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Insights Gathered from the National Survey of Student Engagement (NSSE) About Engineering/Computer Science Participation in High-impact Educational Practices at Two Western Land-grant Institutions

Mr. Ebenezer Rotimi Ewumi, Washington State University

Ebenezer Ewumi is a Computer Engineering master student at Washington State University. His research is in engineering education and software engineering techniques. His recent research focuses on the effect of high impact practices on engineering and computer science undergraduate student outcomes around academic success and persistence.

Dr. Olusola Adesope, Washington State University

Dr. Olusola O. Adesope is a Professor of Educational Psychology and a Boeing Distinguished Professor of STEM Education at Washington State University, Pullman. His research is at the intersection of educational psychology, learning sciences, and instructional design and technology. His recent research focuses on the cognitive and pedagogical underpinnings of learning with computer-based multimedia resources; knowledge representation through interactive concept maps; meta-analysis of empirical research, and investigation of instructional principles and assessments in STEM. He is currently a Senior Associate Editor of the Journal of Engineering Education.

Dr. Candis S. Claiborn, Washington State University

Dr. 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.

Dr. Angela Minichiello P.E., Utah State University

Angela Minichiello is an assistant professor in the Department of Engineering Education at Utah State University (USU) and a registered professional mechanical engineer. Her research examines issues of access, diversity, and inclusivity in engineering education. In particular, she is interested in engineering professional formation, problem-solving, and the intersections of online learning and alternative pathways for adult, nontraditional, and veteran undergraduates in engineering.

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Work-In-Progress (WIP): Insights Gathered from the National Survey of Student Engagement (NSSE) about Engineering/Computer Science Participation in High Impact Educational Practices at Two Western Land-grant Institutions

Abstract

Student engagement, especially among Engineering and Computer science majors (E/CS), has been extensively studied over the past decades. Although considerable efforts have been made to improve college students' engagement and interest, underrepresented minority groups and first-generation students are still at risk of dropping out of E/CS majors due to lack of inclusiveness, motivation, and other related factors. According to [7], student participation in High-Impact Educational Practices (HIEP) is correlated with several student outcomes such as persistence, performance, achievement, and intent to complete their current major.

The present study reviews the existing National Survey of Student Engagement (NSSE, 2012, 2017) data from two western land-grant universities to examine participation of first-year students and seniors ($N = 3223$) through a survey. The HIEP considered include service-learning, learning communities, research with faculty, internship or field experience, study abroad, and culminating senior experience. These practices are designed to encourage meaningful interactions between faculty and students, foster collaboration with students within different demographics groups, and facilitate learning outside the classroom.

The purpose of the present study is to examine the extent to which E/CS students participate in HIEP and the effects that HIEP participation has on E/CS student outcomes. This study also offers comparisons or possible relationships between student demographics, student success, and HIEP involvement. For example, HIEP's participation rates on different engineering and computer science majors, including civil, chemical, electrical, mechanical, and materials engineering, etc., are analyzed to examine the practices that work for a particular E/CS major. The present study reports findings from NSSE 2012 and 2017 surveys.

Results show that, among the E/CS seniors, service-learning, learning community, and study abroad program are the HIEP with the highest non-participation rate with 41% (service-learning), 59% (learning community), and 68% (study abroad program), indicating that they do not plan to engage in these practices in their senior year. Conversely, internships, and culminating senior experiences had the most participation among E/CS seniors with 52% participating in internships and 68% participating in culminating senior experiences. Interestingly, first-year students showed a significant interest to participate in the following HIEP: internships, study abroad programs and culminating senior experiences – with 76% (internships), 47% (study abroad program), and 68% (culminating senior experiences) of participants indicating plans to engage in these practices.

Finally, findings show that participation or engagement in HIEP is a significant predictor of student learning outcomes. Findings may serve as a guide for future research in E/CS student participation

in HIEP. The paper concludes with theoretical and practical implications of the findings on student engagement and learning.

