Enhancement of Engineering Student Engagement

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Abstract

A high level of student engagement with the academic content of degree programs and experiential learning is often linked to positive academic outcomes. Cocurricular activities that effectively enhance student involvement tend to promote academic self-efficacy. This paper presents results of a pilot program in which a cohort of engineering and technology students were intensively mentored and actively engaged in academic cocurricular activities with the goal of enhancing student self-efficacy. Results are drawn from quantified student performance against common benchmarks, and student perceptions of their academic experiences as given through surveys and personal interviews. These results indicate that students were more interactive with academic content than their peers outside the pilot program, and that overt measures to encourage student engagement appeared to be effective in enhancing academic immersion and long-term student success.

1. Introduction

Academic engagement may be broadly defined as the student's depth of interaction with the academic content of their degree program, and with the college experience. More specifically, it is evidence of the *quality of effort* (Pace 1980) students apply to educationally purposeful activities (Hu and Kuh 2002) that affects their level of learning. Through concerted involvement, the student develops habits of mind that augment their foundation of skills, and thus, their disposition for fulfillment in their careers and lives (Kuh 2003). Engagement represents a connection, or relationship, with the academic environment that enables the student to overcome a perceived risk associated with learning (Case 2008). Students who are actively engaged in academic cocurricular activities, both in and out of the classroom, are more likely to persist in their degree paths, to have higher grades, to show improved psychological adjustment to college life (Ohland et al. 2008), and improved ethical/professional development (Finelli et al. 2012).

While the effects of engagement may be observed across the spectrum of higher education, there exist differing formulations of it as pertains to the student's educational goals. Among students in the arts and humanities, the focus may be on conceptual development of ideas and interpersonal communication, whereas students in the sciences and engineering typically focus on improvement in technical and collaborative skills targeting future employment. Both these paths are, however, positive indicators of students who would seek advanced degrees (Brint, Cantwell, and Hanneman 2008). Although some aspects of the approach described in this paper are transferrable, the general focus will be on engineering and technology student engagement.

Since 1999, a primary source of research on student academic involvement at the college level has been the National Survey of Student Engagement (NSSE) (Brint, Cantwell, and Hanneman 2008). The NSSE survey instrument defines ten related indicators aligned across four major themes (NSSE Website n.d.):

1. Academic challenge including higher-order learning, reflective and integrative learning, learning strategies, and quantitative reasoning.
2. Learning with peers including collaborative learning, and discussions with a diversity of others.
3. Experiences with faculty including student-faculty interactions, and effective teaching practices.
4. The campus environment including quality of interactions, and quality of support structures.

Academic challenge is a critical benchmark of student engagement within a degree program. It encompasses the student's application of theory, analysis skills, evaluation of information, and the ability to draw conclusions from multiple sources of information (NSSE Website n.d.). NSSE correlates these abilities with reported time spent preparing for class, time spent reading, and institutional/faculty expectations for academic performance (Pascarella, Seifert, and Blaich 2009). Indeed, engineering students have been shown to prefer courses that are challenging to courses that are too easy, provided they are not so hard as to be overwhelming (Martin et al. 2008).

Active and collaborative learning refers to methods by which students interact with peers and faculty, both in and out of class, to master difficult material. Students' efforts to seek help from one another, to provide explanations of course material, to ask questions in class, and to work together on projects are contributing factors to productive learning in a collaborative manner. Such tactics are seen to improve a student's ability to handle open-ended problems with greater confidence in professional life (NSSE Website n.d.). Collaborative learning also extends to the diversity of encounters that a student has during their time in school. Diversity often refers to differences in gender and ethnicity. However, these implicitly give rise to other relevant factors including learning styles, approaches to learning and orientations to studying, and levels of intellectual development (Felder and Brent 2005; Boles and Whelan 2017). As engineering is an increasingly global field, the need is significant for engineering students to converse, engage with, and understand a diversity of people with backgrounds and outlooks different from their own (Davis and Finelli 2007).

