Fralick, Kearn, Thompson, & Lyons, 2009).

In the study of Gibbons et al., the researchers stated that a majority of secondary school students like finding out how things work and thinking about innovative and better ways of doing things. Despite this, a very small number of students were able to accurately identify five types of engineers. None of the students were able to correctly give examples of the work that the engineer type they wrote about did (Gibbons, Hirsch, Kimmel, Rockland, & Bloom, 2004).

In another study in which views of 6th grade students on the nature of engineering, DAET was used and the students were interviewed. As a result of the study, a majority of the students perceived engineers as individuals who produced products. Despite this finding, some students understood the role engineers play in the design and planning of products. A majority of the students regarded the process of engineering as building or assembling vehicles and constructing buildings and thought that engineering is a professions performed by a handful of skilled workmen both in their drawings and the interviews. Although there were no women depicted as engineers in the drawings, the students expressed in the interviews that engineering is not a profession which is focused on males (Karatas, Micklos, & Bodner, 2011).

In a study carried out in Turkey, the perception of 72 students of high-intelligence was determined with DAET. As a result of the study, it was determined that a majority of the students drew construction engineers, mentioned the design dimension of engineering and perceived engineering as a male profession (Koyunlu Ünlü & Dökme, 2017). In another study in which the perceptions of 82 5th grade students of engineers were identified with DAET, a majority of the students perceived the gender of engineers as male. In addition, the students regarded engineering as a profession which is carried out with machines and drew mechanical engineers who performed the repair, design and development of machines. It was concluded with the students' drawings that the students associated construction engineers with the concepts of construction and repair. The most commonly seen objects in the students' drawing were safety helmets, tools, work machines, vests and gloves. It was stated in the study that there were very few drawings of engineers who did laboratory work and that the tools used by engineers were experiment materials and microscopes. It was seen in the drawings that engineers who worked in laboratories invented things with chemicals and performed work which is research-oriented. It was seen that very few students regarded engineering as design and development and that there were engineers who

used computers, drawing-measurement tools, models and calculators, mostly wearing glasses in their drawings. In the engineer drawings which depicted them as doing mechanical production, car, robot, plane and rocket productions were given place to and that the concept of mechanics was associated mostly with cars (Çetin & Asiltürk, 2017). In a study in which the engineer perceptions of 5th and 7th grade students were identified, the students mostly drew engineers who constructed buildings and did work on computers and that as the grade level increased, engineering areas, such as agriculture, genetics, machinery and environment were drawn. It was seen that the students, in general, drew workmen who did work, such as painting, plaster, in constructions and that they depicted engineers as designers. The students gave very little place to female engineers in their drawings and as the grade level increased, the number of female engineers drawn decreased (Gülhan & Şahin, 2018). In another study in which the engineer perceptions of 220 middle-school students were identified, the findings showed that the students mostly drew construction engineers and computer engineers and perceived engineers as a person who repaired a broken electronic device. In addition, the female students mostly drew food and environment engineers, whereas male students mostly drew aircraft engineers and ship engineers (Bilen, Irkıçatal, & Ergin, 2014).

The results of all mentioned studies showed that many students perceive engineering as repairing and buildings things or driving vehicles, think that engineers perform work which requires too much physical labor and that very few students are aware of the design dimension of engineering (Bilen et al., 2014; Capobianco et al., 2011; Carr et al., 2012; Cunningham et al., 2005; Fralick et al., 2009; Gülhan & Şahin, 2018; Knight & Cunningham, 2004; Oware et al., 2007). Another finding acquired in the literature review is that, students adopted the stereotypical view that engineers are mostly male (Çetin & Asiltürk, 2017; Fralick et al., 2009; Gülhan & Şahin, 2018; Karatas et al., 2011; Koyunlu Ünlü & Dökme, 2017).

Individuals acquire knowledge, attitude and behaviors about occupations in the middle-school period; therefore, middle-school years are a critical period regarding career choice (Gottfredson, 2002). It is stated that the perceptions of students of different occupations in this period are important regarding career development and that they need to be analyzed (Super, 1990). Engineering, which is one of the disciplines of STEM education which came to the agenda with the draft Science Education program in 2017 and started to be implemented with the program in 2018, is a very new area for our country in the primary education level. When the studies published in Turkey were analyzed, it was observed that the number of studies in which the engineer perception of middle-school students is quite low compared to international literature. Therefore, it can be stated that the results to be obtained from this study will contribute considerably to the national literature as well. In addition, it is considered that the results of this study will provide valuable insights into the integration of engineering into the science program to teachers who have an important role in creating an accurate engineer perception in the students, the academicians who educate them, textbook writers and program development experts.

The purpose of the study

The present study aimed to determine the perceptions of 5th, 6th and 7th grade middle school students (aged 11-13) of engineers through drawings. In the light of this purpose, it was attempted to determine the students' views on the physical characteristics of engineers, their work environments, and the work that they do and the objects found in their work environments through their drawings.

Study problem

The problem sentence of this study was determined as, "What is the perception of 5th, 6th and 7th grade secondary school students of engineers?" The sub-problems of this study are presented below:

What is the perception of the students of the physical characteristic of engineers?

What is the perception of the students of the work environment of engineers?

What is the perception of the students of the work performed by engineers?

What is the perception of the students of the objects found in the work environments of engineers?

Method

Research Design

This study was carried out the purpose of determining the perception of secondary school students of engineers using the pictures they envision in their minds. Therefore, in this study, the descriptive survey model was used. The studies in the descriptive survey model which is the most widely used model in social sciences are aimed at presenting the attitudes, views or behaviors of individuals towards the subject of the study (Creswell, 2008).

Research Sample

The study group of this research consists of 119 students from the 5th, 6th and 7th grade students of a state middle school located in a district in a medium level socioeconomic rural region in the East Anatolian region of Turkey. Since the first years of middle-school are a critical period regarding the identification of the perception of occupation (Gottfredson, 2002), 8th grade students were not included in this study. The study group was formed with the number of students who could be reached from the 5th, 6th and 7th grade students. In the formation of the study group, convenience sampling which is a type of purposeful sampling was used. According to Yıldırım and Şimşek (2013), in line with the purpose of this type of sampling method, the researcher chose a close and easily accessible situation, which sped up this study and made practical. The distribution of the students in accordance with their grade and gender is presented in Table 1.

Table 1.

