

Metaphoric Perceptions of Engineering Students Regarding Concepts of Science, Technology and Design

Mühendislik Öğrencilerinin Bilim, Teknoloji ve Tasarım Kavramlarına İlişkin Metaforik Algıları

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Abstract. The purpose of this study is to identify perceptions of students studying at faculty of engineering regarding science, technology and design through metaphors. The sample group is consisted of a total of 130 students who are at the first, second, third and fourth year of their education in civil engineering department of a state university in the Eastern Black Sea region. The data of the study is collected by having students complete the following sentences: "Science is like; because", "Technology is like; because", "Design is like; because". In this study, which uses phenomenological research pattern within the framework of qualitative research perspective, the data obtained is analyzed through content analysis. In the research, it is seen that metaphors identified by most of the students regarding the concept of science are "space", "ocean" and "tree", regarding the concept of technology are "food" and "human", regarding the concept of design is "imagination". At the end of the study, it is found that most of the students perceive the concept of science as "infinite", "changing and developing", "enlightening", "life source" and "nerve-shredding", the concept of technology as "changing and developing", "facilitating", "harmful as much as beneficial" and "unlimited", the concept of design as "imaginary". Moreover, it is identified that metaphors produced regarding concepts of science and technology are more in numbers compared to metaphors produced regarding the concept of design.

Keywords: Science, technology, design, engineering students, metaphor.

Öz. Bu çalışmanın amacı mühendislik fakültesi öğrencilerinin bilim, teknoloji ve tasarım kavramlarına ilişkin algılarını metaforlar aracılığıyla tespit etmektir. Çalışma grubunu, Doğu Karadeniz Bölgesinde yer alan bir devlet üniversitesinde İnşaat mühendisliği bölümünün birinci, ikinci, üçüncü ve dördüncü sınıflarında öğrenim gören toplam 130 öğrenci oluşturmaktadır. Çalışmanın verileri öğrencilerin, "Bilim.....gibidir; çünkü.....", "Teknoloji.....gibidir; çünkü.....", "Tasarım.....gibidir; çünkü....." kalıplarını tamamlamaları yoluyla elde edilmiştir. Nitel araştırma yaklaşımı çerçevesinde olgubilim araştırma deseni kullanılan bu çalışmada, elde edilen veriler içerik analizi yöntemiyle analiz edilmiştir. Araştırmada öğrenciler tarafından bilim kavramına yönelik "uzay", "okyanus" ve "ağaç" metaforlarının, teknoloji kavramına yönelik "yemek" ve "insan" metaforlarının ve tasarım kavramına yönelik ise "hayal gücü" metaforunun en fazla ifade edilen metaforlar olduğu görülmüştür. Araştırma sonucunda öğrencilerin çoğunluğunun bilim kavramını "sınırsız", "değişen ve gelişen", "aydınlatıcı", "yaşam kaynağı" ve "merak uyandıran" olarak, teknoloji kavramını "değişen ve gelişen", "kolaylaştırıcı", "faydasının yanı sıra zararı olan" ve "sınırsız" olarak ve tasarım kavramını ise "hayal ürünü" olarak algıladıkları belirlenmiştir. Ayrıca bilim ve teknoloji kavramlarına yönelik üretilen metaforların, tasarım kavramına yönelik üretilen metaforlara oranla sayıca daha fazla olduğu görülmüştür.

Anahtar Kelimeler: Bilim, teknoloji, tasarım, mühendislik öğrencileri, metafor.

Public Interest Statement.

The purpose of this study is to identify perceptions of engineering students regarding science, technology and design through metaphors. Identifying the perceptions of engineering students regarding science, technology and design may provide information about their approach to these concepts both during their undergraduate studies and in their future career. It is seen that the positive perceptions of students regarding the concepts about science, technology and design are more dominant compared to negative perceptions.

Toplumsal Mesaj.

Bu çalışmanın amacı mühendislik fakültesi öğrencilerinin bilim, teknoloji ve tasarım kavramlarına ilişkin algılarını metaforlar aracılığıyla tespit etmektir. Mühendislik öğrencilerinin bilim, teknoloji ve tasarım kavramları hakkındaki algılarının belirlenmesi, onların lisans eğitimleri boyunca ve ilerideki meslek hayatlarında bu kavramlara nasıl bir yaklaşım içinde bulunacakları hakkında bilgi sağlayabilir. Çalışmada öğrencilerin bilim, teknoloji ve tasarım kavramları ile ilgili pozitif algılamalarının negatif algılamalarına göre daha baskın olduğu görülmüştür.

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1. INTRODUCTION

Although the concept of science has been searched by scientists for years, it has been difficult to reach one and common definition for it. It is stated that the reason for this is the science having a continuously developing and deepening structure, having indefinite boundaries of subjects and methods, being a multidimensional and complex synthesis (Doğan Bora, Arslan & Çakıroğlu, 2006; Bıyıklı, Başbay & Başbay, 2014). For this reason, there are various definitions regarding the concept of science in the literature. According to Albert Einstein (1940), the science is the effort to have a harmony between the sensory data (perceptions), which are deprived of any kind of order, thinking logically in order (Aydın, 2009). According to McComas (2002), science is the activity of producing generalizations and explanations that are open to discussion by everyone, valid and reliable by using scientific research methods in order to answer questions about the natural world (Hastürk, Öztürk, Demir & Kartal, 2014). According to Russel, science is the effort to find first the facts about the world and then the rules connecting these facts to each other by using reasoning based on observation (Seven, 2004). In textbooks, it is stated that science is a result of neither absolute reason nor pure observation and experiment although it is denoted that science is completely obtained through observation and experiment (Yıldırım, 2002; cited in Doğan Bora, Arslan & Çakıroğlu, 2006).

Technology is also a concept which is often heard together with science and it is an inseparable part of our life today. According to Güvenç, technology is a concept that is difficult to understand but directly or indirectly affecting everyone's life to a certain extent (Karaa, Aydın, Bahar & Yılmaz, 2014). Aydın (2009) defines technology as "an aggregation consisted of all man-made products emerged by changing the natural world, nested with many environmental and social elements and including contradictions on numerous issues due to its nature, having distinctive characteristics of its own and involving a process from design to production". Technology includes application of knowledge, resources, materials, tools and information in the design, production and utilization of products, structures and systems in order to increase human capacity to control and change the natural and artificial environment (Stein, Docherty & Hannam, 2003). Today, technology is a process involving the data of essential and applied sciences to be turned into production in creative phases, their utilization and analysis of their social impact (Aydın & Karaa, 2013; Karaa, Aydın, Bahar & Yılmaz, 2014).