Faculty play a key role in students' interaction with the content of their programs and in the quality of student learning. Faculty who value and emphasize challenging academic activities are seen to encourage appreciation for intellectual challenge among their students, and to motivate higher-order mental tasks to a greater extent (Chen, Lattuca, and Hamilton 2008). Faculty also play a role in creating the environment that supports free inquiry into challenging subjects by projecting approachability and by creating an environment in which students feel comfortable. Faculty who are considered approachable tend to create more opportunities for formative conversations with students, promote ease with student-faculty interactions, and thereby promote ease with in-class participation and collaboration with students on projects and research. Faculty may extend this role by conveying a sense of enthusiasm for what they teach (Pomales-Garcia and Liu 2007; Nelson and Brennan 2019).

The quality and supportiveness of the campus environment is also an important catalyst of engagement. Included in this benchmark are the atmosphere and structures that facilitate a student's academic success. The frequency and quality of interactions with other students, faculty, administrators, and campus services are of strong influence in this area. The level to which these entities encourage and support academic growth, personal well-being, social interaction, and non-academic pursuits (athletics, arts, political involvement, etc.) are directly supportive of student engagement and satisfaction with the university experience (Brint, Cantwell, and Hanneman 2008), (NSSE Website n.d.).

High impact practices conducive to these major themes may include learning communities, student-faculty research, internships, and capstone/culminating experiences, among others. These are shown to be particularly impactful for students from low-income backgrounds (Kuh 2009). The aim of this work is to examine the efficacy of specific efforts and activities to enhance student engagement in engineering and technology study. A clearer picture of which practices best promote significant positive effects in this area might inform curricular decisions and enable engineering faculty to design courses, structure learning communities, and interact with students in ways most conducive to positive academic outcomes.

The research questions that this work seeks to answer are whether concerted efforts to enhance student engagement are effective in doing so, and whether they have a positive impact on common metrics of student success including persistence to graduation within an engineering or engineering technology degree, grades, post graduate study, and student perceptions of personal success and self-efficacy. Quantitative analysis of survey data was performed to compare results from a student cohort that participated in a pilot program with a control group of students selected from the general population of students in the same family of degree programs. Qualitative analysis of feedback based on personal interviews of selected participants is also examined to assess the perceived impact of the pilot program's interventions toward increasing engagement.

This paper is structured as follows: Section 2 describes the pilot program including recruitment of the student cohort and the activities in which they were purposefully involved over the course of the program; Section 3 describes the survey instrument and process used for data collection, along with the analysis methods; Section 4 evaluates results and reflects on the strength of the observed outcomes and limitations of the study; and Section 5 discusses conclusions drawn from this work and suggests possible future directions.

2. The Pilot Program

This section discusses the structure and activities associated with a pilot program that was conceived as a vehicle to address and facilitate the themes of student engagement described above. Students participating in the program were awarded a scholarship through a grant from the National Science Foundation (NSF). The program titled *SPIRIT: Scholarship Program Initiative via Recruitment, Innovation, and Transformation* (Ferguson et al. 2018) ran from fall 2014 through spring 2018 at Western Carolina University (WCU). A cohort of 27 student-scholars was recruited from two engineering and two engineering technology degree programs to participate in the program. Participants were selected from the student population presently in the majors and from among incoming freshmen. Selection criteria included academic merit, unmet financial need, demographics, intent to pursue an undergraduate engineering or engineering technology degree, and evaluation of a submitted personal essay. Academic merit was determined by standardized test scores (ACT or SAT), and grade point average (high school or current). Financial need was determined from the shortfall in resources assessed using Free Application for Federal Student Aid applications.

Upon acceptance to the program, scholars were required to sign an agreement to maintain full-time enrollment (minimum of 12 credit hours per semester) and a grade point average of 3.25/4.0, engage in one extracurricular assignment within their academic discipline, generate an artifact resulting from the extracurricular activity each semester, and submit their accumulated work as a scholarly paper in a conference or journal prior to graduation.

Through a suite of focused activities and connections with customized and institutional support services, the program sought to develop a cohesive learning community among the scholars. These activities offered opportunities for peer-peer (vertically and horizontally integrated across academic years) and faculty-student mentoring (Ferguson et al. 2018; Kaul et al. 2019), development of technical competency and professional skills, and exposure to undergraduate research and scholarly publishing. Scholarly activities were coordinated through weekly, required one-hour meetings. During these meetings, scholars engaged in small group discussions, open-ended problem solving and teaming exercises, workshops, and presentations of their respective research progress. Outside these meetings, students were asked to complete occasional reflection prompts and to meet with program directors and faculty mentors for routine advising and coaching.

