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# Development of Engineering Perception Scale

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**Abstract**

The study aimed to develop an engineering perception scale for pre-service science teachers. The data were obtained from a total of 151 pre-service science teachers attending the department of science teaching at a state university in a province in the eastern region of Turkey. It took 3 years to collect the data. Engineering education was given to pre-service science teachers for 14 weeks within the framework of the "STEM, Robotics, Coding" course. Engineering education includes machine-style activities made with simple materials, that is, with materials found in our environment, which we can even call waste. In addition, activities involving the construction of machines used in daily life using Legos were also carried out. For example; washing machine, carousel, hand dryer, car windshield wiper, etc. They created working, that is, moving machines. In engineering education, they first made drawings for the objects they would create, then determined the materials needed to realize the drawings, and then proceeded to the construction phase. While determining these activities, the objectives of the course, the development of pre-service teachers' engineering skills, making machines and objects that exist in their environment, understanding their working principles, using knowledge from other fields and gaining experience in making different designs with them were taken as the basis. First of all, 5 open-ended questions were prepared to reveal the engineering perceptions of pre-service teachers. The literature was reviewed while preparing the questions. The open-ended questions were prepared by taking the opinions of 3 faculty members specialized in science education and 2 engineering faculty members. A 5-point Likert-type scale consisting of 40 items was developed based on the answers given by the pre-service teachers to the questions. All items of the 40-item scale were examined by 2 field experts and 2 Turkish language experts and finalized. The data obtained were analyzed through Exploratory Factor Analysis (EFA). Then, the same data set was analyzed using Confirmatory Factor Analysis (CFA). As a result of the analyses; a 31-item scale consisting of 6 sub-factors was obtained.

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## Introduction

Engineering is a profession that produces new things in line with the needs of the age and people (Brophy et al., 2008). In doing so, they use knowledge from many disciplines such as mathematics, physics, chemistry and biology together and use this knowledge for a common purpose by bringing them together in a common denominator. In fact, engineering has a structure that is built on basic sciences and technology, solving problems with the whole body of knowledge and producing new things. Engineering has developed many important inventions throughout history and has made people's lives easier (NRC, 2012). Engineering has had an important place throughout history not only for the benefits it has provided to human life, but also for the progress of societies and for societies to compete with each other. This situation started especially in the technological race between Russia and the United States, that is, between the United States and the Soviet Union after the Soviet Union announced in 1957 that it had launched a satellite called Sputnik into space. This situation has forced not only the two countries but all countries to move towards the use and production of technology. In addition, radical changes have been made in the field of education in order to train the manpower to produce this technology (Daugherty, 2013).Currently the International Technology and Engineering Educators Association (ITEEA) emphasizes that students should be educated in technology and engineering subjects in schools, especially from an early age, for the manpower planned to be trained (Denson et al., 2009). In order to achieve this, a new educational approach has been put forward and started to be implemented. STEM education, which is an interdisciplinary understanding that includes engineering skills by using knowledge from different disciplines together, has been tried to be integrated into the education system (Robert, 2012). Because science education based on engineering is a teaching approach that includes the integration of STEM disciplines, which aims to provide individuals with the ability to produce solutions to problems within the framework of the engineering design process, which creates a connection with real life, where systematic research-inquiry and engineering design are handled together in order for individuals to acquire target behaviors (Peterman et al., 2017).STEM education aims both to meet the need for manpower in fields such as science, technology, engineering and mathematics (Archer et al., 2014) and to increase students' interest in these fields (Sanders, 2009). When the literature is examined, it is seen that students' interest in science, engineering and mathematics fields has decreased (Dasgupta & Stout, 2014). In order to eliminate this situation, many countries have integrated STEM education into the education system starting from pre-school (Chubb, 2013). For example, the UK government is widely implementing STEM education with the support of British businessmen (Confederation of British Industry-CBI, 2011). The Taiwanese government, on the other hand, has adopted the policy of disseminating an educational approach based on engineering education (Marginson et al., 2013). South Korea, on the other hand, has incorporated this educational approach into education programs from primary school to doctoral level (Sorensen, 1994).

