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**Araştırma Makalesi**
***Research Article***

# An Analysis of Engineering Students' Perceptions of Engineering and Their Attitudes Toward the Profession in Terms of Different Variables

## *Mühendislik Öğrencilerinin Mühendislik Algıları ile Mesleğe Yönelik Tutumlarının Farklı Değişkenler Açısından İncelenmesi: Ankara Yıldırım Beyazıt Üniversitesi Örneği*

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**Abstract**: The aim of this study is to examine engineering students' perceptions of the concept of engineering and their attitudes toward the profession at a public university, in terms of various variables. The study adopted a descriptive survey design within the quantitative approach and employed a phenomenological design as part of the qualitative methodology. The study was conducted with a total of 674 students enrolled in engineering programs at a public university in Türkiye. To measure students' attitudes toward the profession, a scale developed by Özyurt and Özyurt (2016) was used. To determine students' perceptions of the concept of engineering, an open-ended question was posed. For the analysis of quantitative data, the Mann–Whitney U test and Kruskal–Wallis tests were performed using the SPSS 24 statistical software package. The results indicated that students' attitudes toward the profession differed based on program and emotional variables, but not based on gender, grade level, or family socioeconomic status. Also, in this study according to the Higher Education Entrance Exam (HEEE) results, the comparison revealed that there is no linear relationship between departmental University Entrance Rankings (UERs) and students' professional attitude scores. In analyzing the qualitative data, content analysis was applied and word clouds were generated for the codes. It was observed that the majority of students in engineering programs produced positive metaphors about the concept of "engineering", likening it to concepts such as life, a bridge, or a tree.

**Keywords**: Engineering education, university students, attitude, perception, variables

**Özet**: Bu çalışmanın amacı, bir devlet üniversitesindeki mühendislik öğrencilerinin mühendislik kavramına ilişkin algılarını ve mesleğe yönelik tutumlarını çeşitli değişkenler açısından incelemektir. Araştırmada nicel yaklaşıma dayalı betimsel tarama deseni, nitel yöntemlerden ise fenomenolojik desen kullanılmıştır. Çalışma, Türkiye'deki bir devlet üniversitesinde mühendislik programlarına kayıtlı toplam 674 öğrenci ile yürütülmüştür. Öğrencilerin mesleğe yönelik tutumlarını ölçmek amacıyla Özyurt ve Özyurt (2016) tarafından geliştirilen ölçek kullanılmıştır. Öğrencilerin mühendislik kavramına ilişkin algılarını belirlemek için ise açık uçlu bir soru yöneltilmiştir. Nicel verilerin analizinde SPSS 24 paket programı kullanılarak Mann–Whitney U testi ve Kruskal–Wallis testi uygulanmıştır. Elde edilen bulgulara göre, öğrencilerin mesleğe yönelik tutumlarının program türü ve duygusal değişkenler açısından farklılaştığı, ancak cinsiyet, sınıf düzeyi ve aile sosyoekonomik durumu açısından anlamlı bir fark göstermediği belirlenmiştir. Ayrıca, Yükseköğretim Kurumları Sınavı (YKS) sonuçlarına göre yapılan karşılaştırmada, bölümlerin üniversite giriş sıralamaları (UER) ile öğrencilerin mesleki tutum puanları arasında doğrusal bir ilişki bulunmamıştır. Nitel verilerin analizinde içerik analizi yöntemi uygulanmış ve elde edilen kodlara ilişkin kelime bulutları oluşturulmuştur. Sonuç olarak, mühendislik programlarındaki öğrencilerin büyük çoğunluğunun "mühendislik" kavramına ilişkin olumlu metaforlar ürettikleri, bu kavramı yaşam, köprü veya ağaç gibi kavramlarla benzeştirdikleri gözlemlenmiştir.

**Anahtar Kelimeler**: Mühendislik eğitimi, Üniversite öğrencileri, tutum, algı, değişken

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## 1. Introduction

Engineering is a pioneering profession concerned with designing and developing products, systems, processes, and technologies to address societal needs while overseeing their implementation and production. It plays a central role in technological advancement and economic development (Korkmaz, Kösterelioğlu, & Kara, 2015). By applying scientific and technical knowledge, engineers contribute directly to regional and national progress. Haldun et al. (2006) highlight their contribution to the national economy through employment generation. Historically, engineering has shaped civilizations—from water channels and temples in Mesopotamia and the Egyptian pyramids to Archimedes' compound pulleys (Alpaslan, 2014).

The institutionalization of modern engineering education in the Ottoman Empire dates back to the eighteenth century with the establishment of military engineering schools, which laid the foundation for contemporary engineering education in Türkiye. Today, while some engineering faculties operate at international standards, others face infrastructural constraints (Gençoğlu & Cebeci, 1999). Engineering education systems also differ across countries in duration and professional designation. In Türkiye, programs typically last four years and confer the title "engineer," whereas in France programs extend to five years. In the United Kingdom, graduates may receive titles such as professional engineer or engineering technician (Simpson, 1994).

Engineering education seeks to prepare graduates who can respond effectively to labor market demands (Sarıer, 2016). For this reason, examining students' perceptions and professional attitudes during undergraduate education is critical. The faculty environment, where students acquire foundational knowledge and skills, plays a decisive role in shaping these attitudes. Research demonstrates that attitudes are associated with psychological variables such as academic achievement (Hwang, Wu, & Chen, 2012; Lai et al., 2012; Landry et al., 2002; Van de Gaer et al., 2012).

