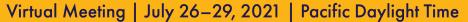# Effects of High Impact Educational Practices on Engineering and Computer Science Student Participation, Persistence, and Success at Land Grant Universities

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Professor Emeritus Candis Claiborn has been at Washington State University since 1991. In 2016, she returned to faculty after serving for 10 years as Dean of the Voiland College of Engineering and Architecture at WSU. Prior to that, she served as interim dean and as associate dean for research and graduate programs. Dr. Claiborn received her PhD in chemical engineering from North Carolina State University in 1991. Her research interests are in atmospheric aerosols, air pollution, and atmosphere-biosphere interactions.

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Effects of High Impact Engagement Practices at Land Grant Universities on Engineering Student Participation, Persistence, and Success

Introduction

Despite efforts to attract and retain more students in engineering and computer science — particularly women and students from underrepresented groups — diversity within these educational programs and the technical workforce remains stubbornly low. Research shows that undergraduate retention, persistence, and success in college is affected by several factors, including sense of belonging, task value, positive student-faculty interactions, school connectedness, and student engagement [1], [2]. Kuh [1] found that improvement in persistence, performance, and graduation for students in college were correlated to students' level of participation in particular activities known as high impact educational practices (HIEP). HIEP include, among others, culminating experiences, learning communities, service learning, study abroad, and undergraduate research; Kuh [1] concluded that these activities may be effective at promoting overall student success. Kuh [1] and others [3] further hypothesized that participation in HIEP may especially benefit students from non-majority groups.

Whether and how engineering and computer science students benefit from participating in HIEP and whether students from non-majority groups have access to HIEP activities, however, remain as questions to investigate. In this project, we examine engineering and computer science student participation in HIEP at two public land grant institutions. In this study, we seek to understand how and why students participate in HIEP and how participation affects their persistence and success in engineering and computer science majors. Set within the rural, public land grant university context, this study conceptualizes diversity in a broad sense and includes women, members of underrepresented racial and ethnic groups, first generation college students, adult learners, and nontraditional student as groups contributing to the diversity of academic programs and the technical workforce.

Purpose

The purpose of this project is to develop and disseminate evidence-based recommendations for implementing HIEP at rural, land-grant universities, with the long-term goal of broadening the effects of such participation among women and underrepresented group members in engineering and computer science degree programs. This project was initiated in September of 2019 and is still in progress.

Literature Review

Student engagement has often been linked with desirable student outcomes such as perseverance, academic performance, satisfaction, retention, and graduation rate [4], [5], [6]. Engagement refers to the quality and quantity of effort that students put into activities that are aimed at certain educational outcomes, and it includes both academic and non-academic aspects of a student's learning experiences [7]. As such, engagement, as measured by student participation in various activities, encompasses not only engagement in academic activities, but also social and extracurricular activities [8].

Lack of meaningful student engagement leads to poorly prepared graduates and engineering or computer science degree program dropouts, and these in turn limit the US's capacity to meet future demands for engineers and computer scientists. It has been reported that nearly half of students who declare a science, technology, math or engineering (STEM)-related major leave STEM fields before or during their second year [9]. For underrepresented groups (URG), including ethnic minorities and women, attrition rates in engineering remain at 57% [9] despite investments in student retention research and translation of findings.

High impact practices that promote student engagement among undergraduate students across the country in all disciplines have been examined [1]. Such high impact practices included first-year seminars, learning communities, writing-intensive courses, collaborative projects and assignments, service learning, internships, capstone courses and projects, and undergraduate research. This work examines the role of HIEP on student outcomes specifically in engineering and computer science programs at two western, rural, land-grant universities.

This study will address the following research questions:

1. To what extent do engineering and computer science (E/CS) students at two rural, land-grant universities participate in HIEP?

2. What factors (e.g., personal, social, institutional, financial) affect E/CS student participation in HIEP at these two institutions?

3. How do those factors influence E/CS student awareness, interest, and participation in HIEP at both universities?

Research Design

The two participating universities are Washington State University and Utah State University. Both of these universities are land-grant institutions, and both are situated in rural, western communities. Land-grant institutions have a fundamental mission to provide all Americans, regardless of race, ethnicity, or social class, opportunities for social mobility via practical education in agricultural, engineering, science, and technology fields [10].