As much as engineering skills need to be integrated into the education system, the teachers who will apply them need to be trained (Tehrani, 2014). In integrating engineering into lessons, teachers do not need to be engineers; instead, every teacher should provide this integration (Çakır & Altun Yalçın, 2022; Roehrig et al., 2012). In order to achieve this, it is also important to reveal teachers' existing knowledge, skills, perceptions and attitudes towards engineering. Because the development of students' basic engineering knowledge and skills depends on teachers' knowledge and experience (Denson et al., 2009; Meral et al., 2022). As the implementers of the programs, teachers' expertise in engineering education is the most important element that determines the success of the programs and thus the success of education (Kayacan & Güneş Koç, 2018). Teachers need to be adequately equipped in terms of content and pedagogy in order to apply engineering and design skills in classroom practices (Marulcu & Sungur, 2012). Likewise, teachers and prospective teachers think that teachers' level of education, engineering content knowledge, pedagogical knowledge, and teaching experience are very important in engineering education (Hudson et al., 2009).When the literature is examined; very few studies have focused on the engineering knowledge, skills, perceptions, attitudes and acceptance levels of teachers and pre-service teachers (Culver, 2012). In the study conducted by Harman and Yenikalaycı, 2021;Cuijck et al. (2009), teachers stated that they did not consider themselves sufficient in integrating engineering education into their courses. Similar results were found in the study conducted by Hsu et al. (2011). It was concluded that although teachers have beliefs in the importance of engineering, design and technology, they feel inadequate in teaching these areas. Since teachers' positive attitudes and understandings towards engineering education will affect classroom practice, it is also very important to measure and monitor the development of teachers' attitudes and understandings (Mesutoğlu, 2017). When the literature is examined, very few studies have focused on pre-service teachers' perceptions of engineering and their level of receptivity. There is a lack of information about what pre-service teachers know about engineering and what they think about it (Culver, 2012).

Perception is formed by combining the stimuli from the individual's environment in the form of physical sensations in the mind (Battro et al., 2008). Perception is based on "philosophical practice and complex habitual patterns of thought that we derive from our past experiences" (Hayward, 1997). Perceptions also create (Stupak, 2000) or diminish values in our minds. An individual's past experience related to the stimulus that he/she perceives at that moment affects his/her new perception and leads the individual to exhibit positive or negative attitudes based on that experience (O'Brien, 2004). Since perception affects attitudes and behaviors, managing them is parallel to managing perceptions (Johansson & Xiong, 2003). Because "people make decisions based not only on facts but also on perceptions, whether they are true or not" (Fombrun, 2004). Noyes (2004); Managing the attitudes and behaviors of pre-service teachers by revealing their perceptions is one of the main objectives of educational studies. Pre-service teachers come to the university with some perceptions thanks to the education they have received throughout their lives, their own experiences and experiences, and the education they have received at the university, the professors they have encountered, the observations and experiences they have made have an impact on these perceptions. This situation can be positive or negative and cause changes in their perceptions (Kasoutas & Malamitsa, 2009).Revealing the perceptions of pre-service teachers is of great importance in terms of providing them with the necessary education and making the necessary arrangements (Marulcu & Sungur, 2012). In this context, pre-service teachers are in a very suitable position to be trained in the field of engineering and to teach the necessary pedagogical knowledge (Yasar et al. 2006). The necessity of determining the level of teacher candidates' perceptions will shed light on the curriculum changes to be made in education faculties, the educational policies to be made on this subject, and the ways to be followed for the teaching of courses. Especially low perception levels and investigating the reasons for this will facilitate the solution of many problems. It will pave the way for training qualified teacher candidates (Altun Yalçın & Yalçın 2019). In this study, a scale development study was carried out in order to reveal the perceptions of pre-service teachers about engineering.

## Method

Sequential exploratory method was used in the study. Sequential exploratory method offers some advantages in scale development studies. In this method, qualitative data are first collected, analyzed and interpreted, and then quantitative data are collected, analyzed and interpreted (Creswell, 2014). One of the aims of this method is to develop a tool to measure the same phenomenon using qualitative data investigating a particular phenomenon (McMillan & Schumacher, 2006). For this purpose, firstly, a questionnaire consisting of open-ended questions was applied to pre-service science teachers. The answers given by the pre-service teachers were analyzed and the items of the scale were formed. Necessary quantitative analyses were conducted to create the final version of the perception scale.