Professional attitudes influence career orientation and engagement. Perceptions of engineering are closely linked to students' interest and participation in coursework (Towers, Simonovich, & Zastavker, 2011). Attitudes are also related to performance in both foundational and capstone courses (Dobela & Seboni, 2023) and affect career intentions and professional decision-making (Hammack, Ivey, Utley, & High, 2015). Positive attitudes foster motivation, engagement, and career planning, while negative attitudes may contribute to attrition from the profession and exacerbate shortages of qualified engineers.

The capacity to approach real-world problems and develop solutions is intertwined with professional attitudes. A deeper understanding of these attitudes can inform curriculum development by revealing gaps in industry collaboration, internships, and practice-oriented training. Students' perceptions also signal how prepared they feel for professional life. Career satisfaction is closely linked to well-being; dissatisfaction may result in burnout and reduced productivity (Torun, Çelik, & Otar, 2009). Since vocational education aims to cultivate behaviors necessary for both professional and personal life (Alkan, Doğan, & Sezgin, 2001), strengthening positive professional attitudes remains a priority.

International scholarship has examined engineering students' field satisfaction (Kajfez et al., 2018), professional perceptions (Cruz et al., 2016; Opara et al., 2006; Miguel-Cruz et al., 2017; Taylor et al., 2017; Towers et al., 2011), and professional attitudes (Azodo, 2017; Baylor et al., 2005; Besterfield-Sacre et al., 2001; Felder et al., 1995; Hilpert et al., 2009; Vrcejl & Krishnan, 2008). In Türkiye, research remains comparatively limited (Korkmaz et al., 2015) and tends to focus on first-year students (Özyurt & Özyurt, 2016; Polat, Yanmaz, & Kadaifçi, 2020), science teacher candidates (Marulcu & Sungur, 2012), or middle school students (Çil & Özlen, 2019; Yıldız-Aslan, 2024).

Existing findings generally report moderate to high levels of professional attitudes, with limited gender-based differences, though institutional context may influence outcomes (Korkmaz et al., 2015). Scale development studies have produced reliable instruments for assessing professional attitudes and their relationship with academic indicators (Özyurt & Özyurt, 2016). Longitudinal research suggests that perceptions evolve through disciplinary exposure (Polat et al., 2020). Research involving younger students reveals persistent stereotypical and gendered views of engineering, often associating the field primarily with civil engineering (Çil & Özlen, 2019). Collectively, the literature underscores the influence of educational experiences, institutional environments, and societal narratives on professional attitudes.

Against this backdrop, examining the perceptions and professional attitudes of students across all engineering programs within a single faculty offers an opportunity to address a gap in the national literature. Given engineering's strategic importance, such findings may inform improvements in educational quality and institutional practices. Supporting the development of positive perceptions and attitudes can enhance both academic success and long-term professional satisfaction.

### 1.1. The Purpose of the Study

This study aims to examine engineering students' perceptions of the profession and their professional attitudes at a public university in Türkiye across several variables. The research seeks to answer the following questions:

- What is the level of professional attitudes toward engineering among students enrolled in the Faculty of Engineering at a public university?
- Do professional attitudes differ significantly according to gender, year of study, family socio-economic status, engineering program, the primary emotion fostered by the program, and national university entrance exam ranking?
- How do students conceptualize the engineering profession?
- How do these perceptions vary according to program, grade level, gender, and socio-economic status?

## 2. Methodology

This study employed a convergent parallel mixed methods design (Creswell & Plano Clark, 2018). In this approach, quantitative and qualitative data are collected concurrently, analyzed independently, and integrated during interpretation.

The quantitative component was based on a descriptive survey model to examine students' professional attitudes toward engineering across multiple variables. The descriptive survey model aims to portray an existing situation without manipulation (Karasar, 2020).

The qualitative component followed a phenomenological approach to explore the meanings students attribute to the concept of "engineering" through metaphor analysis. Phenomenology focuses on individuals' lived experiences and the meanings they assign to a phenomenon (Büyüköztürk et al., 2024). This approach enables an in-depth understanding of participants' perceptions and constructed meanings (Özmen & Karamustafaoğlu, 2019).

The two strands were integrated at the interpretation stage. Quantitative results regarding differences in professional attitudes were compared and interpreted alongside qualitative themes derived from students' metaphorical expressions.

### 2.1. Sample

The population comprised all undergraduate students enrolled in the Faculty of Engineering at a public university in Türkiye. The study was conducted with 674 volunteer participants, representing a substantial portion of the accessible population. Demographic characteristics, including gender, program, and grade-level distribution, are presented in ▶**Table 1**.

Qualitative data were obtained from the same participants through a single open-ended question designed to elicit metaphors about "engineering." The purpose was not to conduct in-depth individual interviews but to analyze collectively generated metaphorical expressions. The large number of participants therefore supported the identification of recurring themes and shared experiential patterns.

Participation was voluntary, and no identifying information was collected. Students were assigned codes (E1–E674) to ensure confidentiality. Ethical approval was obtained from the relevant institutional ethics committee (see Appendix 1).