Considering the literature, science can be defined as the systematical information produced by knowledge and experience; and the technology can be defined as having scientific information of any kind to be transferred to application or using scientific findings in practical life (Sağlam, 1990). As a result of rapid changes and developments in science and technology, our society has become a kind that intensely produces and consumes information and technology. In parallel to developing science and technology, scientific and technological developments have a meaning in lives of people; people shape themselves and their world of thought and this situation affects their perspective on life (Batur & Uygun, 2012). Hence, scientific and technological information is a significant criterion for modernization and development of societies, and it is a product of individuals' sense of curiosity and efforts to understand the nature (Timur & Taşar, 2011). In addition, technology plays an important role in raising qualified individuals with its role to reach out to information and instructiveness and in globalization as the source of information (Durukan, Hacıoğlu & Dönmez Usta, 2016). As a result of improving technology and increasing needs of the society, science is in continuous change and development (Bıyıklı, Başbay & Başbay, 2014). Hence, understanding science and technology enables to produce new information and more advanced technologies. Moreover, living in a society intimidated with scientific and technological developments gives the opportunity to raise students who prefer to be scientific to find solutions for problems in life and are interested in scientific data, questioning and willing to learn more information (Doğan Bora, Arslan & Çakıroğlu, 2006).

According to Technology Education Centre (2008), technology is "related to science", "consisted of design", "consisted of production", "related to values" and "socially formed and being formed"

(Aydın, 2009). Basalla (2000) claims that science and technology are in mutual interaction and similarly Kiyıcı (2008) argues that there is an infinite relationship between technology and science (Karaa, Aydın, Bahar & Yılmaz, 2014). While science uses technology to produce knowledge, technology uses scientific knowledge to produce solutions. Thus, science and technology are holistically related (Zorlu & Baykara, 2014). Moreover, it is noted that technology is a combination of creativity and intelligence that is brought by science, art, engineering, economy and social work together to improve life quality of people; and the relationship between science and technology is like the one between subject and object (MoNE, 2006).

In addition to this, technology and design are in relation and many innovations that make our lives easier have emerged as a result of productizing technologies developed by scientific research through design (MoNE, 2016). Technology and design are concepts that directly affect each other and it is claimed that improving the relationship between technology and design is possible through improving the level of creativity of the individual. Also, design is a form of animating the idea in mind and it is argued that advanced level cognitive processes such as finding differences, imagination, questioning, creative thinking, critical thinking, and reasoning have an important place in designing (MoNE, 2006). According to Eggleston (1997), reaching solutions that meet design criteria is related to using technology; reaching to solutions that meet technological criteria is related to using design (Aydın, 2009). Design is in the heart of technology and the statement of "Design is the core of engineering" is a verification that all subjects of engineering want to materialize technology. This design process in technology is a sequential process that starts with producing ideas by perceiving a need, continues with a description formula including a final solution and ends with the evaluation of the solution (Technology Education Centre, 2008; cited in Aydın, 2009).

As it is seen, concepts of science, technology and design are concepts that are parts of an interwoven loop and there is a strong relationship between these concepts. When the concepts in this loop are taken into consideration, it is needed to have individuals effectively administer this loop. At this point, particularly engineers and to-be-engineers have critical responsibilities to ensure the operation of the loop, and to produce design by using science and to produce technology by using design. In this regard, this study aims to identify the perceptions of engineering students regarding the concepts of science, technology and design, which are closely related to engineering, through metaphors. Identifying the perceptions of engineering students regarding science, technology and design may provide information about their approach to these concepts both during their undergraduate studies and in their future career. In addition to this, there is no research on the perception of the three concepts affecting each other by the same individual. At this point, it is believed that this study will bring light to research that aim to reveal perceptions/thoughts of individuals about more than one subject and concept.

2. METHODOLOGY

In this study, which aims to demonstrate the existing perceptions of engineering students regarding science, technology and design without any interference, phenomenology research pattern is used within the framework of qualitative research. Phenomenology research design focuses on researching phenomena that we are aware of, but do not have a deep and detailed understanding of them (Yıldırım & Şimşek, 2011).

2.1 Sample Group

The sample group is consisted of a total of 130 students (26 students in the first grade, 26 students in the second grade, 27 students in the third grade and 51 students in the fourth grade) in the civil engineering department of a state university in the Eastern Black Sea region. Voluntary participation is taken as the basis of selecting the participants.

2.2 Data Collection Tool

For the last years, it is seen that metaphor studies are frequently used to identify the perceptions of participants towards a subject or concept (Akbaba Altun & Apaydın, 2013; Akgün, 2016; Aktamış, & Dönmez, 2016; Aladağ & Kuzgun, 2015; Derman, 2014; Durukan, Hacıoğlu & Dönmez Usta, 2016; Kahyaoğlu, 2015; Kasapoğlu, 2016; Kaya, 2014; Korkmaz & Ünsal, 2016; Paliç Şadoğlu & Uzun, 2014; Saban, 2009; Uzun & Paliç, 2013; Wahyudi, 2007; Yılmaz, Esentürk, Tekkurşun Demir & İlhan, 2017). It is stated that metaphors, which are defined as explaining a concept or phenomenon via images as it is perceived (Aslan, 2013; Aydın & Eser Ünalı, 2010; Saban, 2008), are strong research tools to be used to understand and explain an advanced level abstract or theoretical concept or phenomenon (Yob, 2003; Semerci, 2007; Saban, 2008). According to Vosniadou & Ortony (1989), metaphors are analogies that enable complex subjects or new situations to be understood easier by expressing an experience with another experience terminology (Akgün, 2016). According to Yıldırım & Şimşek (2011), metaphors are tools that enable humans to understand the nature and its environment, as well as giving meaning to the life and experiences. The essential reason for using metaphors in this study is the necessity to reach out subconscious ideas of individuals regarding the concepts of the study and present their perspectives in a richer way (Lakoff & Johnson, 2005). In studies that use metaphor as a research tool, the word of “be like” is used to evoke the link between “the subject of the metaphor” and “the source of the metaphor” more openly, and the word of “because” is used to have participants give a “justification” (reasonable basis) to their own metaphors (Saban, 2009).