In this study, it is aimed to develop a valid and reliable measurement tool to measure pre-service science teachers' perceptions of engineering. Firstly, engineering education was given to pre-service science teachers and then the data required to develop the scale were collected from these students. The developed scale was created in a way to reveal the positive and negative attitudes of pre-service teachers towards that phenomenon. In the development phase of the instrument; firstly, engineering education was given to pre-service science teachers. Then, 5 open-ended questions were prepared by reviewing the literature and taking the opinions of 3 faculty members specialized in science education and 2 engineering faculty members. The prepared questions were applied to pre-service science teachers who received engineering education. From the data obtained, an item pool of 50 items was formed. This item pool was shown to the experts again and their opinions on the items were taken. From the item pool, items that were thought not to measure pre-service science teachers' perceptions of engineering, items that were similar to other items, and items that included measuring several characteristics at the same time were removed. After the removal of these items, a 40-item scale was formed. This scale was again examined by 2 field experts and 2 Turkish language experts and a consensus was obtained on the final version of the scale.

Data collection took 3 years. Within the scope of the elective course "STEM Robotic Coding", pre-service science teachers were given engineering-based applications. Each training/semester, approximately 30 pre-service teachers were trained and data were collected from pre-service teachers who voluntarily participated in the study. A total of 151 pre-service science teachers participated in the study. The data obtained from the pre-service teachers were first used to perform Exploratory Factor Analysis (EFA). EFA is a technique that tries to reveal complex patterns by exploring the data set and testing predictions (Yong & Pearce, 2013). In line with the EFA results, the same dataset was subjected to Confirmatory Factor Analysis (CFA). CFA is a technique used to confirm that hypotheses are realized (Yong & Pearce, 2013). As a result of the analysis, the reliability coefficient of the final 31-item scale was calculated.

**Engineering education**

Engineering education was given to pre-service science teachers for 14 weeks within the framework of the "STEM, Robotics, Coding" course. Approximately 30 pre-service science teachers were trained in each semester. The data were obtained from a total of 151 pre-service science teachers who voluntarily participated in the study. Data collection lasted for 6 semesters, i.e. 3 years. Engineering education is based on the use of simple materials, i.e. materials found in our environment or even waste. For example, activities such as a snake with a remote control, a motorized car, a moving caterpillar, a car that works with a mousetrap, a CD that does not collapse, etc. were carried out with simple materials. In addition, activities involving the construction of machines used in daily life were carried out using Legos. For example; washing machine, carousel, hand dryer, car wiper, etc. They created machines that work, that is, move. In engineering education; first they made drawings for the objects they would create, then they determined the materials necessary to realize the drawings, and then they proceeded to the construction phase. While determining these activities, the objectives of the course, the development of pre-service teachers' engineering skills, making machines and objects that exist in their environment, understanding their working principles, using knowledge from other fields and gaining experience in making different designs with them were taken as the basis. For this purpose, activities were determined in line with the opinions of 5 experts consisting of 2 engineering faculty members and 3 science education faculty members. Particular care was taken to ensure that the activities had different content, different working and designing logic, different areas and different materials. For example, in the mousetrap-powered car, the mousetrap constitutes the engine part of the car. Students generated many ideas on how to use this mousetrap as an engine, made drawings and created prototypes. For example, by giving lego-style materials to prospective teachers, they were enabled to make a prototype of the same washing machine. All washing machines produced are in operable format and have equipment that can be coded. Codes were provided to prospective teachers to ensure that this washing machine operates as desired in daily life.

### Overview of Statistical Analysis

Statistical analysis was carried out in 3 stages. Firstly, EFA was conducted to reveal the factor structure of the scale. EFA was conducted using the basic analysis components of SPSS 21.0 program. Secondly, CFA was used to confirm the factor structure obtained with EFA. CFA uses the analysis diagram to describe the variables and factors (Yong & Pearce, 2013). Factors and variables were obtained using Analysis of Moment Structure (AMOS) 21. Modification index; researchers have ways to improve model fit using AMOS. It provides opportunities for researchers to use these additional ways (Kim & Glassman, 2013).

## Findings

### Explanation of Factor Analysis

First of all, Kaiser-Meyer-Olkin (KMO) coefficient and Barlett test results were examined to determine whether the data were suitable for factor analysis. It is recommended that the KMO coefficient should be above .70 in order to perform factor analysis on the data (Leech, Barrett, & Morgan, 2005) and the Barlett test shows that the correlation matrix is significantly different from the identity matrix. It is also important that the correlations between the factors are all zero (Leech et al., 2005). In this context, the KMO coefficient of the instrument was .93 and Bartlett's Test of Sphericity was statistically significant ($\chi2$ = 5111.049, df = 780, p <.0001). These results indicate that the EFA.