The research was carried out at Ankara Yıldırım Beyazıt University.

### 2.2. Data Collection Process

An online Demographic Information Form was administered in the first phase of the study. The form gathered data on gender, grade level, family socio-economic status, enrolled program, and the emotion most strongly fostered by the program. Descriptive statistics are provided in ▶**Table 1**.

The sample consisted primarily of male students (62.6%). Second-year students formed the largest group (33.1%), and Mechanical Engineering had the highest representation among programs (22%). Most participants reported a middle-income family background (81.9%). Curiosity was the emotion most frequently associated with studying engineering (67.7%).

Socio-economic status categories were determined using 2025 minimum wage benchmarks. Families with incomes close to the minimum wage were classified as low socio-economic status, while higher income levels were grouped accordingly.


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**Table 1.** Analysis Results Regarding the Demographic Characteristics of the Participants

| Variable | | Frequency (f) | Percentage (%) | UER |
|---|---|---|---|---|
| Gender | Male | 422 | 62.6 | |
| | Female | 252 | 37.4 | |
| Class Level | Preparatory Year | 24 | 3.6 | |
| | First Year | 199 | 29.5 | |
| | Second Year | 223 | 33.1 | |
| | Third Year | 118 | 17.5 | |
| | Fourth Year | 110 | 16.3 | |
| Program | Computer Engineering, CoE | 54 | 8 | 21608 |
| | Electric – Electronic Engineering, EEE | 88 | 13.1 | 40028 |
| | Industrial Engineering, IE | 122 | 18.1 | 50933 |
| | Energy Systems Engineering, ESE | 11 | 1.6 | 133394 |
| | Mechanical Engineering, ME | 148 | 22 | 58536 |
| | Metallurgical and Materials Engineering, MME | 135 | 20 | 137380 |
| | Civil Engineering, SiE | 74 | 11 | 165647 |
| | Software Engineering, SE | 42 | 6.2 | 27795 |
| Socio-economic level of the family | Low | 87 | 12.9 | |
| | Medium | 552 | 81.9 | |
| | High | 35 | 5.2 | |
| The Most Heightened Emotion of Studying Engineering | Curiosity | 456 | 67.7 | |
| | Hope | 77 | 11.4 | |
| | Love | 15 | 2.2 | |
| | Gratitude | 12 | 1.8 | |
| | Zest | 31 | 4.6 | |
| | None | 83 | 12.3 | |
| General | | 674 | 100 | |

Students whose family incomes were approximately twice the minimum wage were classified as middle socio-economic status, whereas those with incomes three times the minimum wage or higher were categorized as high socio-economic status. HEEE scores were also included as a variable to determine whether professional attitudes toward engineering vary according to students' performance on the Higher Education Entrance Examination.

Quantitative data were collected using the scale developed by Özyurt and Özyurt (2016). The instrument consists of 18 items structured on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree) and measures the cognitive, affective, and behavioral dimensions of attitude. Negatively worded items were reverse-coded to ensure scoring consistency. The original study reported a Cronbach's alpha coefficient of α = .83 for the overall scale. Reliability coefficients for the six sub-dimensions were α = .75, .78, .72, .62, .58, and .43, respectively. Based on Tavşancıl's (2010) classification, coefficients between .80 and 1.00 indicate high reliability for the overall scale.

For the present study, internal consistency was recalculated, yielding a Cronbach's alpha value of .792. This result demonstrates that the scale provides an acceptable level of reliability for assessing engineering students' professional attitudes in this sample. Two field experts evaluated the suitability of the instrument for the research purpose and confirmed its appropriateness. Permission to use the Engineering Attitude Scale (EAS) was obtained from the developers, and the instrument was administered in its original form without modification.

Factor analysis results reported in the original study show that the 37 items are organized under six dimensions: Engineering Perception (9 items), Contribution to Society (8 items), Engineering Skills (9 items), Career and Money (5 items), Group Work (3 items), and Numerical Intelligence (3 items).

In the qualitative component, participants were asked to complete the prompt: "Engineering is like … because …". Students were requested to provide a metaphor in the first blank and to justify their choice in the second.

### 2.3. Data Analysis

The data were analyzed in line with the research questions. To examine professional attitudes across variables, scores obtained from the Engineering Attitude Scale were first evaluated to determine whether the assumptions of parametric tests were satisfied. Normality was assessed using skewness and kurtosis coefficients, along with the Kolmogorov-Smirnov and Shapiro-Wilk tests. According to Liu et al. (2005), skewness and kurtosis values should fall within ±2.58 at the 5% confidence level and within ±1.96 at the 1% confidence level. The calculated values exceeded these thresholds, suggesting deviation from normal distribution. The Kolmogorov-Smirnov and Shapiro-Wilk test results, presented in ▶**Table 2**, further supported this conclusion.

**Table 2.** Results of Normality Tests

| Scale | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | p | Statistic | df | p |
| EAS | .066 | 674 | .000 | .969 | 674 | .000 |

If the significance values obtained from the Kolmogorov-Smirnov and Shapiro-Wilk tests exceed .05, the data are considered to follow a normal distribution (Seçer, 2015). In this study, however, the p-values were below .05 ($p < .05$), demonstrating that the data deviated from normality. Because the assumptions required for parametric testing were not satisfied, non-parametric alternatives were employed. The Mann–Whitney U test was used for comparisons between two groups, and the Kruskal–Wallis H test was applied for comparisons involving three or more groups. All statistical analyses were conducted using SPSS 24. A significance level of $p < .05$ was adopted.