Our approach is to employ a two-phase, explanatory, sequential, mixed methods research design [11]. Contextualized data will illuminate how constraints to participation in HIEP are experienced by women and URG members and allow for recommendations on how universities can help students overcome these constraints.

This ongoing research is being conducted in two phases. In Phase I, which is the quantitative data collection phase, we establish a baseline to describe how E/CS students participate in HIEP at these two institutions. After an examination of survey results collected by NSSE for both universities, we develop a survey instrument that was deployed at both universities in their E/CS programs. In that survey, we investigate student awareness, attitudes,

and level of interest in HIEP, as well as students' ability to participate. Some of the early results from Phase I are being presented elsewhere in this conference [12] [13] [14].

In Phase 2 (the qualitative data collection phase), we are now examining the factors that affect students' interest and ability to participate in HIEP, following up on the results from the surveys by conducting focus group interviews to understand why students opt in or out of HIEP. The focus group interviews are ongoing.

Phase 1: Quantitative Methods

We began with an examination of existing NSSE survey data specifically for E/CS students at our respective universities. We worked with the IR offices at both institutions to ensure that all data were anonymized and only aggregate information was gathered. In the case of very small student subsets, aggregated data must have a minimum number of 3 to preserve anonymized data, and IRB approval preceded any requests for access to NSSE data.

After an examination of the NSSE survey data, we developed a survey to be deployed at both schools. Our goal was to collect 1000 responses from both universities. The web-based survey was hosted at one on its secure server. E/CS students at both universities received multiple reminders, spaced at approximately two-week intervals beginning at the end of April 2020 and ending in late June 2020, to complete the online survey. We received 683 responses between the two universities.

Survey data are being analyzed using inferential statistical techniques to examine relationships among variables across samples. These include two sample t tests and one-way ANOVA, chi square analysis, and factor analyses. We will also use advanced modeling statistics (such as latent profile analysis [15]) to identify profiles or characteristics of students that could benefit the most from participating in HIEP.

Phase 2: Qualitative Methods

Focus group interviews will be conducted at each site. Each focus group will consist of a small group of participants (e.g., 6-10 students) that have similar backgrounds; i.e., students that have comparable educational experiences. Students for the focus group interviews will be recruited from the online surveys conducted in Phase 1, and monetary incentives will be offered to participants. Data from the focus groups will be both audio and video recorded, transcribed, and analyzed using modified constant comparative analytic methods [16] [17] [18].

The results from both the quantitative and qualitative data will be analyzed separately, and then combined to identify the most critical aspects of participation in HIEP and develop recommendations for implementing HIEP programs at land-grant universities.

Limitations

We note at least two limitations in this study. First, the two universities are both located in small, western, rural communities with comparatively low ethnic minority representation.

Despite that limitation, our survey responses were reasonably well represented by women, Asian, Hispanic and Latinx, multi-racial, first generation, and nontraditional undergraduates. Overall, the combined population of engineering and computer science students that responded to our survey were 81% white and 34% female. These demographics are discussed in more detail in a companion paper [14]. Second, data collection has been taking place during the COVID-19 pandemic, during which both universities have had extended periods of remote learning, and students were not encouraged to return to campus. There is a good possibility that participation in our study was reduced because of this. Students were not asked about the impact of the pandemic-related limitations on their participation in HIEP. The focus groups interviews will also not be conducted in person, and it is possible that the participation rates in these will be reduced as well. Despite these limitations, we feel we received an adequate response rate to the survey and have successfully conducted three focus group discussions to date.

This work will lead to the following:

1. This project will provide information on the relationship between participation in HIEP and student persistence and success.
2. We will develop a better understanding of this relationship especially as it pertains to nontraditional students, women, and members of underrepresented groups.
3. We will develop evidence-based recommendations for how to make HIEP more accessible to all E/CS students.
4. Recommendations will be provided on which HIEP are most effective, how much participation should be encouraged, and interventions for removing potential barriers to participation.

Acknowledgments

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