The data of the study is collected with the form given to students that includes the below mentioned metaphor templates:

- “Science is like.....; because.....”,
- “Technology is like.....; because.....”,
- “Design is like.....; because.....”

Before collecting the data, students are presented with several examples by referring to the structure of the metaphor. Students are set free to produce metaphors as many as they want by using the metaphor templates. Additionally, students are given the duration of one lecture to produce their metaphors easily.

2.3 Data Analysis

In the analysis and interpretation of metaphors, steps of “naming”, “classifying”, “reordering and editing”, “category development” and “ensuring validity and reliability” are used by benefitting from the work of Bıyıklı, Başbay & Başbay (2014).

Naming Step; An alphabetical temporary list (family, mind, river etc.) is made by defining metaphors produced by students in concepts. For this purpose, it is controlled if the metaphor is stated openly or not; data with no defined metaphor are separated by noting as no metaphor.

Classifying Step; In this step, each metaphor is decoupled by using content analysis method and analyzed in terms of their similarities and common characteristics with other metaphors. The basic purpose of the content analysis is to pool similar data together in the framework of certain concepts and themes; and to interpret these by ordering them in a way that the reader can understand (Yıldırım & Şimşek, 2011). For this purpose, metaphors produced by students are reviewed and each metaphor image is analyzed in terms of “the subject of the metaphor”, “source of the metaphor” and “the link between the subject and the source of the metaphor”. Metaphors that do not include a metaphor image or do not give justification regarding the metaphor are eliminated. In this step, it is observed that all students produced valid metaphors for the concepts of science and technology; however, some of the students provided no reasonable justification for the concept of design, despite producing a particular metaphor.

Reordering and Editing Step; For the concepts of science 79, technology 87 and design 63, valid metaphors are obtained. These metaphors are reordered alphabetically and several sample metaphor statements are chosen to represent each metaphor by reviewing the raw data. A metaphor list (i.e. space, brain etc.) is made for each metaphor obtained for the concepts of science, technology and design by compiling the metaphor images of engineering which are thought to be the best representative of the metaphor. This list is used to collect metaphors under a certain category.

Category Development Step; Common characteristics are identified by taking all metaphors stated by students regarding each concept of science, technology and design and their justification to these metaphors into consideration and themes that are thought to be representatives of these are created. The metaphor list of the previous step is used as a reference guide to collect metaphors under a certain category (such as "unlimited", "source of information" etc.). In this step, there are 12 conceptual categories for the concept of science, 10 conceptual categories for the concept of technology and 7 conceptual categories for the concept of design.

Ensuring Validity and Reliability Step; A professor, who lectures qualitative data analysis class at the graduate level is consulted to confirm that metaphors provided under categories regarding each concept of science, technology and design are representing the respective conceptual category. The percentage of harmony formula [$\text{Percentage of Harmony} = \frac{\text{consensus}}{\text{consensus} + \text{dissensus}}$] by Miles & Huberman (1994) is used to identify the consensus during the data analysis; and it is calculated that the value of percentage of harmony for the concept of science is 83, for the concept of technology is 90 and for the concept of design is 81. Quotations are used with codes by ensuring that the identities of participants remain unknown. Moreover, in order to ensure the validity for the results of the study, it is aimed to provide raw data in the findings section and to explain the data analysis process in the method section as much as possible. It is seen that in other studies aiming to identify the perceptions of participants regarding subjects or concepts with the help of metaphors also followed a similar process for the data analysis (Akgün, 2016; Aktamış & Dönmez, 2016; Aladağ & Kuzgun, 2015; Durukan, Hacıoğlu & Dönmez Usta, 2016; Gültekin, 2013; Kahyaoğlu, 2015; Kasapoğlu, 2016; Kaya, 2014; Paliç Şadoğlu & Uzun, 2014; Saban, 2008, 2009; Uzun & Paliç, 2013; Korkmaz & Ünsal, 2016; Yılmaz, Esentürk, Tekkurşun Demir & İlhan, 2017).

3. FINDINGS

Findings that are obtained from answers of the engineering students to open-ended questions regarding their perceptions of the concepts of science, technology and design are presented in this section. Metaphors that are produced by students of engineering towards the concept of science are given in Table 1.

Table 1. Metaphors regarding the concept of science

Metaphor Name	f	Metaphor Name	f	Metaphor Name	f
Space	11	Cell	1	Military camp	1
Ocean	7	Chameleon	1	Modernization	1
Tree	6	Child that constantly asks questions	1	Moon	1
Infinite/ immense	5	Child that just learnt how to speak	1	Mysterious road	1
Food	4	Cook	1	Nature	1
Sun	4	Cosmos	1	Novel	1
Universe	4	Counting to infinite	1	Olympicrace	1
Book	3	Development	1	Ore	1

Penny bank	3	Discovery of the explorer	1	Rainbow	1
A bottomless/deep pit	2	Divine light	1	Reason	1
Baby	2	Evidence	1	River	1
Brain	2	Explorer	1	Sea	1
Bread	2	Family	1	Seed	1
Child	2	Father	1	Serving to humanity	1
Curiosity	2	Flour	1	Smoky air	1
Field	2	Football team	1	Snow	1
Football game	2	Galaxy	1	Swirl	1
Horse	2	Garden	1	Time	1
Oxygen	2	Ghost	1	To learn	1
Rain	2	Honey hive	1	Torch	1
Sky	2	Human body	1	Wall under construction	1
Water	2	Imagination	1	Water treatment plant	1
Artwork	1	Jail	1	Woman	1
Bamboo	1	Labyrinth	1	Yunus Emre	1
Black hole	1	Lake	1	Zebra	1
Breast milk	1	Life	1		
Car race	1	Light	1		

As it is seen in Table 1, there are 79 different metaphors towards the concept of science produced by engineering students. When the table is analyzed, it can be seen that metaphors of “space”, “ocean” and “tree” are the ones expressed the most.

Taking metaphors used by students of engineering regarding the concept of “Science” and explanations/justifications provided for these metaphors into consideration, they are placed under 12 categories in terms of their common characteristics. These categories are presented in Table 2.