For the qualitative data, content analysis was applied to systematically examine the metaphors generated by participants. This method involves coding, categorizing, and organizing textual data to identify recurring patterns and themes (Miles & Huberman, 1994).

Two researchers independently reviewed the metaphor statements and developed preliminary codes based on conceptual similarities. These codes were subsequently compared and refined through discussion to establish a shared coding framework. Once consensus on the coding scheme was achieved, the metaphors were organized into broader thematic categories. Word clouds were produced using Python to visualize the frequency and distribution of codes.

Inter-coder reliability was calculated using the percentage agreement formula proposed by Miles and Huberman (1994). After resolving minor initial discrepancies through discussion, a high level of agreement was reached between the researchers. Both coders possess prior experience in qualitative data analysis and engineering education research.

## 3. Results

### 3.1. Results Related to the First Sub-Problem

Within the scope of the research, the findings obtained from the descriptive statistics based on the scores from the EAS are presented in ▶**Table 3**.

**Table 3.** Descriptive Statistics Results

| Scale | Min | Max | | Variance | Standard Deviation |
|---|---|---|---|---|---|
| EAS | 64 | 165 | 129.06 | 134.200 | 11.584 |

As a result of the data analysis of the scores collected from the scale, it was determined that the minimum score obtained by engineering students from the EAS was 64, and the maximum score was 165. Since the scale consists of 37 items, the minimum possible score for a student is 37 (37×1), the average score is 111 (37×3), and the maximum possible score is 185 (37×5). Considering that the average score obtained by students from the EAS was ($\bar{X}$ = 129.06), it can be concluded that engineering students' attitudes toward the profession are above the moderate level.

### 3.2. Results Related to the Second Sub-Problem

▶**Table 4** presents that the scores obtained by engineering students regarding their attitudes toward the profession do not show a statistically significant difference based on the gender variable.

**Table 4.** Mann-Whitney U Test Results for the Comparison of Engineering Students' Attitudes Toward the Profession Based on Gender

| Scale | Gender | N | Order Mean | Order Sum | U | p |
|---|---|---|---|---|---|---|
| EAS | Female | 252 | 322.03 | 81152.50 | 49274.500 | .111 |
| | Male | 422 | 346.74 | 146322.50 | | |

There was no statistically significant difference between female and male engineering students in terms of their scores on the Attitude Toward Engineering Profession Scale based on the gender variable ($U = 49{,}274.500$, $p > .05$).

▶**Table 5** presents that the scores obtained by engineering students on their attitudes toward the profession did not show a significant difference based on the grade level variable.

**Table 5.** Kruskal-Wallis Test Comparison Results on Engineering Students' Attitudes Toward the Profession According to Grade Level Variable

| Scale | Class Level | N | Order Mean | df | $\chi^2$ | p |
|---|---|---|---|---|---|---|
| | Preparatory year | 24 | 416.17 | 4 | 6.185 | .186 |
| | First Year | 199 | 340.11 | | | |
| | Second Year | 223 | 328.27 | | | |
| | Third year | 118 | 352.25 | | | |
| | Fourth year | 110 | 318.50 | | | |
| | Total | 674 | | | | |

No statistically significant difference was found in the scores obtained by engineering students from the Attitude Toward Engineering Scale based on the grade level variable [$\chi^2$ (df=4, N=674) = 6.185, $p > .05$]. These results suggest that students' attitudes toward the profession did not significantly differ by grade level.

▶**Table 6** presents the results of the analysis examining whether the scores obtained by engineering students on their attitudes toward the profession differ significantly according to the variable of family socio-economic status.


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**Table 6.** Kruskal-Wallis Test Results Comparing Engineering Students' Attitudes Towards the Profession Based on Family Socio-Economic Status

| Scale | Socio-economic level of the family | N | Order Mean | df | | p |
|---|---|---|---|---|---|---|
| EAS | Low | 87 | 321.15 | | | |
| | Medium | 552 | 335.35 | 2 | 5.819 | .055 |
| | High | 35 | 412.06 | | | |

No statistically significant difference was found in the scores obtained by engineering students on the Attitude Towards Engineering Scale in terms of the family income level variable [$\chi^2$ (df=2, N=674) = 5.819, p > .05]. These results suggest that family socio-economic status was not significantly associated with students' attitudes toward the engineering profession.

The analysis results regarding whether there is a statistically significant difference in the scores obtained by engineering students on the Attitude Towards Engineering Scale based on the variable of the program in which they are enrolled are presented in ▶**Table 7**.