2.1. Academic Challenge

As noted above, scholars were required to maintain a grade point average of 3.25/4.0. Students falling below this standard were sent letters of notification and required to meet with a program director to devise a plan for refocusing their academic efforts, possibly including change of major in certain cases. Students were also required to conduct a research project under the guidance of a faculty mentor. Projects were conducted in a conventional research progression including a literature survey, proposal of a research question and a method for testing it, collection of data, and discussion of results. Typically, this process required several semesters to complete. At the end of each semester, the cohort would spend one weekly meeting giving formal presentations of their work for the term. Scholars who successfully completed their projects were coached in academic writing and possible ways of submitting their work as a poster or paper at scholarly conferences, journals, and undergraduate research expositions. Since the projects were of the scholar's choosing, it was expected that a meticulous and structured approach would inculcate study habits due to the extra effort put forth in research.

2.2. Collaborative Learning

The host department for the program includes in its curriculum a project-based learning (PBL) course sequence which all students are required to complete. PBL courses are taken one per academic year (freshman through junior years), culminating with a two-course capstone experience during the senior year. Each course involves the student in teaming scenarios with progressively challenging engineering problems. The PBL sequence is inherently integrative, bringing together teams of students from across degree disciplines to solve open-ended problems which typically have multiple possible solutions. PBL involves inductive learning wherein the individual must learn the concepts needed to complete a loosely defined task (Prince and Felder 2007). Students work together to converge on a viable outcome. The program scholars, as a learning community, were periodically asked to reflect on their in-class PBL experiences in small groups at weekly meetings, and to take notes on their collected observations. In this way, methods for dealing with uncertainty in technical problems, and associated anxieties related to academic success were potentially mitigated (Yanik et al. 2016).

Scholars also worked collaboratively on open-ended Rube Goldberg-style projects (Yanik et al. 2017) conducted in a series of five weekly meetings. These projects were designed by the program directors to focus on teaming skills, situational leadership, project planning, and technical communication and documentation. Interdisciplinary teaming in these scenarios exposed students to a diversity of learning styles and problem-solving approaches.

Scholars were encouraged to participate (and to take leadership roles where possible) within student chapters of professional societies, clubs, competition teams, honors-related organizations, and others. Many scholars were active with IEEE (and its robotics team), ASME, SAE Mini Baja, NSBE, SME, and the College Ambassadors program. A key focus of the program, and of consistent interest to engineering and technology majors, is career readiness (Brint, Cantwell, and Hanneman 2008). Thus, these activities were strategically selected to enhance engagement that would position program graduates well for their professional future, and to integrate classroom theory with the engineering soft skills valued by modern employers.

2.3. Student-Faculty Interactions

As noted above, students were required to complete a research project under the guidance of a faculty mentor. Through students' regular interaction with their faculty mentor, it was observed that such interaction may defuse students' anxiety about approaching faculty with questions, and about seeking help with difficult problems to build confidence with technical subject matter (Kaul et al. 2016). While many students reported that they found undergraduate research to be difficult, it was observed qualitatively that their maturation to address research questions in a disciplined and systematic manner improved over the course of the program. As noted in (Ferguson et al. 2018), program participants produced forty-five project artifacts through their faculty-guided research projects. These were published and presented in a variety of undergraduate research venues and other scholarly conferences such as NCUR, ASEE, and IEEE. The program directors also encouraged scholars to take on summer Research Experiences for Undergraduates and arranged shadowing experiences with potential employers.

2.4. Campus Support Structures

The pilot program conducted periodic workshops during weekly meetings to connect students with the various support services available on campus. These included Career Services, the Writing and Learning Commons Tutoring Center, the Math Tutoring Center, and the Library's Research Liaison (Ferguson et al. 2018). Program directors also created content to instruct scholars on concepts of leadership, quality, and application to graduate degree programs.

3. Data Collection

This section discusses the data collection process conducted for the study. A questionnaire was created to gather quantitative data and qualitative perceptions ranging across the students' undergraduate experience within the department. Responses in question groupings that focused on specific engagement outcomes were compared between the program and control groups to comprehend the efficacy of program interventions.