Keywords: NSSE, high impact educational practices, engagement

Introduction

Research shows that engineering majors lose talented, capable individuals to other non-engineering majors and careers [3]. Despite ongoing efforts to improve science, technology, engineering, and mathematics (STEM) undergraduate persistence and success, the attrition rates among women and students in underrepresented minority groups have increased over the past decade. A recent report suggests that nearly half of college students starting in STEM majors leave the STEM field before the fourth year of their degree program [13]. Over the years, researchers have developed innovative ways to increase engagement among engineering students. Several ideas have been proposed and adopted to generate interest in engineering majors. Some of these engagement activities include engineering societies or student groups (i.e., National Society of Black Engineers or NSBE), undergraduate research experiences, departmental events such as Hackathons and academic showcases, internship opportunities, capstone experiences, study abroad programs, learning communities, mentoring programs, professor office hours, career centers, and study groups.

Study abroad program involves faculty or students traveling to another country to enhance their degree programs. The foreign countries chosen for study abroad programs can be in the same region or another region. One of the primary motivations for students taking on study abroad programs might be personal enrichment and a quest to experience other cultures and ways of living [19]. Student participation in study abroad program has been shown to have positive outcomes on cultural, linguistic, and academic knowledge [20]. Students who participate in study abroad programs are more likely to understand and empathize with students from a different culture and are more likely to interact with students from other countries, especially students from countries they have previously visited [20].

Internships are an excellent tool to expose students to experiential learning, industry culture, and practical applications of their college degrees. Internship experiences help students decide positions aligned with their career goals [24]. Internships could enhance students' intellectual, personal, and professional attributes as they focus on working in teams, relying on or providing feedback on other peoples' work, and reporting to a direct supervisor. Internships are a good opportunity for students to discover and explore their likes and dislike about their majors and build and develop professional skills and expand professional networks, tailor their short/long term goals [21]. Internship programs are an excellent recruiting tool for Industry employers [25][26].

Learning communities are student communities intentionally built for students enrolled in a different discipline connected to the main aim of achieving a common goal [27] Building a student learning community is essential for E/CS students, especially students in

underrepresented minority groups who are likely to feel left out and not included in classroom activities and group projects. The feeling of alienation could result in students developing dropout intention for an engineering/computer science degree.

Research experiences are an excellent tool to promote and foster engagement among engineering and computer science students. They provide an avenue to collaborate with faculty and build a close relationship with their teachers or professors. Choosing to engage in research activities is considered a voluntary activity and conducting research gives a student the avenue or platform to explore his / her ideas on inventions or discoveries to make a significant contribution to the engineering field. Research gives a student the place to deliberate and share ideas on how to tackle real-world problems with other research team members with the faculty member's guidance outside the classroom environment. Undergraduate research promotes collaborative learning and an avenue to motivate students [22]. Undergraduate research experiences have been shown to influence retention [23].

The purpose of this study is to investigate and identify the HIEP E/CS student participate in, and effects of HIEP among E/CS undergraduates, including women. More specifically, we examine student engagement using past NSSE survey data to gather historical trends about student engagement in HIEP and serve as a background or benchmark to answer some of the research questions for this research.

Theoretical Framework

Student engagement is the quality and quantity of effort students put into educational activities to contribute directly to the desired outcome [15]. Engagement can be categorized into different parts, including cognitive, behavioral engagement, and emotional engagement. [16]. Emotional engagement can be defined as the process of having a sense of belonging, inclusiveness, and being valued. [16] define behavioral engagement as including participation in academic and social or extracurricular activities. Such participation is considered very important for developing social networks that help prevent or limit dropping out. According to [18] the measures of behavioral engagement include putting in considerable effort, persistence, and resilience in the face of obstacles and actively seeking assistance when faced with challenges. [16] define cognitive engagement as the effort students invest in understanding their learning. The ICAP (Interactive, Constructive, Active, and Passive) framework is a cognitive engagement tool that predicts increased learning when a student becomes more engaged with learning materials ranging from passive to active, constructive to interactive [17].

According to [7], HIEP participation improves student outcomes such as academic performance, persistence, and intent to complete their respective majors. The study also outlined four main HIEP measures: service-learning, study aboard programs, undergraduate research, and culminating senior experiences. These activities demand students' time and effort, interactions between faculty and their peers, especially for students from different racial or ethnic backgrounds. Short-term goals are also essential for engineering students' academic success as they influence learning strategies for tasks related to students' courses [12]. Research has shown that self-efficacy improves learning and understanding in introductory ("Gatekeeper") engineering courses [5].