EFA shows that there are 6 factors with eigenvalues greater than 1. All sub-factors explain 72.326% of the total variance. Varimax rotation method was used to clearly reveal the factors in which the items were clustered. Field (2009, p. 644) reported that the importance of factor loading depends on the sample size. According to Field (2009), the factor loading cut-off criteria for a sample of 100 and 200 participants should be .512 and .364 respectively. In this study, the cut-off criteria reported by Field (2009) were used as a reference. Therefore, the cut-off criterion was set as .40 due to the current sample size. First, 40 items were factor analyzed and the items were clustered under six factors. However, items clustered under the same sub-factor but with less than .10 difference between factor loadings were considered as overlapping items (Büyüköztürk, 2009) and these items (2, 3, I7, 18, 19, 20, 22, 25 and 30) were removed from the scale. As a result, the remaining 31 items were grouped under six factors and the factor loadings ranged between .549 and .829. In addition, Pallant (2020) stated that if the proportional variance (communality) value of an item is less than .30, that item is not compatible with the other items in its factor. The results of the analysis show that the loadings (communalities ranged) between .549 and .829.

The factors were named according to the statements (sentences) of the items. In this context, the factors are Advantage, Self-efficacy, Positive Attitude, Relevance to Mathematics, Contribution, and Negative Attitude. Reliability refers to the consistency or stability of the assessment results and is therefore considered a characteristic of the scores or assessment results and not a means of testing themselves (Reynolds et al., 2002). It consists of the sub-factors Advantage (ADV), Self-efficacy (SEF), Positive attitude (POZ), Relevance to mathematics (MAT), Contribution (CONT), and Negative attitude (NEG). Cronbach's alpha (a measure of internal consistency) values were determined for each sub-factor (Table 1.). The reliability coefficients (alpha) for these six sub-factors were .96, .96, .88, .88, .78, .88, .75 and the total reliability of the scale was determined as .97. According to statisticians, a reliability coefficient of .70 and higher is considered acceptable (Bland & Altman, 1997; Reynolds et al., 2006).

**Table 1**

*Results of EFA of the 31-item Engineering Perception Scale*

| Factor | Items | Facor Loadings |
|---|---|---|

| Factor 1 | | ADV | SEF | POZ | MAT | CONT | NEG |
|---|---|---|---|---|---|---|---|
| | 16) We use science in engineering design. | .573 | .212 | .099 | .443 | .027 | .209 |
| Advantage | 32)Engineering designs develop students' production skills | .827 | .257 | .118 | .097 | .209 | .167 |
| | 33)Engineering designs develop students' engineering skills. | .804 | .240 | .096 | .099 | .251 | .171 |
| | 34)Engineering designs help students understand how machines work. | .739 | .216 | .198 | .257 | .139 | .182 |
| | 35) Engineering designs help students realize the relationship between science, mathematics, technology and engineering. | .737 | .111 | .144 | .385 | -.032 | .079 |
| | 36) Engineering design makes students love science. | .778 | .162 | .095 | .146 | .203 | .090 |
| | 37) Engineering design helps students to love science lessons. | .829 | .188 | .103 | .099 | .151 | .138 |
| | 38) Engineering design allows students to experience the excitement of production. | .819 | .223 | .146 | .068 | .188 | -.003 |
| | 39) Engineering design helps students understand the working principles of machines. | .778 | .118 | .181 | .251 | -.022 | .018 |
| | 40) Engineering design helps students learn the knowledge needed to produce engineering and technology. | .780 | .225 | .183 | .213 | .187 | .041 |
| | Factor 2 | | | | | | |
| | I can anticipate problems that I may encounter in engineering designs. | .050 | .702 | .351 | .126 | .303 | -.082 |
| | 9) I believe that I can take precautions in advance for the problems I will encounter in engineering designs. | .206 | .680 | .237 | .108 | .326 | .076 |
| | 10) I can solve the problems I encounter in engineering design. | .049 | .794 | .102 | .124 | .156 | .203 |
| Self-efficacy | 11) I can produce new solutions for the problems I encounter in engineering design. | .245 | .749 | .101 | .107 | -.010 | .248 |
| | 13) I know how to make engineering designs. | .231 | .774 | .293 | -.010 | -.002 | -.017 |
| | 14) I can design engineering with different materials | .248 | .743 | .279 | .133 | .073 | .105 |
| | 15)I would like to design engineering with different materials | .304 | .603 | .401 | .103 | .015 | .318 |
| | 21) I believe that I can make engineering designs using science. | .427 | .650 | .160 | .183 | .160 | .065 |
| | 29)I believe that I can adapt engineering designs to my course | .473 | .599 | .187 | .193 | .383 | .099 |
| | Factor 3 | | | | | | |
| | 1) I like to make engineering designs | .332 | .398 | .667 | .047 | .158 | .255 |
| Positive attitude | 4) I would also like to do other Engineering designs. | .269 | .342 | .590 | -.040 | .134 | .225 |
| | 6) I believe I can make new engineering designs. | .208 | .502 | .633 | .129 | .296 | .083 |
| | 7) I would like to make new engineering designs. | .257 | .405 | .595 | .102 | .275 | .261 |
| | Factor 4 | | | | | | |
| Relevance to mathematics | 23) we need mathematics to design engineering | .398 | .075 | .144 | .733 | .010 | -.060 |
| | 24) Engineering and Mathematics are related. | .350 | .133 | -.024 | .743 | .090 | .239 |
| | 26)We used mathematics in engineering | .238 | .114 | -.044 | .663 | .296 | -.192 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | design. | | | | | | |
| | Factor 5 | | | | | | |
| | 27) Doing engineering design opened my horizons. | .370 | .322 | .284 | .193 | .600 | .127 |
| Contribution | 28)Engineering designs help me to understand my course better. | .378 | .350 | .216 | .155 | .613 | .205 |
| | 31)Engineering designs give students a different perspective. | .448 | .226 | .282 | .162 | .566 | .231 |
| | Factor 6 | | | | | | |
| Negative attitude | 12) I don't want to do engineering designs. | .120 | .109 | .158 | .051 | .232 | .785 |
| | 5) I have no interest in engineering designs | .187 | .221 | .147 | -.090 | -.015 | .810 |