Table 2. Categories that are developed based on the metaphors of engineering students regarding the concept of science

Categories	Metaphors	f	%	Sample Quotation
1. Infinite / immense	Ocean (7), <i>Space</i> (5), Infinite/ immense (5), <i>Universe</i> (3), Sky (2), Brain(2), A bottomless/deep pit (2), Galaxy (1), Counting to infinite (1), Nature (1), Rainbow (1), Sea (1), Black hole (1), Smokyair (1), Cosmos (1)	34	26.2	<p>“Science is like ocean. Because it will never overflow even if everyone adds water to it, it will never diminish regardless of how much power you have”. S1</p> <p>“Science is like space. Because it is infinite, new things emerge continuously. There is always a long way regardless of how far you go”. S42</p> <p>“Science is like universe. Because the universe has no ends and there are still many things unknown. Whenever you think you have reached somewhere, there is always more”. S80</p>

2. Changing and developing	Tree (6), Penny bank (3), Baby (2), Horse (2), Field (2), Reason (1), Bamboo (1), Chameleon (1), Development (1), Lake (1), Human body(1), Wall under construction (1), Snow (1), Child that just learnt how to speak (1), Seed (1), Time (1), <i>space</i> (1)	27	20.8	<p>“Science is like a tree. Trees blossom and produce fruits as they grow. Likewise, different fields and different answers emerge as science expands, too. Like branches of the tree, branches of science are different as well”. S3</p> <p>“Science is like a baby. You will collect the crop in the future when the harvest time comes as much as you protect, love and show interest to it”. S25</p> <p>“Science is like a penny-bank. Because science is developing and improving day by day. We make it full by putting knowledge instead of money. The more our knowledge savings are, the better it gets”. S47</p>
3. Enlightening/ Guiding	Sun (4), River (1), Moon (1), Modernization (1), Service (1), Light (1), Torch (1), Divine light (1), Water treatment facility (1), Yunus Emre(1)	13	10	<p>“Science is like sun. Because if you trust science among all the unnecessary misinformation, it lights up everywhere like the rising sun after the night. You can find your way, you will see the good and go away from the bad”. S65</p>
4. Source of life/ Basic need	Food (4), Bread (2), Water (2), Oxygen (2), Flour (1), Breast milk (1), Cell (1)	13	10	<p>“Science is like food. Because just as humans cannot survive without eating, there would be no meaning of life without science, you would be living idly”. S45</p>
5. Exciting / Intriguing	<i>Book</i> (2), Curiosity(2), Discovery of the explorer(1), Swirl(1), Mysterious road(1), Imagination (1), Woman (1), Explorer (1), Novel (1), Artwork (1)	12	9.2	<p>“Science is like a book. Because the curiosity for the following pages increases as you flip pages”. S70</p> <p>“Science is like a sweet swirl. Because once you get caught in its riptide, you cannot go out of it. Your sense of curiosity would take you to the deepest points of the swirl and present you with knowledge that would surprise you and you have never seen before”. S104</p>
6. Source of information	<i>Space</i> (2), Rain (2), <i>Book</i> (1), Family(1), Cook(1), Father (1), Evidence (1), <i>Universe</i> (1)	10	7.7	<p>“Science is like a book. We acquire more knowledge by reading books... Science also enables us to gain many things”. S30</p> <p>“Science is like space. Because space is an accumulation of knowledge. Despite the number of research, there is still unknown knowledge”. S59</p>

7. Understanding and discovering life	Child (2), Life (1), To learn (1), Child that constantly asks questions (1)	5	3.8	"Science is like a child that constantly asks questions. Because the child always wants to learn new things by constantly asking questions; new questions and new answers align one after another". S21
8. Competition	Football game (2), Car race (1), Olympic race (1)	4	3.1	"Science is like a football game. Because if you do not or cannot use the right methods and right tools at the right moment at the required amount, it can be like flogging a dead horse". S69
9. Waiting to be discovered	Space (3), Gem (1)	4	3.1	"Science is like space. Because there are always new things to be discovered and there are still mysteries that have not been discovered and are waiting to be solved". S120
10. Team work	Honey hive (1), Garden (1), Football team (1)	3	2.3	"Science is like a garden. Because many living and dead creatures live together. They are all in an order. Small animals are fed by the crumbs of the food of a bird. A living creature needs another to survive. Like science, they are born from each other and may die of each other". S86
11. Requires struggle	Military camp (1), Labyrinth (1), Jail (1)	3	2.3	"Science is like a military camp. Because it has certain rules and limits. Science also has its limits that needs to be paid attention". S100
12. Open to discussion	Zebra (1), Ghost (1)	2	1.5	"Science is like a zebra. Because even if we know the correct answer of a question, it has white stripes over black ones or black stripes over white ones, it is still open to discussion". S18

In Table 2, it is seen that students perceive the concept of science as "unlimited", "changing and developing", "enlightening", "source of life" and "source of knowledge".

Metaphors that are produced by students of engineering regarding the concept of "technology" are given in Table 3.

Table 3. Metaphors regarding the concept of technology

Metaphor Name	f	Metaphor Name	f	Metaphor Name	f
Food	7	Cage	1	Making a table from the tree	1
Human	7	Cancer	1	Marathon	1
Child	5	Car	1	Moon	1
Space	4	Carpenter	1	Mother	1
Tree	4	Chameleon	1	Plane	1
Fatih Terim	3	Cold water in hot weather	1	Play baglama	1
Human organs	3	Computer	1	Power	1

Ocean	3	Computer game	1	Puzzle	1
Servant	3	Countries	1	Radiator	1
Universe	3	Culture	1	Reason	1
A nice house	2	Desert	1	River	1
Ability	2	Domino	1	Road	1
Autobus	2	Electronic state (e-state)	1	Sapling	1
Baby	2	Engineering	1	School	1
Bacteria	2	Experience	1	Science pool	1
Book	2	Fight	1	Sea	1
Helping friend	2	Fire	1	Shadow	1
Medicine	2	Food	1	Sharp knife	1
Necessity	2	Forest	1	Ship in the infinite sea	1
Never-ending road	2	Fruits of the tree	1	Sifter	1
Water	2	Gun	1	Snowball	1
A bottomless tip	1	High-speed train	1	Spider web	1
An explorer ship	1	Horse race	1	Surprise egg	1
Archeological excavation	1	Hound	1	Time	1
Bamboo	1	Infinity	1	Tool that make life easier	1
Bird	1	Jail	1	Umbrella	1
Birds feeding from the mouth of an alligator	1	Life	1	Walker	1
Both freedom and captivity	1	Living	1	Walking on the rope	1
Breathe	1	Lyrics	1	Yin and yang	1

As it is seen in Table 3, there are 87 different metaphors towards the concept of technology produced by engineering students. When the table is analyzed, it can be seen that metaphors of "food" and "human" are the ones expressed the most.