Methods

"The NSSE survey, launched in 2000 and updated in 2013, assesses the extent to which students engage in educational practices associated with high levels of learning and development. NSSE annually collects information at hundreds of four-year colleges and universities about student participation in activities and programs that promote their learning and personal development. The results provide an estimate of how undergraduates spend their time and what they gain from attending their college or university. Institutions use their data to identify aspects of the undergraduate experience that can be improved through changes in policy and practice." (NSSE, 2017). Before conducting further research about student engagement, we conducted a review of existing NSSE survey results to gather insights on the lessons learned and identify gaps in the research that needs more attention. More importantly, this study analyses previous NSSE survey data to examine the possible relationship between the demographics of students who participate in HIEP compared to those who do not. Additionally, we check for how participation in HIEP is related to student outcomes around persistence. The NSSE survey aims to measure and report student engagement or participation in activities that impact their educational experience including participation in HIEP. Additionally, the survey aims to investigate the relationship between participation in HIEP and their effect on student learning outcomes including intent to complete a degree, persistence, and academic achievement.

We used data from NSSE 2012 and 2017 surveys to examine and understand historical trends and answer the research questions. The study seeks to answer the following research questions:

1. What types of HIEP (i.e., undergraduate research, study abroad, service-learning, entrepreneurship programs, interdisciplinary courses) do E/CS students engage / not engage in?
2. How do the HIEP participation rates in E / CS students vary as E/CS students' progress in their programs?

To create a historical picture of the E/CS participation, we gathered and analyzed existing NSSE survey data to investigate the possible relationships between student demographics, and participation in HIEP.

Data Analysis / Results

The main objective of this study is to examine the extent to which E/CS students participate in HIEP. The NSSE survey results indicate that the E/CS students engage in culminating senior experiences such as capstone courses and senior projects and internships or co-op programs. The results are consistent with [7] findings, which concluded that five HIEP that students mostly engage or participate in are service-learning, senior culminating experiences, learning communities, study abroad, and undergraduate research. These activities or practices may help promote academic success, persistence, and student retention among E/CS students since they require considerable effort, personal time, and interaction with their student peers. [7]

The result of the NSSE surveys indicates that forty-five percent (45%) of first-year students are currently participating or have previously participated in one HIEP, while nine percent (9%) indicated participating in two or more HIEP. Conversely, among seniors, sixty-seven percent (67%) indicated that they are currently or have participated in two or more HIEP while twenty-three percent (23%) indicated that they are currently or have participated in one HIEP. Also, it is helpful for educators and researchers to know the demographics of students engaging in HIEP to identify vulnerable students on the verge of leaving an E/CS majors. The demographics of the respondents of the survey were 71% (male), 29% (female) for the NSSE 2017 survey, while the opposite is the case with NSSE 2012 with 61% (female) and 31% (male) which might be attributed to low male response rate.

First-year Students: Interestingly, according to Fig I first-year students showed a significant interest to participate in the following HIEP: internships, study abroad programs and culminating senior experiences – with 76% (internships), 47% (study abroad program), and 68% (culminating senior experiences). The result above is essential, as engaging first-year students in HIEP might foster communication between students of different backgrounds and promote project collaboration and interaction with faculty. Internships are important in improving E/CS students' sense of inclusiveness as they see the real-world applications and usefulness of the coursework and projects when they engage in such internships.