A 6-factor 31-item model was obtained from EFA and this model was evaluated with the maximum likelihood estimation method in AMOS. The model was applied and $\chi2$ = 5111.049 (df = 780, $p < .05$) was obtained. The expectation with these values was that they should not be statistically significant. However, the chi-square value is highly affected by sample size (Byrne, 2010; Kenny et al., 2015) and was found to be statistically significant as expected. Therefore, the ratio of chi-square to degrees of freedom, which has the potential to minimize the effect of sample size, is recommended by statisticians as an alternative way of assessing model fit (Kenny et al., 2012).

In addition, according to the chi-square value ($\chi2/df \leq 2$, excellent; Kline, 2012), NFI < 0.90, CFI ≥ .90, acceptable; Hooper et al., 2008), Root Mean Square Error of Approximation (RMSEA ≤ .08, good; Browne & Cudeck, 1993; Hooper et al., 2008) values were used to evaluate the degree of fit between the data and the model. In addition to the relative chi-square ($\chi2/df \leq 2$, excellent; Kline, 2011), other fit indices such as Normed Fit Index (NFI ≥ .90, acceptable; Bentler & Bonett, 1980), Comparative Fit Index (CFI ≥ .90, acceptable; Hooper et al., 2008) and Root Mean Square Error of Approximation (RMSEA ≤ .08, good; Browne & Cudeck, 1993; Hooper et al., 2008) also assesses the degree of fit between the model and the data.

According to the results of the analysis, a 5-point Likert-type scale (1=strongly disagree, 2=disagree, 3=undecided, 4=agree, 5=strongly agree) consisting of 31 items was obtained. The maximum and minimum values that can be obtained from the scale are 31 and 155. There are 2 negative items in the final version of the scale. These need to be reverse coded. These are item 12 and item 5 in the negative attitude factor.

## Discussion and Conclusion

This study aims to develop a valid and reliable instrument to measure pre-service science teachers' perceptions of engineering. In line with this purpose; firstly, data were obtained by applying qualitative method. Pre-service science teachers who have received engineering education were asked 5 open-ended questions obtained by reviewing the literature. An item pool consisting of 50 items was created from the qualitative data. These items were shown to the experts and the items that were thought not to measure perception, thought to measure the same theme, and thought to measure more than one theme were scaled. The 40-item scale was examined by 2 field experts and 2 Turkish language experts and a consensus was obtained on the final version of the scale. The final version of the scale was applied to 151 pre-service science teachers with engineering education. Exploratory Factor Analysis (EFA) was applied to the data obtained from pre-service science teachers.