Students completed the questionnaire through a Qualtrics survey. This survey was approved by WCU's Institutional Review Board. Student participation in data collection was voluntary. Participants were required to provide their informed consent through Qualtrics before beginning the survey. Twelve participants in the pilot program completed the survey. This is approximately the residual population of the original cohort who had not yet graduated. A control group of 24 students who did not participate in the pilot program was selected from the remaining survey respondents. Members of the control group were selected for their similar socio-economic status and academic standing to students within the program.

Five participants from the pilot program were also voluntarily interviewed by the program directors. Selected items regarding their perceptions of the program and its impact on their college experiences are also presented with interpretive analysis. Data are analyzed in Section 4 to evaluate the performance and perceptions of students in the pilot program versus others from the general population of the WCU's School of Engineering + Technology. The survey and the interviews were conducted during the spring semester of 2018.

4. Results and Discussion

This section examines data on indicators of academic engagement related to themes described in Section 1. This section lists outcomes which may be interpreted as following from enhanced engagement activities. Results collected from the survey are reported with comparisons between pilot program participants and non-participants. Although the data may be interpreted as supporting a particular result, it is noted that the small sample size precludes generalizable conclusions, or speculation regarding the scalability of the approach. Where tabular data are cited as percentage differences between the two participant groups, raw data are also added to afford the reader a more nuanced picture of the comparative relationship. Student perceptions of the program's effectiveness as taken from personal interviews are also discussed.

4.1. Engaged Behavior

Efforts to enhance student engagement through the pilot program can be observed through multiple student behaviors. Table 1 provides a list of such behaviors for which a comparison can be made to the control group through survey results. These are categorized according to the major theme that they address.

4.1.1. Academic Challenge

Survey questions reflective of students' engagement with academic challenge are given in Table 2. Hours (average per student) spent preparing for class showed no significant difference (16.0 for the program group vs. 15.4 hours for the control group). However, defining engagement as quality of effort (Pace 1980), it can be seen that students in the pilot program were more willing than the control group to reach out for assistance (100% vs. 79.2% agreement), and particularly in seeking faculty assistance (91.7% vs. 83.3% agreement). Conversely, students in the control group tended to seek assistance from other students (100% of control group students vs. 91.7% of pilot program participants).

Although engagement with faculty for academic purposes may be considered a subset of student-faculty interactions, it is seen here as directly related to dealing with academic challenges. Pilot program participants show a propensity in their willingness to seek out faculty to mitigate academic difficulties. This relationship may perhaps be interpreted as an increased immersion of pilot program students in the culture of the university as an environment of inquiry, where faculty and students are partners in learning. If so, the result may stem from their greater exposure to the faculty as individuals due to regular interactions with the program directors, undergraduate research mentors, and speakers at weekly meetings.

4.1.2. Collaborative Learning

Survey questions related to a student's collaborative learning experiences are given in Table 3. The data broadly indicate a more impactful experience for pilot program participants. Since a focus of the pilot program was triangulated mentorship (Kaul et al. 2019), the range of opportunities for students to engage with faculty, peers, and students of other academic years was augmented over that of the control group.

Students in the pilot program typically expressed greater agreement related to positive effects from their interactions with other students. This is most starkly apparent in responses to questions regarding future coursework and projects such as capstone (83.3% vs. 45.8% seeing benefit), and the rigor of future course requirements (75.0% vs. 45.8% seeing benefit). The vertically integrated nature of the pilot program offered participants a frequent and low-risk forum in which they could ask upper-class students candid questions about their coursework and capstone experiences. Students in the control group would naturally

Table 1. Engagement Activities Queried by Survey.

Engagement Theme	Activity
Academic Challenge	Time spent preparing for class (studying or homework)
	Reaching out for help with academic difficulty
Collaborative Learning	Engaging with mentors
	Collaborating with other students
	Membership in student organizations
	Building strong student relationships
Student-Faculty Interactions	Engaging with faculty
	Participation in undergraduate research
Campus Support Structures	Use of academic support services
	Engagement with services supporting future goals

Table 2. Survey Response: Engagement with Academic Challenge. Percentages Are Those of Students in Their Respective Group Who Responded Within the Noted Reporting Criteria.