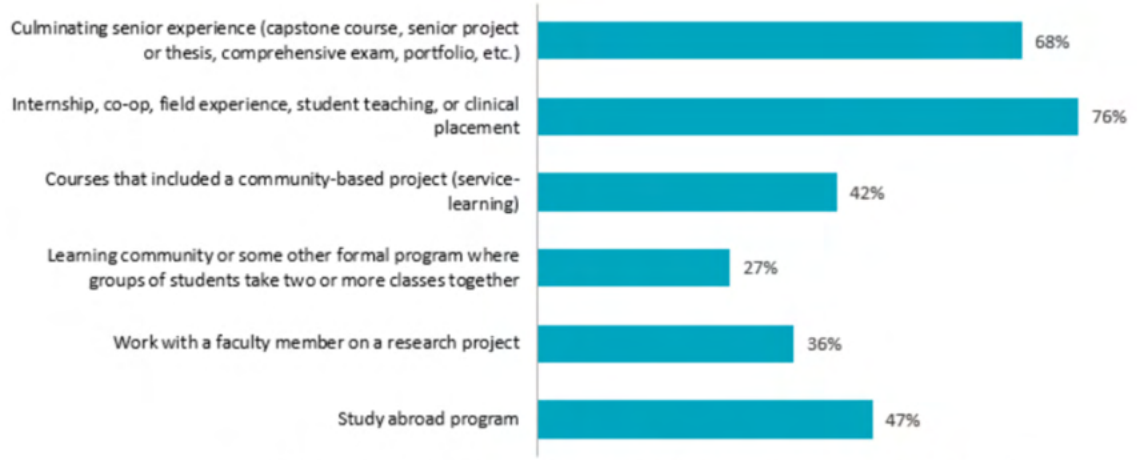

Fig I: Shows the frequencies for first-year E/CS student's plans to participate in HIEP

Among first-year students, six percent (6%) indicated that most of their courses included a community-based project (service-learning) and forty-two percent (42%) indicated that their courses included some form of a community-based project (service-learning). Fifty-two percent (52%) indicated that their coursework did not include any form of service-learning. Nine percent (9%) of the first-year E/CS students indicated that to have completed or in the process of completing learning community, twenty-seven percent (27%) indicated that they plan to do learning community, and thirty percent (30%) plans not to participate in a learning community. Eight percent (8%) of the first-year students indicated to have worked with, or in the process of working on research with a faculty member, thirty-five (36%) indicated that they plan to work with a faculty member on research.

Senior Students: Service-learning, learning communities, and study abroad programs are the HIEP with the lowest participation rate with 41% (service-learning), 59% (learning community), and 68% (study abroad program) of participants indicating that they do not plan to engage in these practices in their senior year. This result suggests that E/CS seniors are more likely to be focused on post-graduation plans and a capstone or senior design projects than engaging in practices such as service-learning, learning communities, or study abroad programs. Conversely, according to Fig II, internships, and culminating senior experiences had the most participation among E/CS seniors with 52% (internships) and 68% (culminating senior experiences). It appears that E/CS seniors are more interested in engaging in activities that might help them better transition to the industry workforce or enter a graduate program.

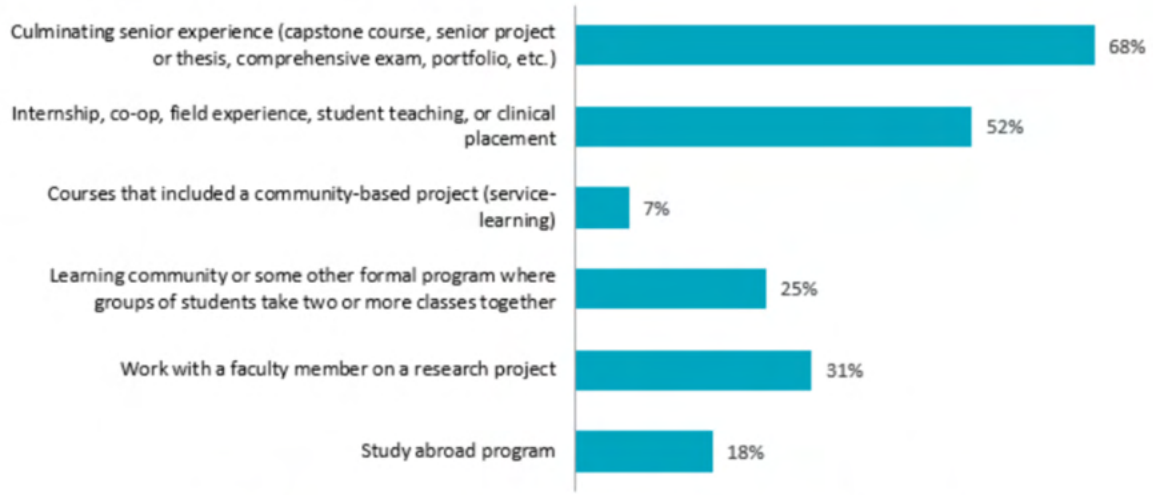

Fig II: Shows the frequencies of the HIEP's completed by senior year E/CS students