Distribution of the Study Group according to Grade and Gender

Grade	Female	Male	Total	%
5	17	15	32	26.89
6	27	32	59	49.58
7	13	15	28	23.53
Total	57	62	119	100.0

Data Collection Tool

The "Draw an Engineer" form was used as the data collection tool. On the front page of the form, there is a large and framed area for the students to draw a working engineer and a separate space underneath this area in which the students write the name of the engineer they draw. On the back page of the form, there are the questions, "What are the personal characteristics of an engineer?", "How is the work environment of an engineer?", "What kinds of work does an engineer do?" and "What is the engineer you drew is doing?" with the purpose of allowing the students describe their drawings (Fralick et al., 2009). The construct validity of the open- ended questions was determined with the views of two experts in the science education area and one language experts. The students were given 45 minutes to draw on the front page of the form and to answer the open-ended questions at the back of the form. In addition, the students were advised to use colored pencils in their drawings.

Data Analysis

In the evaluation of the students' drawing on the characteristics of students, the drawing checklist used by Fralick et al. (2009) was used. The drawing checklist consists of 61 small boxes on the drawings of the participants. These are: skin color (brown, light pink, yellow, green, none, other), outer appearance characteristics (wild hair, protective glasses/glasses, laboratory coat, construction worker clothes, others), gender (male, female, not known), location (interior spaces, open areas, space, underground, underwater, not known), works performed (production/repair/ manual work, operating/using machines, vehicles and tools, design/innovation/production/creation, experiment/test/knowledge production, explanation/teaching, observation, no work of activity, other) and objects (30 common objects including robots, computers, tools and others) (Fralick et al., 2009, p. 72).

For instance, let's have a look at how the analysis was carried out through the drawing in Figure 3-c: In this drawing, the type of engineer was integrated into the *human* code, the gender to *female* code, skin color to *none* code and other physical appearance to *safety helmet/crash helmet code*. When the drawing is analyzed concerning place, it can be seen that the engineer was integrated into the *interior/closed spaces* code since he/she works in a room and when the drawing was analyzed concerning the theme of the work produced, it can be seen that this was integrated into the

design/invention/production/creation code since a design was produced through drawing. The paper and pencil found in the work-space of the engineer were integrated into the *writing materials* code; the table, closet and bookcase to the *furniture* code and the books in the bookcase to the *books'* code. The drawings produced by the engineer were integrated into the *plans, drawings and graphics* code. While the obtained data were recorded on the control list, these were given place to underneath the grade level of the student who drew the picture. In this manner, the data were evaluated both separately and, in general concerning the grade levels.

In the evaluation of data obtained from the checklist, descriptive analysis was used. Data obtained from the descriptive analysis were evaluated in accordance with the pre-determined categories, interpreted systematically in an open manner and the results are presented following the analysis of a cause and effect relationship (Yıldırım & Şimşek, 2013). For the reliability of the descriptive analysis, the data coded by the first researcher were coded by the second researcher as well and the concordance between the two researchers was calculated as 98% with Miles and Huberman's (2015) reliability control coding formula. According to Yıldırım and Şimşek (2013), when the concordance percentage in the reliability calculation is 70%, it is regarded as having reached the reliability percentage. Therefore, the obtained values showed that the coding reliability of the researchers was sufficient.

Results

Findings of the first Sub-Problem

The perceptions of the students of the physical characteristics of engineers were evaluated in accordance with the categories and codes in the drawing checklist. The descriptive analysis results of the evaluations are presented in Table 2.

Table 2.

The Descriptive Analysis Results of the Students' Perceptions of the Physical Characteristics of Engineers

Category	**Code**	**5th grade n=32**		**6th grade n=59**		**7th grade n=28**		**All participants N=119**	
		f	%	f	%	f	%	f	%
Type	Human	31	96.88	57	96.60	27	96.43	115	96.64
	Nonhuman/not human	1	3.12	1	1.70	-	-	2	1.68
	Not a person (no one)	-	-	1	1.70	1	3.57	2	1.68
Gender	Male	26	81.25	52	88.14	25	89.29	103	86.56
	Female	6	18.75	6	10.17	2	7.14	14	11.77
	Not known	-	-	1	1.69	1	3.57	2	1.68

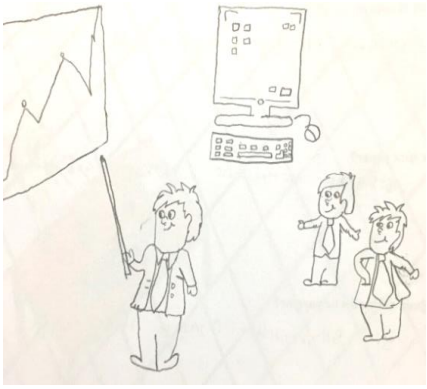
Table 2 Continue

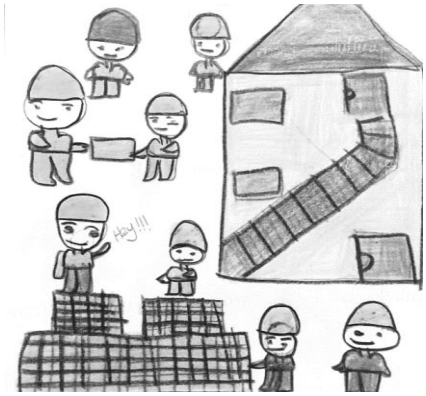
Category	Code	5th grade n=32		6th grade n=59		7th grade n=28		All participants N=119	
		f	%	f	%	f	%	f	%
Skin color	Brown	-	-	2	3.39	-	-	2	1.68
	Light pink	1	3.13	5	8.48	1	3.57	7	5.88
	Yellow	3	9.38	5	8.48	2	7.14	10	8.40
	Green	-	-	1	1.70	-	-	1	0.84
	None	28	87.50	35	59.32	23	82.14	86	72.27
	Other	-	-	11	18.64	2	7.14	13	10.92
Other physical characteristics	Crazy hair style	-	-	2	3.39	-	-	2	1.68
	Protective glasses/glasses	1	3.13	-	-	4	14.29	5	4.20
	Laboratory clothes	-	-	-	-	-	-	-	-
	Construction worker clothes	3	9.38	14	23.73	4	14.29	21	17.65
	Safety/crash helmet	9	28.13	22	37.29	7	25.00	38	31.93
	Moustache/beard	-	-	1	1.70	3	10.71	4	3.36
	Suit	2	6.25	2	3.39	3	10.71	7	5.88
	Bald	1	3.13	10	16.95	1	3.57	12	10.08
	Other	16	50.00	8	13.56	6	21.43	30	25.21

According to the findings in Table 2, it can be seen that 96.64% of the engineers drawn were human, 1.68% was non-human/not human, 1.68% was not in the form of a person. 96.88% of the 5th grade students, 96.60% of the 6th grade students and 96.43% of the 7th grade students drew engineers as humans. While one student each from the 5th and 6th grades drew an engineer who is non-human, one student each from the 6th and 7th grades drew an engineer, not in the form of a person. It can be seen that the gender of the engineer drawn by the students was 86.56% male, 11.77% female and 1.68% unknown. It was observed that the gender of the engineers drawn by 81.25% of the 5th grade students, 88.14% of the 6th grade and 89.29% of the 7th grades was perceived as male. It was also observed that there were more female engineers in the drawings of the 5th and 6th grade students in comparison to the 7th grade students.

