

”I AM an engineer!” Three Scales used in Measuring Identification of Engineering as First-Year Students

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Work in Progress: “I AM an engineer!” Two Scales used in Measuring Identification of Engineering as First-Year Students

Abstract

Changing the extent to which first-year undergraduate engineering students identify with engineering may help improve retention. Research suggests that the degree to which students identify with engineering is positively related to their decisions to continue in engineering as a major. Therefore, identity frameworks have proven useful for furthering understanding of engineering retention. However most of the studies examining engineering identity have been conducted using qualitative research methodologies. While qualitative studies provide rich insights into engineering identity, evaluating engineering identity for hundreds or thousands of first-year students requires a quantitative instrument. Therefore, a current project is the development of a quantitative tool for measuring engineering identity. It uses information from six scales to measure different aspects of engineering identity. The scales are: identification, self-assessment, engineering embeddedness, university embeddedness, satisfaction, and retention.

Since all six scales are not assessed each time the tool is administered to students, the paper will describe the two given thus far to students in the project: identification and self-efficacy. Further, it presents results responses from approximately 2,000 first-year engineering students at a large public institution. The paper addresses two questions: 1) How do engineering students respond to two scales related to identity frameworks; and 2) What has been learned by giving these two scales to first-year engineering students.

Introduction

The importance of increasing the number and diversity of B.S. graduates with degrees in science, technology, engineering, and mathematics (STEM) has been highlighted in several national reports^{1,2}. Increasing retention of students, including retention of students traditionally underrepresented in engineering is one approach to addressing this challenge because nationally, less than half of the students that enter engineering actually graduate with an engineering degree³. Multiple studies have highlighted findings with respect to retention⁴⁻⁸. Many strategies, such as improving success in mathematics courses required for engineering majors⁹ and incorporating projects in first-year engineering courses to help students understand potential opportunities for engineering contributions after graduation¹⁰, have been implemented to improve retention. Once students leave engineering, it is very unlikely that these students will return to engineering; therefore, improving student retention requires understanding factors that are predictive of retention in engineering, so that programming affecting the factors can be designed.

Research suggests that understanding engineering identity may help design retention initiatives. For example, one recent study examined patterns of value that students assign to earning an engineering degree¹² and suggested that understanding these patterns of values would be useful in improving student retention. The researchers concluded that “a primary differentiating feature of these patterns is whether or not participants choose engineering because it is consistent with

their personal identify or sense of self”¹¹. Another study illustrated the value of professional identity and the need for “students [to have] opportunities to engage with the internal frame of reference” in forming a professional identity (Eliot & Turns, 2011). A third study showed how students determined their engineering identity by learning how to recognize qualities of an engineer¹³. These studies suggest one factor that should be considered is the degree to which students identify with engineering as a major. Collectively, these studies suggest that the degree to which students identify with engineering as a major is likely to be a useful factor in working to improve engineering retention.

Background

This section describes the two scales examined in this paper.

Identification

Identification is measured with an eleven-item scale expanded from previous work described^{14,15}. The scale uses a 5-point Likert type response scale, which ranges from 1 = (*strongly disagree*) to 5 = (*strongly agree*). Preliminary research demonstrates that the scale has a unitary factor structure and that it is valid and reliable ($\alpha = .85$).

Items that form this scale are:

1. Engineering is an important part of who I am.
2. I strongly identify with engineering.
3. When I talk about people in engineering, I usually say 'we' rather than 'they'.
4. When someone praises engineering, it feels like a personal compliment.
5. I am interested in what others think of the engineering field.
6. I am excited when advancements are made in engineering.
7. I feel a personal attachment to engineering.
8. Engineering has a great deal of personal meaning for me.
9. I see engineering as a significant part of my life.
10. I spend a lot of time in casual conversations about engineering.
11. Engineering is something I care about.

Engineering Self-Efficacy

Engineering self-efficacy uses an eight-item scale used to evaluate students' beliefs about their skills and abilities. The scale uses a 7-point Likert type response scale, which ranges from 1 = (*very untrue of me*) to 7 = (*very true of me*).

Items that form this scale are:

1. I believe that I will receive excellent grades in courses required for engineering.
2. I'm certain I can understand the most difficult material presented in courses required for engineering.
3. I'm confident I can understand the basic concepts taught in courses required for engineering.
4. I'm confident I can understand the most complex material presented in courses required for engineering.