**Table 7.** Kruskal-Wallis Test Results Comparing Engineering Students' Attitudes Towards the Profession by Academic Program and University Entrance Rankings of the Departments

| Scale | Program | N | Mean rank | df | | p | UER |
|---|---|---|---|---|---|---|---|
| | CoE | 54 | 340.44 | 7 | 24.513 | .001 | 21608 |
| EAS | EEE | 88 | 333.41 | | | | 40028 |
| | IE | 122 | 290.71 | | | | 50933 |
| | ESE | 11 | 262.59 | | | | 133394 |
| | ME | 148 | 395.14 | | | | 58536 |
| | MME | 135 | 307.53 | | | | 137380 |
| | CiE | 74 | 375.07 | | | | 165647 |
| | SE | 42 | 360.20 | | | | 27795 |
| | Total | 674 | | | | | |

The analysis showed a statistically significant difference in engineering students' professional attitude scores according to academic program [$\chi^2$ (df = 7, N = 674) = 24.513, p < 0.05]. Professional attitude levels therefore varied across engineering programs. To identify the specific group differences, a Dunn–Bonferroni post-hoc test was performed. The results indicated significant differences at the p < 0.005 level between Mechanical Engineering and Industrial Engineering, and between Mechanical Engineering and Energy Systems Engineering. In both comparisons, the difference favored Mechanical Engineering students, whose professional attitude scores were higher than those of students in Industrial Engineering and Energy Systems Engineering.

The findings concerning whether professional attitude scores differed according to "the emotion most enhanced by the program" are presented in ▶**Table 8**.

**Table 8.** Kruskal-Wallis Test Results Comparing Engineering Students' Attitudes Towards the Profession Based on Emotional Variables and Departments' UER

| Scale | Emotional Variables | N | Order Mean | df | | p |
|---|---|---|---|---|---|---|
| | Curiosity | 465 | 364.85 | 5 | 97.243 | .000 |
| EAS | Hope | 77 | 354.97 | | | |
| | Love | 15 | 282.27 | | | |
| | Gratitude | 12 | 343.04 | | | |
| | Zest | 31 | 427.26 | | | |
| | None | 83 | 146.67 | | | |
| | Total | 674 | | | | |

A statistically significant difference was found in engineering students' professional attitude scores based on the emotional variable [$\chi^2$ (df = 5, N = 674) = 97.243, p < .05]. Professional attitudes differed according to the emotions fostered by the academic program. To identify the specific group differences, a Dunn–Bonferroni post-hoc test was conducted. The analysis revealed significant differences at the p < .005 level between students who reported that the program enhanced feelings of curiosity, enthusiasm, and hope and those who reported that it did not enhance any emotion. The difference favored students who experienced curiosity, enthusiasm, and hope. Students who perceived no emotional enhancement from the program demonstrated comparatively lower professional attitude scores.

Professional attitude scores were also examined in relation to departmental University Entrance Ranking (UER) based on Higher Education Entrance Examination (HEEE) results. The analysis showed no linear relationship between departmental UERs and students' professional attitude levels. Although Computer Engineering admits students with the highest entrance scores, Mechanical Engineering students obtained the highest professional attitude scores. Civil Engineering, despite having the lowest UER, ranked second in professional attitude scores. The comparison between departmental UERs and professional attitude scores is presented in ▶**Figure 1**.

### 3.3. Results Related to the Third Sub-Problem

When examining the perceptions of students enrolled in engineering programs regarding the concept of "engineering," it was observed that most students likened engineering to concepts such as life, bridge, and tree. A word cloud representing the students' associations with the concept of engineering is presented in ▶**Figure 2**.

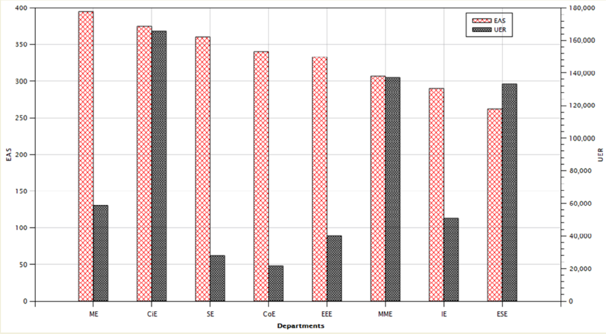



**Figure 1.** Comparison Between Students' Attitude Scores Towards the Engineering Profession and Departmental UERs in the Higher Education Entrance Exam (HEEE)

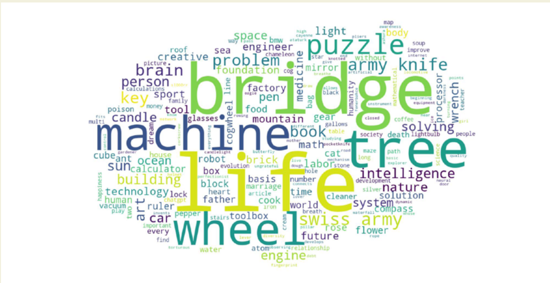
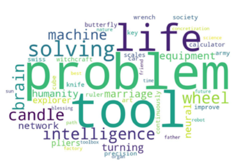
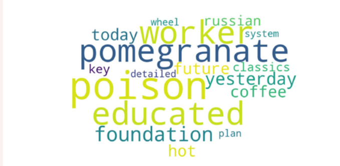
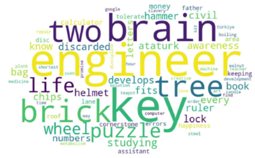



**Figure 2.** Word Cloud of Metaphors Produced by Students Related to the Concept of "Engineering"

## 3.4. Results Regarding the Fourth Sub-Problem

To determine whether the metaphors produced by students regarding the concept of "engineering" differ according to program, grade level, gender, and socio-economic status variables, detailed word clouds created by students for these variables are presented below.