Nine percent (9%) of seniors indicated that most of their courses included a community-based project (service-learning), fifty-one percent (51%) of seniors indicated that their courses included some form of a community-based project (service-learning). Forty percent (40%) indicated that their coursework did not include any form of service-learning. Twenty-five percent (25%) of seniors indicated to have worked with or in the process of working on research with a faculty member. Fifty-one (51%) indicated that they plan to work with a faculty member on research. Forty-eight (48%) of seniors indicated to have completed or in the process of completing an internship or field experience. In comparison, twenty-seven (27%) plans to participate in an internship or field experience. Interestingly, the study abroad program and service learning were the least engaged HIEP among seniors with eighteen percent (18%) and seven percent (7%) E/CS students indicated to have completed or in the process of completing a study abroad program or a service-learning project/activity. In comparison, seventy-four (74%) indicated that they do not plan to participate in a study abroad program.

Findings above show that, among first-year E/CS students, HIEP involvement is relatively minimal. However, there is a sense of optimism about their plans to participate in HIEP in the future. It is crucial to know whether first-year students plan to participate in HIEP in higher levels of their programs as it can reveal insights about HIEP demand and awareness of opportunities. These findings might also be a point of further research about students' expectations in

participating in HIEP in the future. Consequently, it is generally expected that seniors would have completed or currently completing more HIEP compared to first-year students. However, service-learning, study abroad, learning community, and research with a faculty member was the least engaged HIEP. A point of concern is the high percentage of seniors indicating their plans not to be involved in the service learning, learning community and study abroad program because they might not see the importance of these activities to their goal of completing their degree. A plausible reason for the low participation of engaging in research with a faculty member might be that had the opportunity to participate in research during their process of completing their program or senior E/CS student do not plan to conduct further research in the program of study in a graduate school.

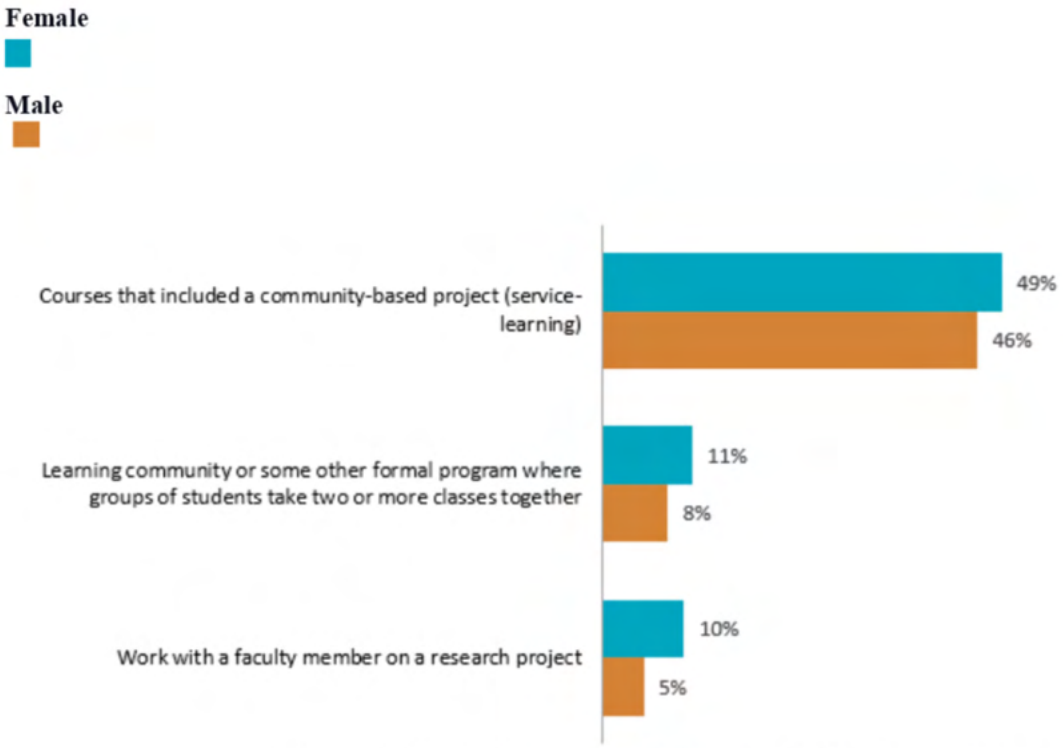

Fig III: Participation in HIEP by gender characteristics for first-year E/CS students