As a result of EFA, a model consisting of 6 factors with 31 items was obtained. Confirmatory Factor Analysis was applied to the acceptable model fit revealed by EFA and the degree of fit between the model and the data was tested. As a result of expert opinions and literature review; 1st, 2nd, 3rd, 4th, 5th and 6th factors were named as Advantage (ADV), Self-efficacy (SEF), Positive attitude (POZ), Relationship with mathematics (MAT), Contribution (CONT), Negative attitude (NEG). The first sub-factor "Advantage" consists of 10 items (positive sentences) that reveal pre-service science teachers' views on the advantages of engineering education. The second sub-factor "Self-efficacy" consists of 9 items (positive sentences) that reveal pre-service science teachers' self-efficacy perceptions towards the application of engineering education in their future professional life. The 3rd sub-factor "Positive Attitude" consists of 4 items (positive sentences) measuring pre-service science teachers' positive attitudes towards engineering education. The 4th sub-factor "Relationship with Mathematics" consists of 3 items (positive sentences) measuring pre-service science teachers' views on the relationship between engineering and mathematics. The 5th sub-factor "Contribution" consists of 3 items (positive sentences) measuring the contribution of engineering education to students. The 6th sub-factor "Negative Attitude" consists of 2 items (negative sentences) measuring pre-service science teachers' negative attitudes towards engineering education. Traditionally, it is recommended that a single subscale should consist of at least three items (Kim & Glassman, 2013). Cronbach's alpha coefficients calculated for each factor and all items indicate that the scale is reliable (overall scale α = .97; factor 1 α = .96; factor 2 α = .96; factor 3 α = .88; factor 4 α = 0.78; factor 5 α = .88; factor 6 α = .75).

Engineering education is rapidly being integrated into educational systems (Wendell, 2011). This is necessary not only to create a productive society but also a well-educated and well-developed society in all aspects (Wendell & Rogers, 2013). This is because engineering education not only develops individuals' production and design skills, but also many mental and psychomotor skills and contributes to the development of other field knowledge. Engineering education, especially by its nature, helps students to establish a relationship between engineering and mathematics and engineering and science and to develop permanent and meaningful learning in these fields (Hammack et al., 2015).

They not only increase their success in these fields but also gain the ability to use the knowledge of these fields by using this knowledge. It is effective in developing positive attitudes towards the courses and increasing their interest and motivation towards the course and engineering discipline (Roth, 2001). In addition, engineering education not only focuses on the application of the scientific knowledge that students learn, but also supports the acquisition and development of scientific knowledge in creating products (Ting, 2016; Yalçın & Çakır, 2022). Engineering education enables individuals to develop by enabling them to use some of their mental characteristics. For example, it contributes to the development of systematic thinking, creativity, cooperation, communication (Katehi et al., 2009), scientific inquiry, problem solving, etc. (Fortus et al., 2004). In addition, it also contributes positively to students' career choices. It is of great importance that students receive education about the professions they want to choose, especially from middle school onwards (Mathner & Martin, 2012). This is because middle school is a critical period for students to make career choices and decisions (Wyss et al., 2012). Studies have shown that the education students receive affects their career choices and their experiences and interests in this field (Godwin et al., 2015). In this context, a scale development study was carried out in the research to reveal the perceptions of prospective teachers about engineering.

**Recommendations**

The biggest responsibility falls on teachers to ensure that engineering education, which is important in many respects, is carried out appropriately and adequately.Teachers' perceptions of this subject are also very important, as is their training to have sufficient knowledge and skills on this subject. Because when the literature is examined, it has been determined that perception affects individuals' attitudes and behaviors. This situation is thought to be important for teacher candidates to be able to properly carry out engineering education in teaching environments in their future professional lives. In this way, it will be possible to determine the perceptions of future teachers, to eliminate their negative perceptions, if any, and to provide them with the opportunity to receive training in a way that can affect them positively.

This study focused on teacher candidates. It may be suggested that future studies focus on teachers and students at all levels. Because engineering education is thought to be an important education that should start from pre-school. The studies to be carried out on teachers are; It will shed light on the situation of teachers and guide the planning of in-service training. Additionally, the study focused on the concept of engineering perception. The work to be done; It is thought that it is of great importance to address many aspects such as attitude towards engineering and engineering education, self-efficacy, knowledge and skill level.

## Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

## Conflict of Interest

None

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