**Table 9.** Distribution of Word Clouds of Students' Metaphors Related to the Concept of "Engineering" by Program Variable

| | |
|---|---|
| Word Cloud of Metaphors Produced by Students Studying Computer Engineering |  |
| Word Cloud of Metaphors Produced by Students Studying Electric-Electronic Engineering |  |
| Word Cloud of Metaphors Produced by Students Studying Industrial Engineering |  |
| Word Cloud of Metaphors Produced by Students Studying Energy Systems Engineering |  |
| Word Cloud of Metaphors Produced by Students Studying Civil Engineering |  |
| Word Cloud of Metaphors Produced by Students Studying Mechanical Engineering |  |
| Word Cloud of Metaphors Produced by Students Studying Metallurgical and Materials Engineering |  |
| Word Cloud of Metaphors Produced by Students Studying Software Engineering |  |

When ▶**Table 9** is examined, it is observed that students' perceptions of the concept of "engineering" differ according to their enrolled program in some cases. It is seen that students from mechanical, metallurgy and materials, and software engineering programs tend to produce more similar metaphors. Students studying in these programs mostly compare the engineering profession to the concepts of a bridge and a tree. Accordingly, sample quotes from students enrolled in the mechanical, metallurgy and materials, and software engineering programs are presented.

*E16: "Engineering is like a bridge because it presents complex science in a simple way for humanity to easily use and serves humanity."*

*E679: "Engineering is like a tree because if you give it water, you get its fruit."*

*E51: "Engineering is like a tree because if you don't care for the tree, it withers and you cannot eat its fruit."*

*E79: "Engineering is like a bridge because it carries humanity from one point to another."*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*E175: "Engineering is like a bridge because it solves complex problems and creates connections between people and solutions."*

*E177: "Engineering is like a tree because it branches out."*

When examining the other metaphors in ▶**Table 9**, it was observed that most students in the energy systems engineering program associated the concept of engineering with poison, laborious work, and pomegranate. Most students studying computer engineering likened the concept of engineering to problems and candles, while the majority of students in electrical-electronics engineering compared it to the sea and humans. Some of the students' explanations regarding why they associate engineering with these concepts are presented below.

*E35: "Engineering is like poison. Because if you use it correctly, it is beneficial; if you don't, it is harmful."*

*E205: "Engineering is like manual labor. Because the only difference between us and a laborer is that we have a certificate."*

*E204: "Engineering is like a pomegranate. Because it is laborious, but the result is beautiful. You do the hard work, but others also benefit."*

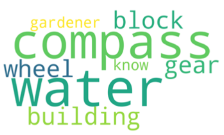
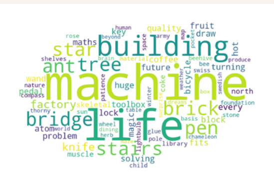
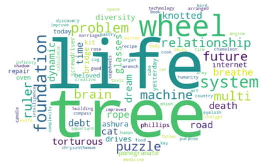
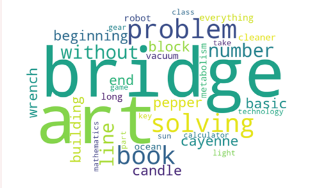
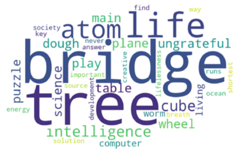
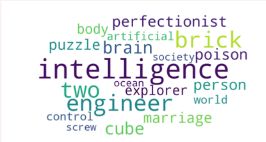
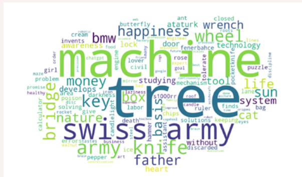
*E13: "Engineering is like a problem. Because the best problem solvers are engineers."*

*E622: "Engineering is like a candle. Because it enlightens everyone."*

*E59: "Engineering is like a human. Because without it, nothing would exist."*

*E444: "Engineering is like the sea. Because it has infinite content."*

**Table 10.** Distribution of Word Clouds of Students' Metaphors Related to the Concept of "Engineering" by Class Level and Gender Variables

| | |
|---|---|
| Word Cloud of Metaphors Produced by Female Students Studying in the Preparatory Class |  |
| Word Cloud of Metaphors Produced by Female Students Studying in the First Class |  |
| Word Cloud of Metaphors Produced by Female Students Studying in the Second Class |  |
| Word Cloud of Metaphors Produced by Female Students Studying in the Third Class |  |
| Word Cloud of Metaphors Produced by Female Students Studying in the Fourth Class |  |
| Word Cloud of Metaphors Produced by Male Students Studying in the Preparatory Class |  |
| Word Cloud of Metaphors Produced by Male Students Studying in the First Class |  |
| Word Cloud of Metaphors Produced by Male Students Studying in the Second Class |  |
| Word Cloud of Metaphors Produced by Male Students Studying in the Third Class |  |
| Word Cloud of Metaphors Produced by Male Students Studying in the Fourth Class |  |

According to ▶**Table 10**, when the metaphors produced by female and male students are examined based on class level, it is generally observed that they produce positive metaphors. A notable finding in these metaphors is that as the class level increases, female students include negative metaphors such as "pepper" and "ungrateful," while male students produce metaphors such as "laborer," "black hole," and "gallows." Direct quotes from students regarding these negative metaphors are also provided.