Survey Question	Response Options	Reporting Criteria	Pilot Program Participants (N = 12)	Control Group (N = 24)
Estimate the number of hours per week spent outside of class studying or completing coursework.	Numeric	Average (hours)	16.0	15.6
How often did you seek help during your course professor's office hours	1W/1M/1S/1Y/N[1]	At least once per month	66.7% (8)	54.2% (13)
When I am experiencing academic problems, I usually reach out for help.	SA/A/D/SD[2]	SA/A	100.0% (12)	79.2% (19)
I feel comfortable contacting a faculty member to discuss personal problems and/or academic problems affecting my academic progress.	SA/A/D/SD	SA/A	91.7% (11)	83.3% (20)
I feel comfortable contacting another student to discuss personal problems and/or academic problems affecting my academic progress.	SA/A/D/SD	SA/A	91.7% (11)	100.0% (24)

1. Once per week/ Once per month/ Once per semester/ Once per year/ Never
2. Strongly Agree/ Agree/ Disagree/ Strongly Disagree

Table 3. Survey Response: Engagement with Respect to Collaborative Learning. Percentages Are Those of Students in Their Respective Groups Who Responded within the Noted Reporting Criteria.

Survey Question	Response Options	Reporting Criteria	Pilot Program Participants (N = 12)	Control Group (N = 24)
The Program's mentorship activities have helped me to acquire skills by closely observing peers and senior students.	SA/A/D/SD[1]	SA/A	83.3% (10)	75.0% (18)
The Program's mentorship activities have exposed me to ideas and concepts that I may not have learned in the classroom.	SA/A/D/SD	SA/A	83.3% (10)	70.8% (17)
I enjoy working with other students on projects.	SA/A/D/SD	SA/A	91.7% (11)	87.5% (21)
Rank the level of benefit you gained from working with a group of students to understand future course projects, like capstone.	HB/B/LB/NB[2]	HB/B	83.3% (10)	45.8% (11)
Rank the level of benefit you gained from working with a group of students to understand future course requirements and rigor.	HB/B/LB/NB	HB/B	75.0% (9)	45.8% (11)
Were you a member of any student organizations while enrolled at the University?	Yes/No	Yes	75.0% (9)	62.5% (15)

1. Strongly Agree/ Agree/ Disagree/ Strongly Disagree
2. High Benefit/ Benefit/ Low Benefit/ No Benefit

have fewer opportunities to engage in such interactions and would likely have kept to their peer group of a given class year. Although this scenario offers implications for increased retention and improved collaborative learning, logistical impediments to the vertical integration of students in the general population present significant challenges in terms of timing, faculty cooperation, and knowledge levels of the students involved.

Students in the pilot program were more likely to participate in student organizations (75% vs. 62.5% participation). Reported percentages are constrained to co-curricular academic or professional organizations including IEEE, NSBE, ASME, SME, SAE-Mini Baja, and Student Ambassadors. Program directors encouraged pilot program participants to join these organizations and to assume leadership roles whenever possible. This was expected to be a means of enhancing their collaborative learning with peers on competition teams (SAE Mini Baja, IEEE robotics) and at chapter meetings, and for professional growth outside the classroom.

4.1.3. Student-Faculty Interactions

Survey questions related to student-faculty interactions are given in Table 4. As previously stated, engagement with faculty may also fall under students' response to academic challenge. Here, we consider those interactions related to undergraduate research, or significant integration in the research area of the faculty member.

In this area, pilot program participants reported levels of interaction with faculty as related to research dramatically surpassed those of the control group for the survey questions shown. This may be seen as a clear strength of the pilot program. Venues at which students published their research results included NCUR, the university's Undergraduate Research Celebration, ASME, various regional workshops, IEEE conferences, and the annual departmental Capstone Symposium. Among members of the control group, inclusion was sparse and was limited to the Capstone Symposium.

As previously noted, pilot program participants were required to submit their work for publication to at least one venue prior to graduation. This requirement likely impacted the far greater publication rate for participants over the control group (100% vs. 8.3% publishing). Although on-campus venues were included among the students' viable options, there were numerous successful submissions to regional and national venues. The students' accomplishments in this category surpassed the program directors' expectations. Over the course of the program, it was observed that students rose to the challenge of their selected research projects and matured immensely in their ability to apply sound research methodology, and to present their work in public forums.

