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Factors Influencing the Self-Efficacy Beliefs of First-Year Engineering Students

Extensive studies link undergraduates' interests, performance, and retention in science, technology, engineering, and mathematics (STEM) fields to their self-efficacy beliefs, i.e. beliefs about one's capabilities to produce specific effects or perform certain tasks [1]. Moreover, gender differences in self-efficacy have been hypothesized to play a major role in the relatively high attrition of women from engineering curricula. Because self-efficacy beliefs correlate with motivation, performance, retention, and professional success, agencies and foundations have sponsored the development of interventions designed to promote women's self-efficacy in engineering. However, research has not sought to understand how self-efficacy beliefs are formed and how different aspects of the learning environment influence these beliefs. Promoting positive self-efficacy expectations among students requires identifying how students arrive at their self-efficacy beliefs. Using methodology that focuses on personal meanings, as qualitative approaches do, is particularly important for addressing questions such as why male engineering students appear to have higher efficacy expectations than do female engineering students.

In this paper we sought to answer the questions: What factors influence students' self-efficacy beliefs in their first engineering course, and how do these influences vary by gender? To capture the different ways students might perceive their experiences in their first engineering course, we used phenomenography as our theoretical framework. Phenomenography seeks to understand the different ways that people experience or perceive a particular phenomenon (in this case the different ways engineering students perceive their first engineering course). We surveyed all first-year engineering students enrolled in Engr 106, Engineering Problem-Solving and Computer Tools, at Purdue University. An open-ended question prompted students to list factors affecting their confidence in their ability to succeed in the course. Then students were asked to rank the items on their list from most influential to least influential. The survey was given as part of an online homework assignment midway through the semester, i.e. late enough into the semester that the students already had some experience with the course but early enough that final course grades were not determined. Students were informed that their survey responses were completely confidential and would not be linked to their individual identities.

With such a large class (1387 survey responses), smaller sample populations were selected for analysis. The student population was stratified by gender and each stratum randomly sampled. (Purposeful sampling ensured that the sample populations accurately represented the ethnic diversity of the overall population.) Factors that students cited as influencing their self-efficacy were categorized and coded, as were the rankings students assigned to each factor. Nine categories emerged from the classification of the factors affecting students' responses to the statement: "I am confident I can succeed in Engr 106." These categories, each cited by at least 20% of male or female students, included understanding or learning (e.g. “I understand what we talk about in lecture”), drive and motivation (“If I want to be an engineer I am going to be an engineer, I am not going to give up my goals”), teaming (“Using my teaming skills and being able to work together as a team…”), computing abilities (“I can apply the MATLAB tools to actual situations and problems”), help (“I have excellent help and resources to go to if in fact I find myself struggling to succeed”), working assignments (“I can usually finish the homework assignments, even though it takes me a long time to understand them”), problem-solving abilities (“I am a good problem-solver”), enjoyment interest and satisfaction (“Solving the problems in the labs and in the homework is challenging but interesting”), and grades (“The fact that so far, I have an A”). Of these, both male and female students ranked drive and motivation, understanding, and computing abilities as most influencing their efficacy beliefs. There was little gender variation in the results – statistically significant differences were only observed for the percentages of students citing “understanding” and “help” as factors influencing their ability to succeed in the course.

With the possible exception of “drive and motivation”, these categories support Bandura’s theorized sources from which efficacy beliefs are developed. However, the results warrant further investigation and raise additional questions. For example, how do students define the construct of course efficacy? (What does it mean to succeed in a course? What sub-tasks are required to achieve the criterial task of succeeding?) Which sub-tasks most influence beliefs critical for persistence and achievement? Moreover, what do students mean by the factors they cited as affecting their course efficacy? While male and female students report similar factors, they may be envisioning different phenomena. How do students interpret their experiences and the learning environment when forming their efficacy beliefs? For example, what aspects of help promote efficacy – the mastery experience of knowing when one needs it, how to get it, or how to apply it; the social influence provided when receiving help; the vicarious experience of having a classmate provide help; or the comfort of knowing one is not alone (i.e. help is available)? To answer such questions, we are conducting interviews with first-year engineering students. We are also collecting student persistence and retention data so that we may better quantify the relationship between student efficacy and success.

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