Taking metaphors used by students of engineering regarding the concept of "Technology" and explanations/justifications provided for these metaphors into consideration, they are placed under 10 categories in terms of their common characteristics. These categories are presented in Table 4.

Table 4. Categories that are developed based on the metaphors of engineering students regarding the concept of technology

Categories	Metaphors	f	%	Sample Quotation
1.Changing and developing	Human (7), Child (5), Tree (4), Human organs (2), Ability (2), Baby (2), Bamboo (1), Puzzle (1), High-speed train (1), Computer (1), Computer Game (1), Life (1), Countries (1), Shadow (1), Road (1), Bird (1), Time (1), Living (1), Sapling (1), Culture (1), Snowball (1), Chameleon (1), River (1), Experience (1), Sapling (1)	41	31.5	"Technology is like a human. Because human grows gradually starting from its birth by learning many things. Technology also develops gradually. There is always a better emerging everyday". S59 "Technology is like a tree. Because you first plant the seed and in the end you eat the fruit. If the science is the seed in the soil, technology is the fruit on the tree". S26

2.Facilitator	Servant (3), Autobus (2), Helping friend (2), Humanorgans (1), Engineering (1), Electronic state (e-state) (1), Hound (1), Cold water in hot weather (1), Birds feeding from the mouth of an alligator (1), Walker (1), Life (1), Mother (1), Tool that make life easier (1), Car (1), Umbrella (1), Plane (1), High-speed train (1)	21	16.2	<p>“Technology is like a servant. Because it is to make our life easier” S34</p> <p>“Technology is like a human organ. Because it makes maintaining human life easier”. S51</p> <p>“Technology is like electronic state (e-state). Because electronic state provides you with many documents without going to any government offices and makes your life easier”. S97</p>
3.Harmful as much as beneficial	Food (3), Bacteria (2), A nice house (2), Medicine (2), Both freedom and captivity (1), A sharp knife (1), Forest (1), Fire (1), Cage (1), Radiator (1), Water (1), Yin and yang (1), Fruits of the tree (1)	18	13.8	<p>“Technology is like food. Because when you eat unhealthy food, it both fattens you and invites illnesses. It is important to eat beneficial food”. S73</p> <p>“Technology is like bacteria. If you come across good ones, you benefit from them and they make your life easier. If not, it might cause unexpected harms” S81</p>
4. Infinite/ Immense	Universe (3), Ocean (3), Space (3), Never-ending road (2), Domino (1), A ship in the infinite sea (1), Science pool (1), Sea (1), A bottomless tip (1), Infinity (1)	17	13	<p>“Technology is like universe. Because it has no end”. S15</p> <p>“Technology is like space. Because space is a place with no ends and it is everlasting. Technology is also like that. It develops everlastingly”. S108</p>
5.Finding new things	Fatih Terim (3), Archeological excavation (1), Making table from a tree (1), Play baglama (1), Food (1) Lyrics (1)	8	6.2	<p>“Technology is like Fatih Terim. There is no precise tactic in it. Every day brings about various things”. Ö60</p>
6. Enlightener/ Guiding	Reason (1), Moon (1), School (1), Book (2), Sifter (1), Carpenter (1)	7	5.4	<p>“Technology is like reason. Because regardless of the intensity of the opportunities at hand, they are rubbish if you don't know how to use them”. S18</p>
7.Basic need	Food (3), Necessity (2), Water (1), Breathe (1)	7	5.4	<p>“Technology is like breath. Because it has become irreplaceable in our day. It is almost impossible to do something without it. All people have become addicted to it and could not leave it”. S1</p>
8.Technological power /competition	Power (1), Fight (1), Marathon (1), Horse race (1)	4	3.1	<p>“Technology is like power. Because whoever works hard to become powerful, it wins the war”. S23</p>
9.Makes life difficult	Jail (1), Desert(1), Walking on the rope (1), Cancer (1)	4	3.1	<p>“Technology is like a jail. Because it imprisons people. It wakens other aspects of people. It makes people alone in social life”. S128</p>
10.Arouse curiosity	Surprise egg (1), Space (1), Explorer ship (1)	3	2.3	<p>“Technology is like a surprise-egg. Because it arouses curiosity, and requires you to gather parts when you see what is in it after you open it”. S7</p>

In Table 4, it is seen that almost half of students perceive the concept of technology as “changing and developing”, as well as “facilitating”, “harmful as much as beneficial”, and “unlimited”.

Metaphors that are produced by students of engineering regarding the concept of “design” are given in Table 5.

Table 5. Metaphors regarding the concept of design

Metaphor Name	f	Metaphor Name	f	Metaphor Name	f
Imagining	12	Baby	1	Mirror	1
Idea	4	Balls of string	1	Model	1
Nature	4	Beehive	1	Mother	1
Puzzle	4	Brainbox	1	Novel	1
Game	3	Cooking	1	Phoenix	1
Human	3	Culture	1	Politics	1
Istanbul	3	Dig a pit	1	Refinery plant	1
Painting	3	Dough	1	Riding a bike	1
Raising child	3	Dream	1	Salt in the meal	1
Sport car	3	Dress	1	School	1
Tree	3	Esthetic	1	Seed	1
Artwork	2	Factory	1	Sieve analysis	1
Cake	2	Fence	1	Sky	1
Light	2	Fiction	1	Snow flake	1
Love	2	Film scenario	1	Space	1
Mirror of ideas	2	Fire	1	Spring	1
Poem	2	Horizon with an infinite blue	1	Sprout	1
Snow flake	2	Life	1	Steel	1
Time	2	Machine	1	Sunlight	1
Universe	2	Material	1	Table	1
A dark room	1	Medicine	1	Target	1

As it is seen in Table 5, there are 63 different metaphors towards the concept of design produced by engineering students. When the table is analyzed, it can be seen that metaphor of “imagining” is the most expressed one.