According to Table 2, the skin color of the engineers drawn by the students was mostly not indicated (72.27%). 87.50% of the 5th grade students, 59.32% of the 6th

grade students and 82.14% of the 7th grade students did not indicate skin color. 8.40% of the students colored the skin of the engineer yellow and 10.92% colored it as brown, light pink, yellow, green and did not use any color. It was seen that the engineers drawn had crazy hair styles (1.68%), wore protective glasses/glasses (4.20%), wore construction worker clothes (17.65%), wore safety/crash helmets (31.93%), had a moustache/beard (3.36%), wore suits (5.88%), were bald (10.08%) and other physical characteristics (25.21%). There were no engineers in the drawings with laboratory coats. While there were engineers with crazy hair style in the drawings of the 6th grade students (3.39%), whereas the 5th and 7th grade students did not portray engineers in this manner. While there were engineers who wore protective glasses/glasses in the 5th and 7th grade students' drawings, the 6th grade students did not portray engineers in this manner. There were more engineers with construction worker clothes and safety/crash helmets in the drawings of the 6th grade students, whereas engineers with suits were more in the drawings of the 7th grade students. There were no engineers with moustaches/beards in the drawings of the 5th grade students and there were more bald engineers in the drawings of the 6th grade students compared to the students in other grades. The drawings of some students' about their perceptions of the physical characteristics of engineers are presented in Figure 1. In these drawings, a) female engineers, b) male engineers with suits and whose skin color was not apparent, c) engineers wearing safety/crash helmets and construction worker clothes d) engineers wearing safety/crash helmets, with moustaches and no apparent skin color were depicted.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>a) 7th grade
"The engineer I drew is communicating with her friends on the computer."</td><td>b) 7th grade
"He is presenting the computers he built."</td></tr>
</table>



c) 6th grade

"Trying to make people happy with his friends."

d) 7th grade

"The engineer is visiting the work sites, reporting these and doing arrangements."

Figure 1. *Engineer Drawing Samples and Students' Views on the Work Engineers Do*

Findings of the second Sub-Problem

The perceptions of the students of the work environments of engineers were evaluated in accordance with the categories and codes in the drawing checklist. Since some of the students depicted more than one working environment in their drawings, the total frequency was found to be higher than the study group's size. The descriptive analysis results related to the evaluation are presented in Table 3 below.

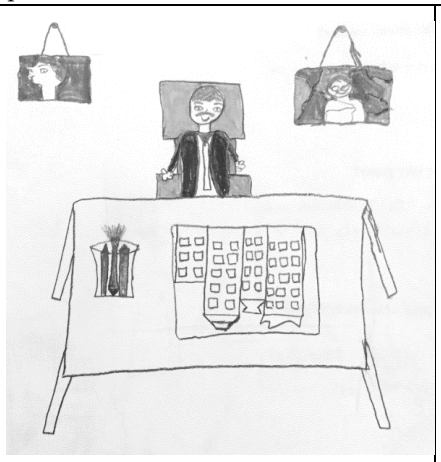
Table 3.

The Descriptive Analysis Results of the Students' Perceptions of the Work Environments of Engineers

Category	**Code**	**5th grade n=32**		**6th grade n=59**		**7th grade n=28**		**All participants N=119**	
		f	%	f	%	f	%	f	%
Location	Internal closed spaces	14	38.89	16	27.12	14	45.16	44	34.92
	External/open Spaces	14	38.89	40	67.80	16	51.61	70	55.56
	Space	-	-	-	-	-	-	-	-
	Underground	-	-	-	-	-	-	-	-
	Underwater	-	-	-	-	-	-	-	-
	Not indicated	8	22.22	3	5.08	1	3.23	12	9.52
Total		36	100	59	100	31	100	126	100

According to Table 3, the work environments of the engineers drawn by the students and the frequency of their mention were determined as internal/closed spaces (34.92%), external/open spaces (55.56%) and not indicated (9.52%). In the drawings of the 5th grade students, it was seen that internal/closed and external/open spaces were mentioned in the same frequency (38.89%) and that the location was not mentioned in the frequency of 22.22%. A majority of the 6th grade students (67.80%) drew engineers in external/open spaces. 51.61% of the 7th grade students drew the location of the engineers as external/open spaces, 45.16% as internal/closed spaces and 3.23% (f=1) of them did not indicate the work environments of the engineer.

The drawings of some students about their perception of the work environment of engineers are presented in Figure 2. In these drawings, a) an engineer working in an internal/closed space and b) an engineer working in an external/open space were depicted.



a) 7th grade

"He is checking all the drawings himself."

b) 6th grade

"She is checking and observing the endurance of the construction one last time."

Figure 2. *The Students' Drawings of Engineers and Their Views on What Kind of Work They Do*

Findings of the third Sub-Problem

The perceptions of the students of what engineers do were evaluated in accordance with the categories and codes in the drawing checklist. Since some of the students depicted the engineer they drew as doing more than one work, the total frequency was found to be higher than the study group's size. The descriptive analysis results of the perceptions of students of the work that engineers do are given in Table 4.

Table 4.

The Descriptive Analysis Results of the Students' Perceptions of the Work Engineers Do

Category	Code	5th grade n=32		6th grade n=59		7th grade n=28		All participants N=119	
		f	%	f	%	f	%	f	%
Inferences about the work engineers do	Production/Repair/ Manual work	10	27.78	17	24.29	6	18.75	33	23.91
	Operating/Using Machines and Tools	1	2.78	13	18.57	3	9.38	17	12.32
	Design/Invention/ Forming products/ Creating products	6	16.67	18	25.71	11	34.38	35	25.36
	Experiment/Testing /Producing knowledge	4	11.11	1	1.43	3	9.38	8	5.80
	Teaching /Explaining	-	-	2	2.86	-	-	2	1.45
	Observing	7	19.44	8	11.43	1	3.13	16	11.59
	No work or activity	8	22.22	10	14.29	8	25.0	26	18.84
	Other	-	-	1	1.43	-	-	1	0.73
Total		36	100	70	100	32	100	138	100

According to Table 4, the work engineers do and their frequency in the drawings were determined as production/repair/manual work (23.91%), operating/using machines and tools (12.32%), design/invention/forming products/creating products (25.36%), experiments/testing/producing knowledge (5.80%), teaching/explaining (1.45%), observing (11.59%). The engineers in the drawings were portrayed as doing nothing in the frequency of 18.84% and doing other work in the frequency of 0.73%. Engineers were generally doing things like production/repair/manual work in the drawings of the 5th grade students, doing things like production/repair/manual work and design/invention/forming products/creating products in the drawings of the 6th grade students and design/invention/forming products/creating products in the drawings of the 7th grade students. While engineers teaching/explain things were portrayed in the drawings of the 6th grade students, these types of engineers were not seen in the drawings of the 5th and 7th grade students. The drawings of some students about their perception of the work engineers do are presented in Figure 3. In these drawings, a) an engineer carrying out an observation, b) an engineer conducting an experiment/testing/producing knowledge and c) an engineer doing design/invention/forming a product/creating a product were depicted.

