A Cross-Sectional Study of Undergraduate Engineering Identity

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ABSTRACT
This paper explores the differences in engineering identity among students of the electrical engineering education department, based on the chosen study program and based on the length of study that has been taken. The focus of this work is subject-related role identities, or how students position themselves and are positioned by others as the kind of people that engage in engineering. Data was collected from students of the electrical engineering study program and electrical engineering education study program during the 2022/2023 academic year. Survey items were taken from previously developed instruments which includes recognition, interest, and performance/competence. The results showed that there was no significant difference between the engineering identities of electrical engineering students and electrical engineering education students and between the engineering identities of second- and third-year students.

Keywords: *Engineering identity, Engineering education.*

1. INTRODUCTION

For educational and professional outcomes that are crucial in engineering education, identity is a key indicator. In this piece, identity is described as a person's perception of oneself as well as how one is perceived by others. In the context of engineering and how undergraduate students become engineers, these two tensions are crucial.

In order to increase student recruitment, retention, and persistence in the engineering profession, identity has gained attention [1-3]. The idea is that students who have more of an engineering identity are more likely to stick with it. Identity is dynamic, multifaceted, and complex. A variety of theoretical frameworks have been used to study it in engineering and STEM [4-6].

Engineering identity is important for undergraduate students' academic motivation and program perseverance, according to recent studies of engineering undergraduate students [7,8]. Understanding engineering identity development in graduate engineering students can be based on the more in-depth research on the subject among undergraduate engineering students.

An earlier analysis of student engineering identities revealed that academics had modified the growth of math and science identities to comprehend the disciplinary traits of engineering identities [9]. Further research into science identities revealed that they can be explained by elements related to performance or competence, recognition, and interest, all of which were associated with career choice and persistence in STEM disciplines [10-12]. These three academic (as opposed to professional) characteristics have been modified by engineering education researchers to create engineering identity measures for students [3, 9, 12].

The performance/competence factor is the notion held by students that they can successfully complete engineering activities in engineering courses and comprehend engineering ideas and materials in their programs. The interest component takes into account students' motives for pursuing engineering jobs as part of their engineering interests, as well as their desire to understand more engineering concepts and to develop and participate in engineering activities. Being acknowledged as an engineer by others, such as engineering instructors, friends, and family, is referred to as the recognition factor.

To complete their major, graduate with a degree in engineering, and start a career in the profession, undergraduate engineering students must have a moderate to strong sense of engineering identity. Three essential elements that make up an engineering identity are interest in engineering-related subjects, self-perception as being competent at "doing" engineering, and empowerment by oneself and others to identify as an engineer [13].

2. METHODOLOGY

This study was cross-sectional; it aimed to measure engineering identity in engineering by comparing identity and the measured factors that comprise it between engineering students at different stages in their college careers (second- and third-year). In their cross-sectional study of undergraduate engineers, Godwin and Lee [14] demonstrated that similar identity measures can be used for undergraduate students across all levels.

2.1. Participants

Participants in this study were second- and third-year students of the electrical engineering (EE) and electrical engineering education (EEE) study programs at the Indonesian University of Education (UPI).

2.2. Survey Development and Data Collection

The engineering identity survey developed by Godwin [12] was administered electronically to engineering students during the 2022-2023 academic year. This 11-item Likert scale survey, which measures the interest (3 items), performance/competence (5 items), and recognition (by others) (3 items) dimensions of engineering identity, has been validated in a later study [14] as well. A total of 172 students took part in this survey, consisting of 82 electrical engineering students (EE) and 90 electrical engineering education students (EEE).

The overall measures of identity asked students to respond on an anchored scale from 1 (strongly disagree) to 5 (strongly agree) for each question.

2.3. Data Analysis

The primary analysis for these data sets relied on student t-tests, which were performed in two groups: third-year EEE versus second-year EEE responses and third-year EEE versus third-year EE responses. F-tests were run to determine the appropriate t-test to use because the variance in the comparison groups could have been equal or unequal. For all of the t-tests conducted, the difference in means was considered significant if the p-value was below 0.01.

3. RESULTS

The total number of participants in the study (n = 172) and the number of second- and third-year electrical engineering and electrical engineering students are listed in Table 1 for simplicity and reference.

Table 1. Participant (n = 172) in the study broken down by category

	Electrical Engineering Education (EEE)	Electrical Engineering (EE)	Total
Second-Year	40	36	76
Third-Year	50	46	96
Total by Year	90	82	172

Table 2 shows the mean response to each factor and the difference in means between second- and third-year electrical engineering education students. The p-value is listed in the final column, along with an indicator if a significant difference was found. None of the factors showed a significant difference between second- and third-year EEE students. However, in almost all factors (recognition, interest, and performance/competence), 3rd year students tend to have higher scores than 2nd year students, especially in recognition and interest.

Table 3 shows the mean response to each factor and the difference in means between electrical engineering (EE) and electrical engineering education (EEE) students in 3-rd year. As in Table 2, there is no significant difference between the 3rd year students of electrical engineering and electrical engineering education in terms of engineering identity.

Qualitative Responses

Student responses to the two open-ended items "What efforts are currently being made to increase knowledge and skills in the field of electrical engineering?" and "Outside of lectures, are you currently doing activities related to electrical engineering?" provide additional insight to interpret the quantitative findings.

