Development of a Survey for Student Backgrounds Affecting Engineering Success

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Abstract - **Universities and state governments invest heavily in pre-college engineering programs, but the ability of these programs to retain students in engineering has not been widely documented. This paper will discuss the process of developing a survey to assess pre-college engineering programs' impact on students. A self-reporting system will be used by issuing this survey to students asking questions about the students' success, retention, self-efficacy, and identity. Additional information, regarding the students' backgrounds and the path they took to enroll in the Aerospace Engineering Department at Mississippi State University, will be collected. The purpose of this survey is to investigate how specific background factors affect students' retention and success in Aerospace Engineering. In the process of developing this survey, we will investigate the following: 1) Why do students choose Aerospace Engineering? 2) Are these the same reasons that students choose the Mechanical Engineering major? 3) What background factors motivate students to choose engineering? 4) Are students with certain background factors more likely to stay in engineering? and 5) How is a student's engineering identity affected by their background factors? This information will be gathered by researching literature and pilot testing versions of the developed survey. Juniors, seniors, and graduate students will be asked to complete the survey as a pilot test of the instrument. The final validation will be done with the results of surveying sophomore students. The finalized survey will be given to freshmen as a part of the Introduction to Aerospace Engineering course. The results from this survey will help in the determination of programs and events that promote retention and student success in aerospace engineering. After developing the survey tool and validating it for the Aerospace Engineering Department, the instrument will be tested on students from other engineering majors, to compare the factors of successful aerospace engineers with those of other disciplines.**

Index Terms - survey design, validation, background factors, student success, retention, self-efficacy, identity.

INTRODUCTION

The workforce demand for engineers is increasing, but student retention and graduation rates are staying constant. Only 57% of engineering undergraduates complete their degree and graduate as engineers, and every year, a higher percentage of students transfer out of engineering majors more than any other major [1]. Universities and state governments work hard to fund, organize, and recruit students into pre-college engineering programs with the expectation of creating both more engineers and better engineers, but the effectiveness of these programs to retain students in engineering and promote student success has not been widely documented [2].

This summer, we decided to develop a survey to extract information from freshmen students about which background factors have influenced their choice in selecting the Aerospace Engineering (ASE) major. The survey will be used to collect data regarding background factors that may affect student success including retention in engineering, engineering self-efficacy, academic success, and the development of students' engineering identities.

PURPOSE

The purpose of this research is to design a survey to determine which background factors affect student retention and success in ASE freshmen at Mississippi State University (MSU). This research will investigate the factors that motivate students to choose this path and the background features (e.g. engineering parents, summer programs, etc) that encourage students to create their aerospace engineering identity.

The two highest dropout rates for engineers are in their first and third semesters [1]. Thus, surveys will be given to freshmen and sophomore ASE students. To further investigate how student perception of success correlates to academic success and retention, student GPA and retention data will be gathered at the end of the semester. The data gathered from this survey will aid in the determination of programs, events, and factors that promote retention and student success in ASE.

This study can aid in the design process by familiarizing other students with the process of survey design and investigating the motivation factors in student backgrounds affecting student success. We will operationally define student success as retention in engineering, a high self-efficacy in engineering, and/or the development of an engineering identity. Retention will be assessed by the students' enrollment into the next course in the introduction series.

PREVIOUS RESEARCH ON IDENTITY, BACKGROUND FACTORS AND STUDENT SUCCESS

Pre-college courses like technology and engineering courses, as well as some hobbies, like programming, electronics, video game development, robotics, and rocketry, have been shown to increase student self-efficacy in engineering. Self-efficacy is important to engineering success, because it has repeatedly been tested as an indicator for student achievement and academic success. [3]

An engineering identity is comprised of many parts creating the system of beliefs that a person holds about themselves and their community in the past, present, and future. Identity is the set of beliefs that people have about themselves and their paths in life. [4] Ever changing, the formation of identity occurs over the course of a lifetime. [5] Formative experiences, like internships and research opportunities, have been shown to inform a student's development of identity, affecting it either positively or negatively, depending on the experience. The situated learning framework may be the best way to inculcate identity in engineering students, immersing them in the culture and community of engineering by having them develop first a belonging in the local community of their departments, then the greater communities, including the community of engineers all over the world. [6]

Engineering identity has been a difficult thing for researchers to define and measure, though several researchers have tried. Women are less likely to self-identify as "engineers"; this is likely due to the same factors that cause women to have a lower self-efficacy. The development of a student's Engineering Identity is often assessed by self-efficacy. Many researchers assume that if a student has a high self-efficacy for engineering, then they have developed their identity as an engineer. Unfortunately, identity is much more complex than just self-efficacy, just as engineering is more complex than just mathematics. [5]

Background characteristics like their parents' education level and number of high school extracurricular activities have been investigated and show no statistically significant correlation to students' retention in engineering. However, students not retained in engineering, showed lower high school science and mathematics grades and higher SAT verbal scores. [7] While some research is being done in the field of student backgrounds, there is still significant need for more research to determine why students choose to major in engineering fields [5, 8]. Specifically, there is a need for more valid and detailed measures of capturing and assessing students' reasons and motivations for choosing an engineering major [9]. This study focuses on the development of a tool for freshmen since these students will most likely have chosen their major within the last 6-12 months, and thus will be more likely to remember their reasons for their selection and subsequently be able to provide a more complete picture of their influences.