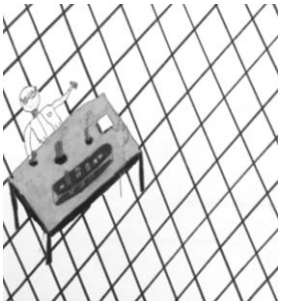
		
a) 5th grade *"He is controlling the building he has drawn the project of."*	**b)** 7th grade *"Producing soap."*	**c)** 6th grade *"She is designing a project. She has drawn lots of pictures but has not liked them and thrown them away."*

Figure 3. *The Engineer Drawings of the Students and Their Views on the Work Engineers Do*

Findings of the fourth Sub-Problem

The perceptions of the students of the objects found in the work environments of engineers were evaluated in accordance with the categories and codes in the drawing checklist. Since the majority of the students gave more than one object in their drawings, the total frequency was found to be higher than the study group's size. The descriptive analysis results are given in Table 5.

Table 5.

The Descriptive Analysis Results of the Students' Perceptions of the Objects Found in the Work Environments of Engineers

Category	Code	5th grade n=32		6th grade n=59		7th grade n=28		All participants N=119	
		f	%	f	%	f	%	f	%
Objects	Other people	9	12.68	25	14.12	6	8.57	40	12.58
	Non-human creatures - such as monsters	-	-	-	-	-	-	-	-
	Parts of the body – such as arms, the brain	-	-	-	-	-	-	-	-
	Robots	-	-	-	-	-	-	-	-
	Computers	8	11.27	10	5.65	5	7.14	23	7.23
	Architecture/Construction tools such as wrench, hammer	-	-	13	7.35	1	1.43	14	4.40
	Measurement tools - such as ruler	-	-	-	-	1	1.43	1	0.32
	Writing tools - such as paper, pens	5	7.04	14	7.91	7	10.0	26	8.18

Table 5 Continue

Category	Code	5th grade n=32		6th grade n=59		7th grade n=28		All participants N=119	
		f	%	f	%	f	%	f	%
Objects	Animals being studied	-	-	1	0.57	-	-	1	0.32
	Other animals	-	-	1	0.57	-	-	1	0.32
	Plants being studied	-	-	2	1.13	-	-	2	0.63
	Other plants	1	1.41	3	1.70	2	2.86	6	1.89
	Rocks	-	-	1	0.57	1	1.43	2	0.63
	Passenger vehicles	1	1.41	1	0.57	3	4.29	5	1.57
	Construction tools	3	4.23	11	6.22	1	1.43	15	4.72
	Flying vehicles	-	-	-	-	-	-	-	-
	Rockets/ space vehicles	-	-	-	-	-	-	-	-
	Trains/Rail Roads	-	-	1	0.57	-	-	1	0.32
	Imaginary machines	-	-	-	-	-	-	-	-
	Other machines	1	1.41	2	1.13	-	-	3	0.94
	Books	1	1.41	3	1.70	1	1.43	5	1.57
	Furniture - such as tables, chairs	15	21.13	14	7.91	13	18.57	42	13.21
	Mathematics symbols	-	-	-	-	-	-	-	-
	Chemistry symbols	-	-	-	-	-	-	-	-
	Plans, drawings and graphics	7	9.86	16	9.04	10	14.29	33	10.38
	Diplomas / Awards	-	-	-	-	-	-	-	-
	Weapons - such as guns, bombs	-	-	1	0.57	-	-	1	0.32
	No Entry / Caution signs	-	-	-	-	-	-	-	-
	Danger - such as fire, explosives	-	-	-	-	-	-	-	-
	Civilian buildings - such as bridges, buildings	12	16.90	27	15.25	11	15.71	50	15.72
	Chemistry - such as volumetric flask, experiment tubes	1	1.41	1	0.57	3	4.29	5	1.57
	Technology - such as TV, radio, telephone	1	1.41	2	1.13	1	1.43	4	1.26
	Medicine - such as bacteria, injectors, needles	-	-	-	-	-	-	-	-
	Meteorology	-	-	-	-	-	-	-	-
	Sports types	-	-	-	-	-	-	-	-
	Thinking signs	1	1.41	8	4.52	2	2.86	11	3.46
	Construction materials – such as cement, sand	3	4.23	9	5.09	2	2.86	14	4.40
	Other	2	2.82	11	6.22	-	-	13	4.09
		71	100	177	100	70	100	318	100

When we analyze Table 5, there were no non-human creatures, body parts, robots, flying vehicles, rockets/space vehicles, imaginary machines, mathematics and

chemistry symbols, diplomas/awards, no entry/caution sings, fire/explosives, etc., bacteria, injectors, needles, animate and inanimate objects about medicine, meteorology and sports types. In 12.58% of the drawings, there were engineers doing group work. The 5th and 6th graders gave more place to engineers doing group work compared to the 7th graders. Some students from each grade drew computers and technological devices, such as television, radio and telephone, were rarely depicted. It was also seen that other types of machines were displayed in the rate of 0.94% along with these types of technological devices.

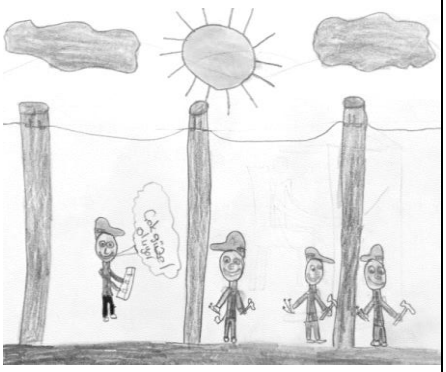
Objects related to construction and their frequencies in the drawings of the students were determined as architecture/construction tools (4.40%), construction vehicles (4.72%), civilian buildings, bridges and other buildings (15.72%), construction materials (4.40%). Objects related to construction were seen the most in the drawings of the 6th grade students. It was seen in the drawings that the students gave place to measurement tools (0.32%), writing tools (8.18%) and furniture (13.21%) and depicted engineers doing design work and drawings. It was observed that only one student from the 7th grade gave place to measurement devices and the other students in the 5th and 6th grades did not give place to these measurement tools. While 7th graders gave more place to writing tools in comparison to the students from the other grades, 5th and 6th grade students gave place to writing tools about the same amount in their drawings. The 5th and 7th graders gave more place to furniture compared to the 6th graders.