Taking metaphors used by students of engineering regarding the concept of “Design” and explanations/justifications provided for these metaphors into consideration, they are placed under 7 categories in terms of their common characteristics. These categories are presented in Table 6.

Table 6. Categories that are developed based on the metaphors of engineering students regarding the concept of design

Categories	Metaphors	f	%	Sample Quotation
1. Imagination /fiction	<i>Imagining</i> (4), Puzzle (4), Nature(4), Human(3), İstanbul(3), Painting (3), Sportcar(3), Raising children (3), Artwork(2), Love(2), Mirror of ideas (2), Cake(2), Poem(2), <i>Universe</i> (1), Brainbox (1), Novel(1), Dream(1), Table(1), Phoenix(1), Politics(1), Esthetic(1), Spring(1), Fiction(1), Snowflake(1), Sprout(1), Steel(1), Film scenario(1), Dough(1), Material(1), A dark room (1)	54	51	<p>"Design is like imagination. Because before actualizing any projects, we make designs about it. Like dreams we have for the future". S59</p> <p>"Design is like puzzles. Because it requires a certain idea, imagination and creativity to design something. Like putting all pieces of a puzzle together to see the entire puzzle". S66</p> <p>"Design is like a phoenix. Because phoenix is always imaginary, always beautiful and is reborn from its ashes when you say it is done". S4</p> <p>"Design is like universe. Because universe is designed and made with an advanced art". S84</p>
2. Changing and developing	Idea (4), <i>Imagining</i> (3), Game (3), Tree (3), Cooking (1), Model (1), Seed (1), Baby (1)	17	16	<p>"Design is like a tree. Because when it first emerges, it does not look like anything and does not seem beautiful. But as the tree grows, it has branches and leaves; it blossoms. Design is born with an idea and becomes a masterwork as it is developed". S93</p> <p>"Design is like child games. Because if we imagine, new things may come out, and we can see the world from a different perspective". S49</p>
3. Infinite/ Immense	<i>Imagining</i> (5), Time (2), Space (1), Horizon with an infinite blue (1), Sky (1), Culture (1), Target (1), <i>Universe</i> (1), Factory (1)	14	13.2	<p>"Design is like imagining. Because it has no end and it never finishes". S27</p> <p>"Design is like space. Because it is immense and has no end. One needs to go to the space to get information about the space. In order to get information about design, one needs to be in designing business and make progress in this path". S19</p>
4. Enlightening / Guiding	Light (2), Ball of string (1), School (1), Mirror (1), Sieve Analysis (1), Refinery plant (1), Sunlight (1), Fire (1), Mother (1)	10	9.4	<p>"Design is like light. Because the light illuminates the world. In the same way, design is another element that illuminates the world". S107</p> <p>"Design is like a school. Because if you want to make a design, you need to get help from a teacher". S88</p>
5. Both harmful and beneficial	Fence (1), Coiffeur (1), Dress (1), Medicine (1), Life (1)	5	4.7	"Design is like a fence. Because it either helps you or restricts you in front of the window you look out, choice is in your hands". S37
6. Serving a purpose	Beehive (1), Digging a pit (1), Prototype (1), Salt in the meal (1)	4	3.8	"Design is like the salt in the meal. Because a project without design is not reasonable at all". S25
7. Making life easier	Riding a bike (1), Machine (1)	2	1.9	"Design is like a machine. Because machines make our lives easier". S115

In Table 6, it is seen that half of students perceive the concept of design as "imagination", as well as "changing and developing", "unlimited", and "enlightened".

4. DISCUSSION, CONCLUSION AND SUGGESTION

Metaphor is a strong cognitive tool for an individual to use to understand and explain an advanced level abstract or theoretical concept or phenomenon (Saban, 2008). The use of metaphors contributes to the demonstration of how the subject and concepts that are desired to be analyzed are perceived (Cerit, 2008). In this sense, it is found that there are 79 different metaphors for the concept of science, 87 different metaphors for the concept of technology and 63 different metaphors for the concept of design in this study which is conducted to identify the perceptions of engineering students regarding the concepts of science, technology and design.

It is seen that among 79 different metaphors, metaphors of "space", "ocean" and "tree" are the ones expressed the most by engineering students regarding the concept of science. These findings suggest that students perceive the concept of science from various perspectives such as "infinite/immense", "changing and developing", "enlightening/guiding", "source of life/basic need", "exciting/arousing curiosity and "source of knowledge". Students related the concept of science to categories of "infinite/immense (26,2%)", "changing and developing (20,8%)", "enlightening/guiding (10%)", and "source of life/basic need (10%)" as most. In the study conducted by Şenel, & Aslan (2014), it is stated that teacher-to-be candidates perceived science as "wide-unlimited structure" (f=18), "dynamic structure" (f=15) and "irreplaceable structure" (f=15) as most; and three metaphors that are repeated the most are like "light" (f=5), "water" (f=5) and "life" (f=4). In the research by Bıyıklı, Başbay, & Başbay (2014), it is found that students stated their metaphors regarding the concept of science as problem solving, dynamism, effort; and grouped as source of reference, source of pleasure and a tool of development criteria.

Students linked the concept of science in the category of "infinite/immense" more to metaphors of "ocean", "space" and "infinite"; in the category of "developing and changing" more to the metaphor of "tree". Linking science to the metaphors of ocean, space and infinity by students proves the perception of continuity and immenseness of science; to the metaphor of tree proves that scientific developments are not constant.

Additionally, it can be commented that the positive perceptions of students regarding the concept of science (i.e. enlightening/guide (10%), source of life/basic needs (10%), exciting/arousing curiosity (9.2%) etc.) are more dominant compared to negative perceptions (competition (3.1%), requires efforts of combat (2.3%). Similarly, it is found that positive perceptions are dominant in metaphors produced by secondary school students (Bıyıklı, Başbay & Başbay, 2014), high school students (Bıyıklı, Başbay & Başbay, 2014) and pre-school teacher candidates (Şenel & Aslan, 2014). It can be concluded that when we consider metaphors produced are based on the personal experiences and comments of the engineering candidates, it can be argued that having positive perceptions regarding science can be an indicator of those having positive attitude towards their own profession in the future.