*E38: "Engineering is like hot pepper. When you eat it, it burns."*

> *E78: "Engineering is an ungrateful field. Because no matter how much you work, you cannot get the result you want."*

> *E52: "Engineering is like being a laborer work. Because they make you do everything."*

> *E323: "Engineering is like laborer work. Knowing math and physics, it's nothing more than laboring."*

> *E327: "Engineering is like a gallows. Because the more you struggle, the more you die."*

> *E442: "Engineering is like a black hole. Because you can't get out of it."*

When examining the word clouds according to the gender variable, it is observed that both female and male students produced common metaphors such as life, bridge, tree, gear, cogwheel, and water. On the other hand, it was also found that female and male students produced different metaphors such as compass, brain, flower, and gardener. Some excerpts related to these metaphors are presented below.

> *E20: "Engineering is like a compass because it always moves forward and develops."*

> *E39: "Engineering is like a gardener because just as a gardener plants seeds, carefully nurtures them, and ensures they grow under the right conditions, an engineer takes ideas, shapes designs, and brings them to reality. Both use patience, knowledge, and skill to shape the world, but most importantly, they guide the process with the care and attention needed to bring something to life."*

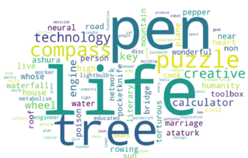
> *E142: "Engineering is like a flower because it withers if you don't pay attention."*

> *E241: "Engineering is like a flower because it thrives when cared for."*

> *E331: "Engineering is like the brain because it manages everything."*

**Table 11.** Distribution of Word Clouds of Students' Metaphors Related to the Concept of "Engineering" by Socio-Economic Status Variable

Word Cloud of Metaphors Produced by Students from Low Socio-Economic Backgrounds




Word Cloud of Metaphors Produced by Students from Medium Socio-Economic Backgrounds


Word Cloud of Metaphors Produced by Students from High Socio-Economic Backgrounds


When examining the word clouds in **▶Table 11** according to the family's socio-economic status, it is observed that metaphors such as pen, life, compass, bridge, water, candle, and human stand out among the metaphors produced by the students. While the life metaphor is similarly prominent among students with low and medium income, the metaphors produced by students with high income show some variation. Some quotes related to these metaphors are presented below.

> *E272: "Engineering is like a pen because it takes shape according to the hands that use it."*

> *E377: "Engineering is like a compass because it guides us toward the future and technology."*

> *E49: "Engineering is like a compass because it acts as a connection point between two endpoints."*

> *E143: "Engineering is like a compass because it unites ideas and people, helping us overcome obstacles and progress."*

> *E126: "Engineering is like an eagle because it applies necessary solutions within a logical framework to problems."*

> *E282: "Engineering is like a human because it adapts to the system and develops."*

> *E660: "Engineering is like a candle because it illuminates everyone."*

## 4. Results and Discussion

This study examined engineering students' attitudes toward the profession and their perceptions of engineering, according to various variables. The results of the research showed that, overall, engineering students' attitudes toward the profession were above a moderate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level. Rather than indicating a highly positive orientation, this result suggests that students generally hold moderately favorable attitudes toward the engineering profession. This finding indicates that engineering education can foster a positive professional orientation in students. In other words, it shows that students are comfortable with and enjoy their chosen fields of study. The results of this study align with the findings of Korkmaz, Kösterelioğlu, and Kara (2015). These researchers stated that students receiving engineering education have positive professional attitudes, which is an effective outcome of the educational process.

Gender, class level, and family socio-economic status did not have a significant effect on students' attitudes toward the engineering profession. These findings indicate that professional attitudes do not significantly vary across these demographic variables within the present sample. This result suggests that students' professional attitudes may be independent of individual development and environmental influences. Based on this explanation, it can be said that engineering education creates similar experiences and perceptions regardless of gender. Similarly, the lack of significant differences based on class level and family socio-economic status indicates that students do not experience a marked change in their professional attitudes over time. This finding aligns with the results of Besterfield-Sacre, Moreno, Shuman, and Atman (2001). These researchers noted that gender-related differences in engineering students' professional attitudes are gradually diminishing, which may be related to transformations in societal gender roles.

A notable finding in the study is the significant difference in students' attitudes based on the type of program. Post-hoc analyses demonstrated that mechanical engineering students reported significantly higher attitude scores compared to students in industrial engineering and energy systems engineering. This difference may be associated with variations in curriculum structure, intensity of applied coursework, and perceived employment opportunities across programs.