According to the findings in Table 5, while there were no vehicles in the drawings, such as flying vehicles, rockets/space vehicles, some other types of vehicles, were depicted by the students. The frequency of depicting vehicles was 1.57% for passenger vehicles, 4.72% for construction vehicles and 0.32% for trains. There was an individual doing experiments in the perception of the students of engineers. While the students gave place to objects related to chemistry in the rate of 1.57% in the drawings, they did not give place to danger signs and chemistry symbols frequently seen in the area of chemistry. The objects depicted in the drawings are mostly inanimate objects in the rate of 84.26%. The inanimate objects which were seen more in the drawings and their frequency were determined as: civilian buildings (15.72%), furniture (13.21%), plans, drawings and graphics (10.38%), writing tools (8.18%), computers (7.23%), construction vehicles (4.72%) and construction materials (4.40%). It was observed that the objects seen in the drawings were animate objects in the rate of 15.74% and that a majority of these consisted of other people (12.58%).

The drawings of some students about their perception of the objects found in the work environment of engineers are presented in Figure 4. In these drawings, a) construction materials, construction vehicles, civilian buildings and other people, b) measurement tool, furniture, drawing tool c) architecture/construction tools and other people, d) architecture/construction tools, other people, construction materials and civilian buildings, e) furniture and computer and f) furniture, drawing tool, construction materials were seen.

a) 7th grade
"He is doing a construction project."

b) 7th grade
"He is drawing a construction project."



c) 6th grade
"He is doing the city's electricity."

d) 6th grade
"He assigns tasks to the workers and guides them."

e) 7th grade
"He is going to sit in front of the computer and try something new."

f) 7th grade
"He is talking about his plan."

Figure 4. *Examples from the Engineer Drawings of the Students and Their Views on What Kind of Work Engineers Do*

Discussion, Conclusion, and Recommendation

In this study in which the purpose was to identify secondary education students' perception of engineers, the physical characteristics, work environments, type of work and the objects found in the work environments of engineers were evaluated. The findings showed that the engineers in the drawings were depicted as humans in the rate of 96.64% and that their gender was male in the rate of 86.56% and female in the rate of 11.77%. Similarly, it was observed that the engineers were depicted as humans in the rate of 69.80%, as males in the rate of 48.90%, as females in the rate of 13.30% (Fralick et al., 2009) and that there are more male engineers in the drawings (Çetin & Asiltürk, 2017; Fralick et al., 2009; Gülhan & Şahin, 2018; Karatas et al., 2011; Koyunlu Ünlü & Dökme, 2017) as the results of this study. It is considered that the underlying reason why mostly male engineers were given place to in the drawings might be that engineering is seen as a male dominant career in Turkey (Korkut-Owen, Kelecioglu, & Owen, 2014) and female students usually do not have role models in the area of engineering.

In this study, it was seen that the 5th and 6th graders gave more place to female engineers in their drawings in comparison to the 7th graders. Similarly, as a result of the research carried out by Gülhan and Şahin (2018), the findings showed that as age increased, the students drew less female engineers. This finding of the study is an unexpected result, because it is expected for the stereotypical perception of gender to decrease as the grade level increases (Gülhan & Şahin, 2018). It is stated that the students' perception of engineers is fragile and can change (Karatas et al., 2011); therefore, it is considered that engineering applications carried out during middle-school years might be effective in developing the engineer perceptions of the students.

In the drawings of the students, it was seen that the students mostly did not color the skin of the engineers they depicted (72.27%). Similarly, it was seen in another study as well that the students did not color the skin of engineers they depicted in the rate of 58.20% (Fralick et al., 2009). In the study, it was seen that the engineers are mostly wearing safety or crash helmets (31.93%), construction worker clothes (17.65) and are bald (10.08%) and that engineers with laboratory coats were not given place to. Fralick et al. (2009) in their study stated that engineers were depicted as wearing construction worker clothes in the rate of 12.30%, wearing protective glasses/glasses in the rate of 6.30% and wearing laboratory coats in the rate of 2.90%. Similarly, it was seen in literature that the engineers in drawings were depicted as wearing safety or crash helmets (Oware et al., 2007) and that the most drawn object was helmets (Çetin & Asiltürk, 2017). In this study, it was observed that engineers with construction worker clothes and safety/crash helmets appear more in the drawings of the 6th graders and that engineers wearing suits appear more in the drawings of the 7th graders. This result shows that, the 6th graders have a perception of construction engineers who work in construction yards, whereas the 7th graders have a perception of construction engineers who work desk jobs in an office environment and mostly draw projects. In Gülhan and Şahin's (2018) study, it was determined that as the grade level increased, the perception of engineers got diversified and the students gave place to engineers who did different works in their drawings.

In this study, the findings showed that the work environments of engineers were depicted as exterior/open spaces (55.56%), interior/closed spaces (34.92%) and that the work environments were not indicated in the rate of 9.52% and space, underground or underwater environments were not given place to in the drawings. Similarly, it was seen in another study that the work environment of engineers was not indicated in the drawings in the rate of 50.90%, were depicted as exterior spaces in the rate of 32.10% and as interior/closed spaces in the rate of 14.70% and mostly depicted as open-air spaces (Fralick et al., 2009). In this study, the findings showed that the 7th grade students gave place to closed areas and the 5th grade students gave place to open areas more compared to other grades. This finding overlaps with the finding that the 5th grade students gave more place to construction/repair/manual work and the 7th grade students gave more place to design/invention/creation of goods in their drawings, because the 5th grade students drew engineers who mostly did construction and repair work in exterior settings and the 7th grade students mostly drew engineers who did design work in closed areas.