It is seen that among 87 different metaphors, metaphors of "food" and "human" are the ones expressed the most by engineering students regarding the concept of technology. These findings suggest that students perceive the concept of science from various perspectives such as "changing and developing (31.5%)", "facilitating (16.2%)", "both harmful and beneficial (13.8%)", and "infinite/immense (13%)". Similarly, Kurt & Özer (2013) classified metaphors produced by teacher-to-be candidates under 7 categories as "technology that makes life easier", "technology that provides benefits", "technology that is harmful" and "technology that is both beneficial and harmful", "technology that is developing", "technology that leads to information" and "technology that is necessary". Karaçam & Aydın (2104) grouped metaphors of secondary school students regarding technology under 8 categories as "technology as something beneficial", "technology as something that is both beneficial and harmful", "technology as something infinite and limitless", "technology as something constantly changing", "technology as something developing rapidly", "technology as something necessary", "technology as something rapidly expanding", and "technology as something constantly developing". Fidan (2014) categorized metaphors produced

by teachers-to-be candidates from different branches regarding technology as “need”, “development-change”, “source of information”, “infinity”, “both beneficial and harmful”, “beneficial” and “harmful”. Durukan, Hacıoğlu & Dönmez Usta (2016) grouped metaphors produced by teacher-to-be candidates of Computer and Teaching Technologies Department (CTTD) regarding technology as “innovation”, “progress”, “development”, “change”, “being source of information/teaching”, “easing”, “being beneficial”, “expanding”, “producing”, “communicating”, “being needed”, “reaching”, “entertaining”, “being harmful”, “being addictive” and “being good-bad”. Common themes of metaphors produced by individuals regarding the concept of technology are around technology being linked to progress, change and making life easier.

Students linked metaphors of “human”, “child” and “tree” under the category of “changing and developing” with the concept of technology. This situation reveals that students’ perceptions on technology or technological developments as not being constant. This finding shows similarities with the one by Durukan, Hacıoğlu & Dönmez Usta (2016).

It can be commented that the positive perceptions of students regarding the concept of technology (i.e. facilitator (15.4%), finding new things (6.2%), enlightening/ guiding (5.4%), basic need (5.4%), arousing curiosity (2.3%) etc.) are more dominant compared to negative perceptions (both beneficial and harmful (13.8%), technological power/competition (3.1%) etc.). It is also found that positive perceptions are dominant in metaphors produced by secondary school students (Karaçam & Aydın, 2014) and teacher candidates (Durukan, Hacıoğlu & Dönmez Usta, 2016). It can be argued that students having positive perceptions regarding technology can be due to actively using information and communication technologies (like internet etc.).

It is seen that among 63 different metaphors, metaphor of “imagining” is the one expressed the most by engineering students regarding the concept of design. These findings suggest that students perceive the concept of design from various perspectives such as “imaginary/fiction (51%)”, “changing and developing (16%)”, and “infinite/immense (13.2%)”. Moreover, it is observed that metaphors produced regarding the concept of design is less in numbers compared to those of science and technology.

As half of the students consider the concept of design as “imaginary/fiction”, the perception that imagining is necessary for design is revealed. It is emphasized that advanced level cognitive processes like finding differences, imagining, questioning, creative thinking, critical thinking, and reasoning have an important place in designing (MoNE, 2006). Moreover, since technology and design are concepts that directly influence each other, it may be possible to improve the relationship between technology and design by improving the level of creativity for individuals (MoNE, 2006). It is seen that the positive perceptions of students regarding the concept of design (i.e. enlightening/ guiding (9.4%), serving a purpose (3.8%), and making life easier (1.9%) etc.) are more dominant compared to negative perceptions (both beneficial and harmful (4.7%) etc.).

It can be suggested that perceptions of engineering students regarding concepts of science, technology and design to be discovered by using different data collection tools and to be compared with the results of this study. The importance of identifying perceptions of individuals by using metaphors can be demonstrated with such research.

References

- Akbaba Altun, S. & Apaydın, Ç. (2013). Metaphorical Perception on the Concept of “Education” of Prospective Girls and Men Teachers. *Educational Administration: Theory and Practice*, 19(3), 329-354.
- Akgün, E. (2016). Prospective Pre-School Teachers’ Metaphors about the Concept of “Child” and “Pre-School Teacher”. *Abant İzzet Baysal University Journal of Faculty of Education*, 16(4), 1652-1672.
- Aktamiş, H. & Dönmez, G. (2016). Metaphoric Perceptions of Students’ towards Science Course, Science, Science Teacher and Scientist. *Ondokuz Mayıs University Journal of Faculty of Education*, 35(1), 7-30.