Table 2. T-tests on second- and third-year electrical engineering education students (no significant differences were found)

Construct	Question	Statement	EEE (2nd-year)	EEE (3rd-year)	Difference	p-value
Recognition	QR_1	My parents see me as an engineer.	3.84	3.90	-0.06	0.820921
	QR_2	My instructors see me as an engineer.	3.36	3.65	-0.29	0.223239
	QR_3	My peers see me as an engineer.	3.56	4.00	-0.44	0.021177
Interest	QI_1	I am interested in learning more about engineering.	4.00	4.50	-0.50	0.016023
	QI_2	I enjoy learning engineering.	3.84	4.25	-0.41	0.080753
	QI_3	I find fulfillment in doing engineering.	3.96	4.15	-0.19	0.415463
Performance/ Competence	QP_1	I am confident that I can understand engineering in class.	3.96	4.05	-0.09	0.624383
	QP_2	I am confident that I can understand engineering outside of class.	3.80	3.75	0.05	0.830494
	QP_3	I can do well on exams in engineering.	3.64	3.55	0.09	0.681799
	QP_4	I understand concepts I have studied in engineering.	3.72	3.85	-0.13	0.445035
	QP_5	Others ask me for help in this subject.	3.16	3.65	-0.49	0.056691

* p-value < 0.01

Table 3. T-tests on third-year electrical engineering and electrical engineering education students (no significant differences were found)

Construct	Question	Statement	EE (3rd-year)	EEE (3rd-year)	Difference	p-value
Recognition	QR_1	My parents see me as an engineer.	4.17	3.90	0.27	0.241929
	QR_2	My instructors see me as an engineer.	3.51	3.65	-0.14	0.500612
	QR_3	My peers see me as an engineer.	3.90	4.00	-0.10	0.615493
Interest	QI_1	I am interested in learning more about engineering.	4.59	4.50	0.09	0.601393
	QI_2	I enjoy learning engineering.	4.34	4.25	0.09	0.634014
	QI_3	I find fulfillment in doing engineering.	4.37	4.15	0.22	0.272055
Performance/ Competence	QP_1	I am confident that I can understand engineering in class.	3.88	4.05	-0.17	0.405042
	QP_2	I am confident that I can understand engineering outside of class.	4.07	3.75	0.32	0.205439
	QP_3	I can do well on exams in engineering.	3.78	3.55	0.23	0.331651
	QP_4	I understand concepts I have studied in engineering.	3.88	3.85	0.03	0.879558
	QP_5	Others ask me for help in this subject.	3.59	3.65	-0.06	0.818700

* p-value < 0.01

4. DISCUSSIONS

What is quite surprising based on Table 2 in this study is that there is no statistically significant difference in the three engineering identity factors between second- and third-year students of electrical engineering education study programs. Even though their length of study is one year different. Statistically, the possible cause is because the p-value used is 0.01. However, even if a p-value of 0.05 is used, the differences are only in certain parts, and even then, the portion is small, namely in one of the items from the recognition and interest factors.

This means that in practice, there is no significant difference between the engineering identities of second- and third-year students. What students get in their third year of study does not increase their engineering identity when they are in their second year. One possibility that is the cause is a curriculum that is not quite right. This is certainly an input related to curriculum evaluation. The second possibility is that the difference in length of their studies is too close together, which is only one year. Maybe in the future it will be possible to study differences in engineering identity for differences in length of study that are more than one year or compare them with freshmen. Another thing that could be the cause is that data collection was carried out not long after the end of the COVID-19 pandemic. While in their first and second years, third-year students were in a pandemic condition, where lectures were mostly conducted online. In this situation, the effectiveness of lectures is relatively low, and what students get from the process becomes less.

The data in Table 2 is no less surprising. There was no statistically significant difference between the engineering identities of third-year electrical engineering students and electrical engineering education students. However, in terms of curriculum, the two are different. Electrical engineering students study more in the field of electrical engineering, while students in electrical engineering education study less in the electrical field because they also have to study the field of education.

As the results of the discussion are based on Table 2, there is no significant difference between the engineering identities of electrical engineering students and electrical engineering education in Table 3, which can be caused by the curriculum (for example, a curriculum that is similar or less appropriate) and also the effects of online learning during the COVID-19 pandemic. Related to the curriculum, of course, it is necessary to do analysis and evaluation.

Even though, based on the p-value, there is no significant difference between the engineering identity of electrical engineering students and electrical engineering education, when observed further, electrical engineering students tend to have a higher average engineering identity factor score. tall. On the recognition factor, the average score of electrical engineering students is 3.86, while the average score of electrical engineering education students is 3.85. For interest and performance/competence factors, electrical engineering students have scores of 4.43 and 3.84, respectively, while electrical engineering education students have scores of 4.30 and 3.77.

In the future, analyses incorporating this survey and its data will go beyond a straightforward t-test. In order to investigate the potential effects of major, year, and gender on engineering identity, we will run regression models on the available data. Additionally, the survey will be run again to allow for longitudinal research. The fact that the present data set only includes students who are currently enrolled in an engineering degree is a limitation. We will be able to follow students who drop out of engineering over time and utilize their early responses to determine whether there is any correlation between persistence in engineering, identity in math and physics, and engineering. Additional institutions will administer the survey, which will include a wider range of engineering fields.

5. CONCLUSIONS

Research on electrical engineering students and electrical engineering education students at the Indonesian University of Education showed that there was no statistically significant difference between the engineering identities of electrical engineering students and electrical engineering education students. Likewise, there is no significant difference between the engineering identities of second- and third-year students. However, judging from engineering identity factors, electrical engineering students tend to have higher scores than electrical engineering education students.

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