The work performed by engineers in the drawings and their frequency were depicted as design/invention/forming products/creating products (25.36%), construction/repair/manual work (23.91%), operating and using machines/tools (12.32%), making observations (11.59%) and it was seen that the engineers not performing any task or action were drawn in the rate of 18.84%. Fralick et al. (2009) concluded that the engineers depicted in the drawings do not perform any task/action in the rate of 26.80%, do construction /repair/manual work in the rate of 31.10%, operate and use machines/tools in the rate of 11.30% and do design work in the rate of 10.10% (Fralick et al., 2009). Similarly, the work performed by engineers were depicted as construction (30%), repair (28%), creating (17%) and design (12%) (Knight & Cunningham, 2004); constructing buildings, repairing things and using vehicles (Carr et al., 2012; Gülhan & Şahin, 2018); building cars or assembling them and constructing buildings (Karatas, et al., 2011); repair and design of machines and constructing buildings (Bilen et al., 2014; Çetin & Asiltürk, 2017; Gülhan & Şahin, 2018) in other studies. In this study, while the rate of engineers who do design work is 25.36%, it was stated in the other study that drawings depicting engineers doing design work are less in number (Capobianco et al., 2011; Çetin & Asiltürk, 2017; Fralick et al., 2009; Knight & Cunningham, 2004). It was seen in this study that construction/repair/manual work was depicted the most by the 5th graders and that as the grade level gets higher, these kinds of work were depicted less in the drawings. It was observed that design/invention/forming and creating products were depicted more as the grade level gets higher and seen more in the drawings of the 7th graders. This result indicates that as the grade level gets higher, some students' perception of engineers changes from hand workmanship to design. However, the work performed by engineers in the drawings in which design was depicted being only related to construction engineering showed that the students did not have knowledge about many engineering areas. In parallel to these results, Gülhan and Şahin (2018) in their study determined that the 5th and 7th grade students mostly drew engineers who constructed buildings and worked on computers and that as the grade level increased, the students gave more place to the activity of design in their drawings.

In this study, the objects and their frequency were determined as civilian buildings, bridges and buildings (15.72%), furniture, tables and chairs (13.21%), other people (12.58%), plans, drawings and graphics (10.38%), writing tools, paper and pencils (8.18%), computers (7.23%) and construction vehicles (4.72%). It was seen that the students did not give place to non-human creatures, body parts, robots, flying vehicles, space vehicles, imaginary machines, mathematics and chemistry symbols, diplomas and awards, caution signs, explosives, bacteria, injectors, animate and inanimate objects related to medicine, objects related to meteorology and sports types. Fralick et al. (2009) stated that the students gave place to other people in their drawings in the rate of 20.80% and that the objects seen in the drawings were mostly passenger vehicles (19.80%), civilian constructions/buildings (16.40%), architecture/construction tools (16.30%), trains/railroads (12.90%), furniture (11.80%) and computers (11.40%). In Çetin and Asiltürk's study (2017), it was concluded that experiment materials were given very little place in the drawings (1.57%). As different from this study, the researchers stated that there were cars, robots, planes and rockets in the drawings and that objects such as computers and objects related to design, such as drawing-measurement tools and models were depicted less in number (Çetin & Asiltürk, 2017). In this study, the findings showed that the rate of giving place to other people was 12.56% in the 5th grades and 8.57% in the 7th grades. This finding can be interpreted as the students adopt the perception that engineers work alone more as the grade level increases. Similar to the result of this study, Gülhan and Şahin (2018) determined in their study that the number of 7th grade students who drew engineers who work alone were more in number compared to the 5th grade students. It is considered that having given more place to cooperative teamwork in lower grades at schools compared to upper grades might have been effective in for this finding.

Conclusion

In this study, it was concluded that in general the students mixed up what engineers do with the work construction workers or repairmen do and that they perceived engineers as individuals who work alone. In addition, it was determined that the students adopted the stereotypical view that the gender of engineers is mostly male. This result was reflected in the objects and the work performed by engineers in the students' drawings. It was seen that the students who think that engineering is a male profession mostly depicted engineers who work in open spaces, wearing construction worker clothes and safety or crash helmets. However, works such as construction, repair, manual activities or operating and using machines and tools indicate that they perceived construction engineers as qualified workers. The depiction of engineers without laboratory coats, space, underground or underwater environments, rockets/space vehicles, mathematics and chemistry symbols, do not enter/caution signs by the students showed that they did not know many work fields such as chemistry, aviation and space, nutrition and genetics which are a part of engineering. Therefore, it can be concluded that the students' perception of what engineers do is quite insufficient. The drawing of students which depicted design activities are only related to construction engineering and the civilian buildings, bridges, other buildings and furniture found high in number in the drawings support

this. Engineers not performing any kind of work or activity in the rate of 18.84% indicated that the students have very little knowledge about the work performed by engineers and their work areas. The appearance of other people in the drawings in the rate of 12.58% suggests that the students think that engineers work alone. In this study, the findings showed that as the grade level increased, the number of female engineers decreased and the number of engineers working alone increased when the drawings of the 5th, 6th and 7th grade students were compared. In addition, it was concluded that as the grade level increased, construction/repair/manual works decreased and design/invention/production works increased.

Recommendation

In the light of the results obtained from this study, the suggestions made to the teachers are as follows: To be able to develop students' perceptions of engineers in a positive manner, it is considered important for students' to experience STEM education applications. In this context, it is suggested to give place to 'Science, Engineering and Entrepreneurship Applications' in all grade levels both in school and outside school learning environments. 'Science, Engineering and Entrepreneurship Applications' can be given place to not only in science lessons but in mathematics, technology and design lessons as well. During the applications, the cooperation of teachers in STEM branches can facilitate the integration of the disciplines. In this study, it is suggested to carry out the applications in question in cooperating groups using the engineering design process and choose applications which are about different engineering areas. In this manner, students can comprehend that engineering is a career which depends on team work and involves many different work areas and can experience the design dimension of engineering through their own projects. The student projects created at the end of the applications can be exhibited in science festivals to be held at the end of the semester or school year. The perception of engineering as a male career can cause female students to view engineering as a career which is not suitable for them. In applications in which the engineering design process is dealt with, bringing students together with female role models who have careers in different engineering areas can be effective in changing the stereotypical perception of engineers in terms of gender.

In the light of the results obtained from this study, the suggestions made to the researchers are as follows: This study which is of descriptive survey model was carried out with 119 students who were receiving education in the 5th, 6th and 7th grades of a middle-school located in a middle-level socioeconomic area of a district in Turkey's East Anatolian region. Studies can be conducted in cities in different regions, in areas which have different socioeconomic levels with different grade levels and wider research groups and students' perception of engineers can be determined and compared. Researches can be supported with data collection methods, such as drawings about engineers, observation and interviews and more detailed results can be obtained. Researches can be conducted to determine and compare different variables which are considered to affect the perception of engineers. Long-term

longitudinal studies can be carried out about the students' wish to become engineers in the future and their perception of engineers.