5. I'm confident I can do an excellent job on the assignments and tests in courses required for engineering.
6. I expect to do well in courses required for engineering.
7. I'm certain I can master the skills being taught in courses required for engineering.
8. Considering the difficulty of courses required for engineering and my skills, I think I will do well in these courses.

Methods

Procedure

Each entering engineering student attends a mandatory two-day student orientation held during the summer prior to starting fall classes at the institution. During this orientation, students register for their fall semester courses. In addition, students learn about university-wide resources, programs, and different engineering majors. As a part of orientation, all engineering students were offered the opportunity to take the quantitative survey via a web interface during an in-person session.

Relationships to Overall Project

Collecting engineering identity data across multiple time points allows the researchers to assess the nature and extent of change in engineering identity. This project started in summer 2016. Thus, results provided relate to the first administrations of the quantitative tool. Scales related to engineering identity and self-efficacy were a part of the first administration of the survey given to students pre-entry into the engineering curriculum. Students will provide additional input each semester in their first two years of the engineering curriculum.

Results and Discussion

Identification

Table 1 provides average responses for identification scale from the 1986 engineering students who completed the pre-entry survey during summer 2016 before they began the engineering program at the institution in the fall. The question students most agreed with was "I am excited when advancements are made in engineering" with an average of 4.5 out of five points. Students answered that they most strongly disagreed or simply disagreed with the statement, "I spend a lot of time in casual conversations about engineering." The average score for this question was the lowest with 3.2 out of five points.

Table 1. Results from identification scale from pre-entry survey.

Question	Average Value
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I am excited when advancements are made in engineering.	4.5
Engineering is something I care about.	4.2
I strongly identify with engineering.	4.1
Engineering is an important part of who I am.	4.1
I am interested in what others think of the engineering field.	4.1
I see engineering as a significant part of my life.	4.1
When someone praises engineering, it feels like a personal compliment.	3.9
I feel a personal attachment to engineering.	3.9
Engineering has a great deal of personal meaning for me.	3.8
When I talk about people in engineering, I usually say 'we' rather than 'they.'	3.6
I spend a lot of time in casual conversations about engineering.	3.2

Self-efficacy

Table 2 presents average responses for the eight self-efficacy items. The question students felt was most true of themselves was “I'm confident I can understand the basic concepts taught in courses required for engineering” with an average of 6.2 out of seven points. Students answered that the questions was very untrue or simply untrue for the statement, “I'm certain I can understand the most difficult material presented in courses required for engineering.” The average score for this question was tied for the lowest with 5.3 out of seven points. The other question, which received an average score of 5.3 out of seven points was “I'm confident I can understand the most complex material presented in courses required for engineering.”

Table 2. Results from self-efficacy scale.

Question	Average Value
I'm confident I can understand the basic concepts taught in courses required for engineering.	6.2
I expect to do well in courses required for engineering.	5.9
I'm certain I can master the skills being taught in courses required for engineering.	5.9
Considering the difficulty of courses required for engineering and my skills, I think I will do well in these courses.	5.8

I'm confident I can do an excellent job on the assignments and tests in courses required for engineering.	5.7
I believe that I will receive excellent grades in courses required for engineering.	5.7
I'm certain I can understand the most difficult material presented in courses required for engineering.	5.3
I'm confident I can understand the most complex material presented in courses required for engineering.	5.3

Conclusion

Due to the timing of the project, this paper presents results from the first administration of the quantitative tool with the two scales related to identification and self-efficacy. Related to identification, overall students answered that they mostly agreed with or felt neutral about each of the eleven statements related to identification. In particular, students strongly agreed or agreed with items related to the importance of engineering, what others think about engineering, and their excitement towards engineering. Questions with the highest numbers of neutral or disagreements related to personal meanings, personal attachment, or personal conversations about engineering. Later administration of the scales will provide information about changes in student identification as they progress through the engineering curriculum and interact with other engineering students. Related to self-efficacy, overall students answered that they felt the statements were somewhat true of them to very true of them for each of the eight statements. Again, once a student completes their first semester in engineering it will be interesting to see differences in their expectations and confidence levels.

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