Yasar used an iterative method in his development a survey to assess K-12 teachers' perceptions of engineers and familiarity with teaching design, engineering, and technology. This process consisted of a literature search to find items for the survey and multiple field tests and revisions to come to the final survey instrument [2]. Yasar's method will be adapted for and used for the design of this survey.

HYPOTHESIS

This study is expected to show that engineering backgrounds facilitate student success and retention. We expect to find that students who have had engineering experience before entering college will easily identify themselves as engineers. We expect this study to reveal that students who have any pre-college engineering experience will be retained at a higher rate than the students who do not have an engineering background. Examples of engineering background include participating in a summer engineering program, taking advanced math, science, or engineering courses in high school, and having early exposure to engineering like having parents who are engineers.

PARTICIPANTS

The participants used for this study will be engineering education experts and ASE student volunteers. The first pilot of the study will be conducted on faculty who are a part of the Engineering Education working group on campus. ASE juniors, seniors, and graduate students will pilot test the survey, and the third test of the survey will be conducted on sophomore students in ASE. The final validated survey will be taken by ASE freshmen as a part of the Introduction to ASE course. Incentives will be provided to motivate people to participate in the pilot tests; the ASE upperclassmen, graduate, and sophomore participants will be entered into a drawing for a gift card. The freshmen and sophomore students will take the survey as a part of their course requirements. They will fill out a consent form, allowing them to opt out of the survey without adversely affecting their grades.

METHODS

First, we will investigate what, if any, background factors lead freshmen students to choose ASE. This investigation will be done primarily using articles from the Journal of Engineering Education and the International Journal of Engineering Education, but also includes factors identified in reflection of personal experience and suggestions from recent alumni and upperclassmen. Also, we will research engineering student retention and the factors that affect students' decisions to remain in engineering, or change majors. Then, we will conduct a literature survey of journal articles to identify possible survey questions. The first draft of the survey will use items from that research and may include items suggested by experts.

An important next step is to apply for institutional review board (IRB) approval. Using MSU IRB forms, we will submit information about the planned research project. At this point, it is important to think about the method of delivery for the survey. As well as developing a survey, we

will also need to create a consent form for the student participants. This will be included in the IRB application.

We will be using a three step validation process involving three groups: Engineering Education experts and faculty, ASE upperclassmen and graduate students, and ASE sophomores. We will pilot the draft survey with engineering education experts. Using the expert suggestions, a second draft of the survey will be created and pilot tested with ASE junior, senior, and graduate students. The survey will be issued both electronically and on paper to students, for a larger sample. The purpose of the multiple methods of delivery for this survey is to increase the response rate. As shown by Wilson et al., paper surveys administered in class provide a nearly 90% response rate, compared to the online-administered surveys' response rate of just 20% [10].

Content and construct validity will be tested through this series of pilot tests and reflections issued to volunteer participants of experts, graduate students, and ASE upperclassmen. After a final review with experts, a finalized survey will be created for use in August with sophomore students. This survey will be issued in paper to assure a greater sample. The data from the sophomore students will be used to validate the survey and suggest any last changes to the survey. The final changes will be made, and the instrument will be delivered on paper to freshmen ASE students in the Introduction to Aerospace class. A finalized validation method will be designed, and ready for testing in August.

Data Analysis

Finally, we will analyze the data to determine common themes among the students. At the end of the semester, we will receive their grade information for the ASE courses, and in January, we will receive the new roster of students and see which students were retained. We will compile this data with the student's survey response data to re-analyze and determine which background factors lead to successful ASE students.

We will take the data received from these surveys and perform specific tests for data analysis. First, we will eliminate incomplete surveys from the data set, so as to ensure that all the data can be fully tested. Then, the pilot surveys will be tested using factor analysis to ensure that the questions in the survey are relevant factors. A t-test will be used to test for statistical significance of each background factor using a statistical analysis program. For reliability testing, the results will be analyzed, and Cronbach's alpha will be computed for each factor to test the internal consistency of the responses. Factors with less than a score of 0.70 will be removed from the data set. Statistical analysis programs like SPSS will be used to do the factor analysis and a chi squared test.

Current Progress and Future Steps

This paper and research are works in progress. It is too early to draw any decisive conclusions at this time. Having completed the background research for the survey items, we are currently researching methods for data validation and testing instrument reliability. We have developed a preliminary survey which will be released for pilot testing by mid-July. The first round of pilot testing will conclude in early August and revisions will be made. The second round of testing will occur in mid-August. The data from both pilots will provide the basis for initial reliability and validity testing.

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