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Özet

Problem Durumu: Türkiye'de 2017 ve 2018 yıllarında, Fen Bilimleri Dersi Öğretim Programında yapılan güncelleme ile mühendislik uygulamalarına ve tasarım sürecine ağırlık verilmiştir. Bu reformun merkezinde yer alan STEM eğitimi; Science, Technology, Engineering ve Mathematics alanlarının baş harflerinden oluşmakta ve bu alanların birden fazlasının kesişmesiyle oluşan bilgi, beceri ve inançları içermektedir. STEM eğitiminin amacı, öğrencilerin mühendislik ile diğer üç disiplin arasında ilişki kurmalarını, disiplinler arası etkileşimi anlamalarını ve öğrenme sürecindeki bilgilerini yaşantılarında kullanmalarını sağlamaktır. STEM eğitiminin amacına ulaşabilmesi için öğrencilerin mühendislerin ne iş yaptığını, çalışma alanlarını ve mühendisliğin doğasını doğru olarak anlamaları önem taşımaktadır. Öğrencilerin mühendislerle ilgili algılarını ve mühendislerin yaptığı işlerle ilgili ne düşündüklerini anlamak önemli görülmektedir; çünkü bu algılamalar öğrencilerin mesleğe ilişkin anlayışlarını, inançlarını ve mesleği kariyer olarak sürdürme düşüncelerini etkileyebilir. "Bir Mühendis Çiz Testi" kullanılarak yapılan araştırmaların sonuçları, pek çok öğrencinin mühendisliği bir şeyleri tamir etme, inşa etme ya da araç kullanma olarak algıladığını ve mühendislerin büyük oranda fiziksel emek gerektiren işler yaptığını düşündüklerini, çok az öğrencinin mühendisliğin tasarım boyutunu bildiğini göstermiştir. Araştırmalarda ulaşılan diğer bir sonuç, öğrencilerin mühendislerin cinsiyetinin çoğunlukla erkek olduğunu düşünmeleridir.

2017 yılında taslak Fen Bilimleri Öğretim Programı ile gündeme gelen ve 2018 yılındaki programla birlikte uygulanmaya başlanan STEM eğitiminin disiplinlerinden biri olan mühendislik, ilköğretim düzeyinde ülkemiz için çok yeni bir alandır. Yurt

içinde yapılan çalışmalar incelendiğinde, ortaokul öğrencilerinin mühendis algılarının belirlendiği araştırma sayısının yurt dışında yapılan çalışmalara göre oldukça az olduğu görülmüştür. Bu araştırmadan elde edilecek sonuçların öğrencilerde yeterli ve doğru bir mühendis algısı oluşturmada önemli rolleri olan öğretmenlere, onları yetiştiren akademisyenlere, ders kitabı yazarlarına ve program geliştirme uzmanlarına, mühendisliğin fen bilimleri programına entegrasyonu konusunda fikir vereceği düşünülmektedir.

Araştırmanın Amacı: Bu araştırmanın amacı ortaokul 5., 6. ve 7. sınıf öğrencilerinin (11-13 yaş) mühendis algılarını çizimler aracılığı ile belirlemektir. Bu amaç doğrultusunda öğrencilerin, mühendislerin fiziksel özellikleri, çalıştıkları ortamlar, yaptıkları işler ve çalışma ortamlarında bulunan nesnelere yönelik düşünceleri çizimler aracılığıyla belirlenmiştir.

Araştırmanın Yöntemi: Araştırmada betimsel tarama modeli kullanılmıştır. Araştırmanın çalışma grubunu, Türkiye'nin Doğu Anadolu bölgesinin kırsal kesiminde yer alan bir ilçede, orta düzey sosyoekonomik bölgede bulunan bir devlet ortaokulunun 5., 6. ve 7. sınıflarında öğrenim görmekte olan 119 öğrenci oluşturmaktadır. Çalışma grubunun oluşturulmasında, amaçlı örnekleme çeşitlerinden biri olan kolay ulaşılabilir durum örneklemesi kullanılmıştır. Veri toplama aracı olarak, "Bir Mühendis Çiz" formu kullanılmış ve çizimler kontrol listesi kullanılarak değerlendirilmiştir.

Araştırmanın Bulguları: Araştırmada çizilen mühendislerin %96.64 oranında insan, %1.68 oranında insan dışı/insan olmayan, %1.68 oranında ise kişi niteliğinde olmadığı görülmüştür. Öğrencilerin çizdikleri mühendisin cinsiyetinin %86.56 oranında erkek, %11.77 oranında kadın olduğu, %1.68 oranında ise cinsiyetinin bilinmediği belirlenmiştir. 5. ve 6. sınıf öğrencilerinin çizimlerinde, 7. sınıf öğrencilerine göre daha fazla kadın mühendise yer verdikleri görülmüştür. Çizilen mühendisin ten renginin büyük oranda (%72.27) belirtilmediği belirlenmiştir. Öğrencilerin çizimlerinde mühendisleri, çılgın saç şekli olan (%1.68), koruyucu gözlük/gözlüklü (%4.20), işçi giysili (%17.65), baret/kasklı (%31.93), bıyık/sakallı (%3.36), takım elbiseli (%5.88), kel (%10.08) ve diğer dış görünüş özelliklerine sahip (%25.21) olarak betimledikleri belirlenmiştir. Çizimlerde laboratuvar giysili mühendislerin bulunmadığı görülmüştür. Öğrencilerin çizdikleri mühendislerin bulundukları ortamlar ve belirtilme sıklıkları, iç/kapalı mekânlar (%34.92), dış/açık mekânlar (%55.56) ve belirtilmeyen (%9.52) olarak belirlenmiştir. Çizimlerde 7. sınıf öğrencilerinin kapalı alanlara, 5. sınıf öğrencilerinin ise açık alanlara diğer sınıflara kıyasla daha fazla yer verdikleri tespit edilmiştir. Çizilen mühendislerin yaptıkları işler ve sıklıkları, yapım/onarım/ellerle çalışma (%23.91), çalıştırma/makine ve aletleri kullanma (%12.32), tasarım/buluş/ürün oluşturma/yaratma (%25.36), deney/test yapma/bilgi üretme (%5.80), öğretme/açıklama (%1.45), gözlem yapma (%11.59) olarak belirlenmiştir. Çizimlerdeki mühendislerin %18.84 sıklıkla herhangi bir iş yapmadıkları tespit edilmiştir. Yapım/onarım/ellerle çalışma işlerinin en fazla 5. sınıf öğrencileri tarafından betimlendiği ve sınıf düzeyi arttıkça bu işlerin çizimlerde daha az yer aldığı belirlenmiştir. Tasarım/buluş/ürün oluşturma işlerinin ise sınıf düzeyi arttıkça daha fazla betimlendiği ve 7. sınıf öğrencilerinin