- Aladağ, S. & Kuzgun, M.P. (2015). The Thoughts and Metaphoric Perceptions of Primary School Teacher Candidates about Value Concept. *Sakarya University Journal of Faculty of Education*, 29, 163-193.
- Aslan, S. (2013). Metaphoric Examination of Perception of Teachers Working in Multigrade Classrooms about "Teacher" Concept. *Turkish Studies - International Periodical for the Languages, Literature and History of Turkish or Turkic*, 8(6), 43-59.
- Aydın, F. (2009). *Development of Pre-Service Science Teachers' Views and Concepts about Nature of Technology and Effectiveness of Dilemmas in Teaching*. Unpublished Doctoral Dissertation, Gazi University, Ankara, Turkey.
- Aydın, F. & Eser Ünalı, Ü. (2010). The Analysis of Geography Teacher Candidates' Perceptions towards "Geography" Concept with the Help of Metaphors. *International Online Journal of Educational Sciences*, 2(2), 600-622.
- Aydın, F. & Karaa, F.N. (2013). Pre-Service Teachers Attitudes toward Technology: Scale Development Study. *Journal of Turkish Science Education*, 10(4), 103-118.
- Batur, Z. & Uygun, K. (2012). Perceptions of Two Generations of a Concept: Technology. *Uşak University Journal of Social Science*, 5(1), 74-88.
- Bıyıklı, C., Başbay, M., & Başbay, A. (2014). Secondary and High School Students' Metaphors about the Concept of Science. *Abant İzzet Baysal University Journal of Faculty of Education*, 14(1), 413-437.
- Cerit, Y. (2008). Students, Teachers and Administrators' Views on Metaphors with Respect to the Concept of Teacher. *The Journal of Turkish Educational Sciences*, 6(4), 693-712.
- Derman, A. (2014). High School Students' Metaphoric Perceptions for the Concept of Chemistry. *Turkish Studies-International Periodical for the Languages, Literature and History of Turkish or Turkic Volume*, 9(5), 749-776.
- Doğan Bora, N., Arslan, O. & Çakıroğlu, J. (2006). What do High School Students Think about Science and Scientists. *Hacettepe University Journal of Education*, 31, 32-44.
- Durukan, U. G., Hacıoğlu, Y., & Dönmez Usta, N. (2016). Computer Education and Instructional Technology Prospective Teachers' Perceptions of Technology. *Journal of Computer and Education Research*, 4(7), 24-46.
- Fidan, M. (2014). Prospective Teachers' Metaphoric Regarding the Concept of Technology and Social Network. *The Journal of Academic Social Science Studies*, 25(1), 483-496.
- Gültekin, M. (2013). The Metaphors that Primary Education Teacher Candidates Use Regarding Curriculum. *Education and Science*, 38(169), 126-141.
- Hastürk, H. G., Öztürk, N., Demir, R. & Kartal, T. (2014). Opinions of Students having Education in Various Levels about the Nature of Science. *Journal of History School (JOHS)*, 7(18), 671-688.
- Kahyaoglu, M. (2015). An Investigation of the Concept of Nature among Elementary School Students through Metaphors Analysis. *Turkish Studies - International Periodical for the Languages, Literature and History of Turkish or Turkic*, 10(11), 831-846.
- Karaa, F. N., Aydın, F., Bahar, M. & Yılmaz, Ş. (2014). Pre-Service Science Teachers' Views about Technology. *Abant İzzet Baysal University Journal of Faculty of Education*, 14(1), 118-139.
- Karaçam, S., & Aydın, F. (2014). Metaphor Analysis of Secondary Students' Perceptions Related to Technology Concept. *Gaziantep University Journal of Social Sciences*, 13(2), 545-572.
- Kasapoğlu, H. (2016). Analysis of Teacher Candidates Perception's of Turkish National Education System through Metaphors. *Educational Administration: Theory and Practice*, 22(1), 59-80.
- Kaya, M. F. (2014). Social Studies Teachers' Perceptions Related to Environmental Problems: A Sample Analysis of Metaphors. *Turkish Studies - International Periodical for the Languages, Literature and History of Turkish or Turkic*, 9(2), 917-931.
- Korkmaz, F. & Ünsal, S. (2016). Preschool Teachers' Perceptions on the Concept of "Technology". *Mustafa Kemal University Journal of Social Sciences Institute*, 13(35), 194-212.
- Kurt, A. A. & Özer, Ö. (2013). Metaphorical Perceptions of Technology: Case of Anadolu University Teacher Training Certificate Program. *Journal of Theory and Practice in Education*, 9(2), 94-112.

- Lakoff, G. & Johnson, M. (2005). *Metaphors: Life, Meaning and Language* (Translation: G.Y. Demir). İstanbul: Paradigma Publications.
- Ministry of National Education (MoNE) (2006). Primary School Technology and Design Teaching Curriculum (6th, 7th and 8th grades). Ankara.
- Ministry of National Education (MoNE) (2016). Secondary School Technology and Design Teaching Curriculum (7th and 8th grades). Ankara.
- Miles, M. B. & Huberman, A. M. (1994). *Qualitative Data Analysis*. Thousand Oaks, CA: Sage.
- Paliç Şadoglu, G. & Uzun, S. (2014). Identifying Pre-Service Science and Technology Teachers' Perceptions Related to the Concept of Physics through Metaphors. *International Journal of Educational Research and Technology*, 5(1), 36-41.
- Saban, A. (2008). Metaphors about School. *Educational Administration: Theory and Practice*, 55, 459-496.
- Saban, A. (2009). Prospective Teachers' Mental Images about the Concept of Student. *Journal of Turkish Educational Sciences*, 7(2), 281-326.
- Sağlam, M. (1990). Social and Cultural Dimensions of Development in Science and Technology. *Ondokuz Mayıs University Journal of Faculty of Education*, 5, 229-237.
- Semerci, Ç. (2007). A View to the New Primary School Curricula with the Metaphors Relating to "Curriculum Development". *Cumhuriyet University Journal of Social Sciences*, 31(2), 125-140.
- Seven, M. A. (2004). Philosophical Principals of Knowledge in Education. *Atatürk University Journal of Graduate School of Social Sciences*, 4(2), 197-207.
- Stein, S. J., Docherty, M. & Hannam, R. (2003). Making the Processes of Designing Explicit Within an Information Technology Environment. *International Journal of Technology and Design Education*, 13(2), 145-170.
- Şenel, T. & Aslan, O. (2014). The Metaphoric Perceptions of Preservice Early Childhood Teachers Conceptions on Science and Scientist. *Mersin University Journal of the Faculty of Education*, 10(2), 76-95.
- Timur, B., & Taşar, F. (2011). The Adaptation of the Technological Pedagogical Content Knowledge Confidence Survey into Turkish. *Gaziantep University Journal of Social Sciences*, 10(2), 839-856.
- Uzun, S. & Paliç, G. (2013). Analysis of Primary School Teachers' Perceptions about the Concept of Classroom Through Metaphors. *Uşak University Journal of Social Science*, 6(4), 245-260.
- Wahyudi, W. (2007). *Using Metaphors to Explore Teachers' Perceptions of School Science Curriculum: An Indonesian Lower Secondary Schools Case*. Paper presented at the Second International Conference on Science and Mathematics Education, Penang, Malaysia.
- Yıldırım, A. & Şimşek, H. (2006). *Qualitative Research Method in Social Science*. Ankara: Seckin Publications.
- Yılmaz, A., Esentürk, O. K., Tekkurşun Demir, G. & İlhan, E.L. (2017). Metaphoric Perception of Gifted Students about Physical Education Course and Physical Education Teachers. *Journal of Education and Learning*, 6(2), 220-234.
- Yob, I. M. (2003). Thinking Constructively with Metaphors. *Studies in Philosophy and Education*, 22, 127-138.
- Zorlu, Y. & Baykara, O. (2014). Is the Technology Application of Science? The Views of Pre-service Science and Technology Teachers. *Journal of Kazım Karabekir Education Faculty*, 29, 123-144.