When compared with the university base scores of the departments, this difference in attitude scale among the departments gains further significance and takes a form that warrants deeper examination. It was observed that mechanical engineering students have higher professional attitudes compared to students in industrial and energy systems engineering. This difference may be related to the practical training opportunities and perceived value of the departments in the job market (Felder, Felder, & Dietz, 2002). The practical aspect of the mechanical engineering program may reflect its positive effect on enhancing students' professional motivation (Ginevicius, Korsakiene, Tvaronaviciene, 2005). Indeed, it is well known that problem-based learning processes in applied engineering fields positively influence student attitudes (Prince & Felder, 2006). Additionally, factors such as the program content, the intensity of applied courses, and post-graduation employment expectations can also be considered influential in producing this outcome. The significant difference observed according to the students' emotional variables particularly indicates that groups with higher levels of curiosity, enthusiasm, and hope exhibit stronger professional attitudes. This finding suggests that affective engagement may play a meaningful role in shaping professional attitudes. This finding supports studies highlighting the enhancing effect of emotions on professional orientation and motivation (Baylor et al., 2005). The finding that students' professional attitudes are at a positive level and are associated with emotional factors such as curiosity, enthusiasm, and hope also aligns with research on the development of engineering students' self-efficacy. Although Mechanical Engineering admits students with the 5th highest UER among 8 departments, it achieves the highest score on the professional attitude scale. Conversely, Civil Engineering, despite admitting students with the lowest UER among the eight departments, attains the second highest score on the professional attitude scale.

This finding indicates that engineering perceptions are not directly related to the university entrance exam scores. Furthermore, the study by Berthold and Ruch (2014) highlights the significant role of curiosity, zest, love, gratitude, and hope in the development of human character and life satisfaction. In this study, students reported that their engineering education fostered the growth of these emotional qualities. This finding can be interpreted as evidence that engineering education positively contributes to character development and the enhancement of life enjoyment. Therefore, this finding aligns with contemporary psychological approaches that emphasize the importance of affective gains in creating a happy life (Berthold, 2015). Based on these explanations, it can be argued that emotional factors should not be overlooked within the context of engineering education. Encouraging emotions such as curiosity, hope, and enthusiasm during the educational process may positively influence students' professional identity development (Fredricks, Blumenfeld, & Paris, 2004; Pekrun et al., 2017).

Within the qualitative findings of the study, metaphors related to the perception of engineering provide important insights into how students make sense of their profession. When the quantitative and qualitative findings are considered together, a coherent pattern emerges. While statistical analyses showed that professional attitudes differed significantly according to program type and emotional variables, the metaphors produced by students supported these findings by reflecting stronger professional identification in certain programs and among students expressing curiosity, hope, and enthusiasm. Conversely, the emergence of negative metaphors among upper-level students provides contextual insight into the emotional fluctuations observed during later stages of engineering education. These integrated findings suggest that professional attitudes are shaped not only by structural variables but also by students' effective and experiential engagement with their programs. Examination of the qualitative data reveals that most students produced positive metaphors about the concept of "engineering," likening it to concepts such as life, bridge, and tree. The study demonstrated that the engineering profession is internalized by students with varying meanings. While engineering was represented with positive metaphors such as bridge, tree, life, compass, some upper-level students also expressed it through negative metaphors like ungratefulness, black hole, and executioner's scaffold. The emergence of more critical metaphors among upper-level students may suggest that students' emotional and cognitive perceptions of engineering differ across class levels and individual experiences. Similarly, Cruz et al. (2016) emphasize that students' perceptions of engineering tend to become more critical and realistic as their education progresses.

When examining the findings according to the type of program, it was observed that various metaphors were produced. For example, students in mechanical and metallurgical/materials engineering generated constructive metaphors such as "bridge," whereas students in computer or energy systems engineering used metaphors like "candle," "poison," and "manual labor." This suggests that the difficulty level of the programs and the practical content of the education influence professional perception. Although similar metaphors emerged across income levels, students from higher socio-economic backgrounds tended to perceive engineering through more abstract and functional metaphors. This indicates a possible relationship between individuals' socio-cultural capital and their perceptions of engineering (Mohammadi-Aragh, Kajfez, Clark, Sassi, 2025).

In conclusion, this study revealed that engineering students generally exhibit moderately positive professional attitudes. However, these attitudes vary according to program type and emotional factors. The results provide guidance for revising engineering education programs in terms of content and methodology, enhancing students' positive attitudes toward the profession, and better preparing them for post-graduation employment processes. Given that students in programs with stronger applied components demonstrated higher professional attitude scores, and that emotional engagement was found to be significantly associated with attitude levels, reinforcing practical training, mentorship, and industry collaboration may contribute to sustaining and enhancing professional attitudes. Considering the variation in attitudes across program types, mentorship and project-based support aimed at increasing motivation should be developed especially in engineering fields perceived as disadvantaged (e.g., energy systems engineering). Negative metaphors emerging in the later stages of education (such as pepper, gallows, black hole) are interpreted as indicators of students' decreasing tolerance toward the challenges encountered in the final phases of their studies. Therefore, it is recommended to develop psychological resilience and professional satisfaction support programs specifically targeting upperclassmen. Future research should focus more deeply on the psychological and pedagogical factors influencing engineering attitudes and conduct longitudinal studies supported by qualitative methods.

## Declarations

### Conference Presentation

The study results were presented as a proceedings paper at the 11th International Symposium on Intelligent Technologies in Engineering and Science (ISITES 2025), held in Diyarbakır, Türkiye, on May 16–17, 2025.

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### Ethical Approval

This study was evaluated by the Ethics Committee of AYBU in the meeting dated October 25, 2024, and was deemed ethically appropriate with the decision number 04/13.

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### Author Contributions

All authors contributed equally to the conception, design, data collection, analysis, writing, and revision of the manuscript.

### Data Availability Statement


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The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this article.

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