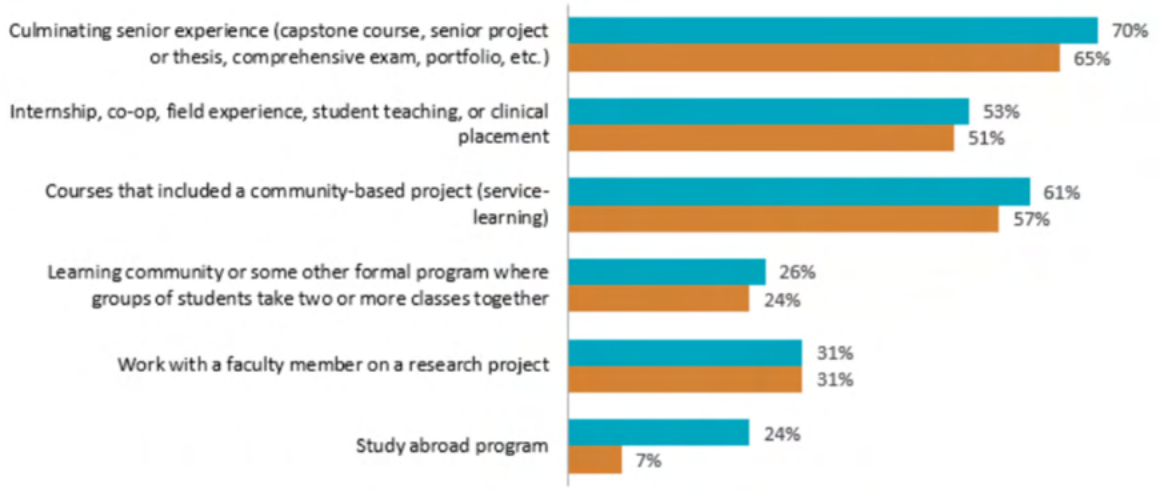

Fig IV: Participation in HIEP by gender characteristics for senior year E/CS students

Fig III shows that the participation of HIEP of E/CS students based on gender characteristics is quite similar. However, in the case of senior students, the percentage of females participating in the five HIEP's are slightly higher than their male counterparts. According to Fig IV, Work with a faculty member on a research project had the same participation from both males and females (31%) which is quite interesting. Furthermore, Fig IV, shows a large female participation (24) compared to male participation (7%) in study abroad program. There was a higher percentage of women (63%) than men among all students (first year and seniors) who participated in an internship, held a formal leadership role in a student organization, worked with a faculty member on a research project, and participated in a culminating senior experience. These results may indicate the work done to target vulnerable groups such as women in E/CS majors may be paying-off. However, women and students from minority racial and ethnic groups were part of a groups of students (67%) who plan not to participate in an internship program, hold a formal leadership role in a student organization, working with a faculty member on a research project, and culminating senior experience. In conclusion, HIEP was designed to improve students' academic success and achievement, especially among women and students in underrepresented minority groups who are often the least engaged among E/CS student majors.

Conclusion

This review is part of an ongoing NSF-funded research to understand and investigate the impact of HIEP and its effect on student outcomes. The review of existing NSSE data provides a baseline to describe the participation rates of E/CS in HIEP. Findings from the two NSSE survey (2012 & 2017) show the participation trends among senior E/CS students with a significant number indicating to have participated in some form of HIEP (such as study abroad, service-learning, and learning community) during their program of study but a reduced participation rate was seen among E/CS seniors currently participating in HIEP. Also, though it's impressive that women were

more than half of participant of HIEP such as study abroad, service-learning, and learning community, they constitute a larger proportion of students that are not engaged in these HIEP. One of the review's main findings is that study abroad programs, learning communities and service-learning were the least engaged HIEP across all E/CS majors for both first-year and seniors. This is significant as it indicates to educators and researchers that such programs might not be well suited for engineering degrees such as bioengineering or electrical engineering. The practical implication of this study will inform educators on the efficacy of HIEP available to E/CS majors and the activities E/CS are most likely to participate in. Similarly, identifying the HIEP participation of various demographics, especially among women and students from minority ethics groups, will help direct educators to make specific engagement activities available to them. In some instances, the lack of engagement might be because students are not aware of the HIEP they can participate in during their program.

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