çizimlerinde en fazla oranda bulunduğu tespit edilmiştir. Öğrencilerin çizimlerinde yer alan inşaat ile ilgili nesneler ve sıklıkları, inşaat/yapı aletleri (%4.40), inşaat yapım araçları (%4.72), sivil yapı, köprü ve binalar (%15.72), inşaat yapı malzemeleri (%4.40) olarak belirlenmiştir. İnşaat ile ilgili nesnelere en fazla sıklıkta 6. sınıf öğrencilerinin çizimlerinde rastlanılmıştır. Çizimlerde öğrencilerin, ölçüm aletleri (%0.32), yazı nesneleri (%8.18) ve mobilyalara (%13.21) yer verdikleri, tasarım ve çizim yapan mühendisler betimledikleri görülmüştür. Çizimlerde uçan araçlar, roketler/uzay araçları gibi araçlar bulunmazken, bazı tipteki araçlara yer verilmiştir. Araçlara yer verilme sıklığının, yolcu araçlarında %1.57, inşaat yapım araçlarında %4.72, trende %0.32 olduğu tespit edilmiştir. Öğrenciler çizimlerinde %1.57 sıklıkla kimya ile ilgili nesnelere yer verirken, kimya alanında sıklıkla karşılaşılan tehlike işaretlerine ve kimyasal sembollere yer vermedikleri görülmüştür. Araştırmada diğer insanlara yer verilme oranlarının 5. sınıflarda %12.68, 7. sınıflarda ise %8.57 olduğu belirlenmiştir. Bu bulgu, öğrencilerin sınıf düzeyi arttıkça, mühendisin yalnız çalıştığı algısını daha çok benimsedikleri şeklinde yorumlanmıştır.

Araştırmanın Sonuçları ve Önerileri: Araştırmada genel olarak öğrencilerin mühendislerin yaptıkları işleri inşaat işçileri ya da tamircilerin yaptıkları işlerle karıştırdıkları ve mühendisleri çoğunlukla erkek ve yalnız çalışan bireyler olarak algıladıkları sonucuna ulaşılmıştır. Bu sonuç öğrencilerin çizimlerinde bulunan nesnelere ve mühendislerin yaptıkları işlere de yansımıştır. Mühendisliğin erkek mesleği olduğunu düşünen öğrencilerin, çoğunlukla dış ortamda çalışan, işçi giysileri giymiş, kask ya da baretli mühendisler çizdikleri görülmüştür. Ancak çizimlerdeki mühendislerin yaptıkları yapım, onarım, ellerle çalışma ya da makine ve alet kullanma gibi işler, öğrencilerin inşaat mühendislerini nitelikli işçiler olarak algıladıklarını işaret etmektedir. Yaşın artması ile birlikte çizimlerde erkek mühendis oranının arttığı ve tasarım yapan mühendise daha sık yer verildiği görülmüştür. Çizimlerde 6. sınıf düzeyinde daha fazla oranda olmakla birlikte dış ortamda çalışan, işçi giysileri giymiş, kask ya da baretli mühendisler betimlenmiştir. Öğrencilerin çizimlerinde laboratuvar önlüklü mühendislere, uzay, yeraltı ya da su altı ortamlarına, robotlar, roket/uzay araçları, matematik ve kimya sembolleri, girilmez/dikkat işaretlerine yer vermemeleri; mühendisliğin kimya, havacılık ve uzay, gıda, genetik gibi pek çok çalışma alanını bilmediklerini göstermektedir. Tasarım faaliyetini ifade eden öğrencilerin çizimleri sadece inşaat mühendisliğine yönelik olup çizimlerde çoğunlukla bulunan sivil yapılar, köprüler, binalar ve mobilyalar da bunu destekler niteliktedir. %18.84 sıklıkla çizilen mühendisin herhangi bir iş ya da eylem yapmadığı sonucu da öğrencilerin mühendislerin yaptığı işler ve çalışma alanları hakkında çok az şey bildiklerini göstermektedir. Çizimlerde diğer insanların genel olarak %12.58 oranında yer aldığı, diğer insanlara yer verilme oranının 5. sınıflarda %12.68, 7. sınıflarda ise %8.57 olduğu, dolayısıyla sınıf düzeyi arttıkça, mühendisin yalnız çalıştığı algısının arttığı sonucuna ulaşılmıştır.

Araştırmadan elde edilen sonuçlar doğrultusunda öğretmenlere yapılan öneriler şunlardır: Öğrencilerin mühendis algılarının olumlu yönde geliştirilmesi için STEM eğitimi uygulamalarını deneyimlemeleri önemli görülmektedir. Bu bağlamda, gerek okul içi gerekse okul dışı öğrenme ortamlarında tüm sınıf düzeylerinde, 'Fen,

Mühendislik ve Girişimcilik Uygulamalarına' yer verilmesi önerilmektedir. Söz konusu uygulamaların, mühendislik tasarım süreci kullanılarak, işbirlikli gruplarda gerçekleştirilmesi ve farklı mühendislik alanlarına yönelik olması önerilmektedir. Bu sayede öğrenciler, mühendisliğin takım çalışmasına dayanan, birbirinden farklı birçok çalışma alanı olan bir kariyer olduğunu ve mühendisliğin tasarım boyutunu kendi projeleri vasıtasıyla deneyimleyerek kavrayabilirler. Mühendislik tasarım sürecinin ele alındığı uygulamalarda, öğrencilerin farklı mühendislik alanlarında kariyer sahibi kadın rol modellerle bir araya getirilmesi, mühendise ilişkin basmakalıp cinsiyet algısının değişmesinde etkili olabilir.

Araştırmadan elde edilen sonuçlar doğrultusunda araştırmacılara yapılan öneriler ise şunlardır: Farklı bölgelerdeki şehirler, farklı sosyoekonomik düzeye sahip bölgeler, farklı sınıf düzeyleri ve daha geniş çalışma grupları ile çalışılarak öğrencilerin mühendis algıları belirlenebilir ve karşılaştırılabilir. Mühendis çizimleri, gözlem, görüşme gibi veri toplama yöntemleriyle de desteklenerek daha ayrıntılı sonuçlar elde edilebilir. Mühendis algısını etkilediği düşünülen farklı değişkenlerin belirlenmesi ve karşılaştırılmasına yönelik araştırmalar yapılabilir.

Anahtar Kelimeler: Basmakalıp mühendislik cinsiyet algısı, ortaokul öğrencileri, STEM eğitimi, çizimler