4.1.4. Campus Support Structures

Survey questions related to student engagement with campus support structures are given in Table 5. Students in the pilot program were significantly more likely to make use of tutoring services for writing (25.0% vs. 0.0% use) and math (25.0% vs.

Table 4. Survey Response: Engagement with Respect to Student-faculty Interaction. Percentages are Those of Students in Their Respective Groups Who Responded within the Noted Reporting Criteria.

Survey Question	Response Options	Reporting Criteria	Pilot Program Participants (N = 12)	Control Group (N = 24)
I have sought engineering faculty member's mentorship for undergraduate research projects.	Yes/No	Yes	91.7% (11)	41.7% (10)
Please rank the level of benefit you gained by having a faculty mentor for projects occurring outside of required coursework.	HB/B/LB/NB[1]	HB/B	91.7% (11)	29.2% (7)
Please indicate the number of significant undergraduate research projects you conducted at WCU.	Numeric	Average (# projects)	1.83	0.13
Please indicate the venue(s) where you published your undergraduate research work. Please select all that apply.	Text response	Number of students publishing	100.0% (12)	8.3% (2)

1. High Benefit/ Benefit/ Low Benefit/ No Benefit

Table 5. Survey Response: Engagement with Campus Support Structures. Percentages Are Those of Students in Their Respective Groups Who Responded within the Noted Reporting Criteria.

Survey Question	Response Options	Reporting Criteria	Pilot Program Participants (N = 12)	Control Group (N = 24)
How often did you seek help from the Writing and Learning Commons	1W/1M/1S/1Y/N[1]	At least once per month	25.0% (3)	0.0% (0)
How often did you seek help from the Math Tutoring Center	1W/1M/1S/1Y/N	At least once per month	25.0% (3)	16.7% (4)
I worked with the Center for Career and Professional Development in developing my resume and cover Letter	Yes/No	Yes	91.7% (11)	12.5% (3)
I participated in a career shadowing experience where I visited a target company, interacted with employees, and met people working in a potential role that I would assume as an employee	Yes/No	Yes	16.7% (2)	20.8% (5)
I participated in an official CO-OP or Internship in my related career.	Yes/No	Yes	41.7% (5)	20.8% (5)
How many career fairs did you participate in at this University	Numeric	Average (# of fairs)	3.2	2.6
How many career fairs did you participate in that were hosted by other universities?	Numeric	Average (# of fairs)	1.4	0.5

1. Once per week/ Once per month/ Once per semester/ Once per year/ Never.

16.7% use). They were far more likely to utilize the campus career center for resume development (91.7% vs. 12.5% use) and to arrange Co-op/Internship experiences (41.7% vs. 21.8% use). They were also significantly more likely to participate in career fairs both at their home university and at other universities. Career self-efficacy in terms of job placement and graduate school placement were significant foci of the pilot program.

Interestingly, students in the control group were more likely to have participated in shadowing experiences with prospective employers or companies of interest (20.8% vs. 16.7%). This may be attributable to these students enjoying on-site visits with industry either through their technology coursework, or through their industrial capstone project sponsors.

4.2. Outcomes of Engagement

Common metrics of success toward academic engagement include persistence/retention in degree programs, grades, and intentions toward graduate education, and general confidence/self-efficacy in their abilities to embark on their career paths. Retention within the pilot program was 100%. Some students chose to change majors during the program (25% of participants); however, none of these migrated to majors outside the School of Engineering and Technology. Rather, students who expressed conflict with their choice of major, due either to their level of interest in the course material or to flagging academic performance, were closely mentored and advised by faculty program directors and peers as they considered their move. The high level of retention may be attributable to these advisement measures (Kaul et al. 2019). Retention data were not gathered for the control group.

Table 6 provides a comparison of GPAs between the program and control groups from high school through the program's conclusion in April 2018. Data were quantitatively evaluated using a t-test. For high school GPAs, the t-test is inconclusive ($p = 0.46$), indicating that the two groups performed approximately equally at the high school level. However, university GPAs indicate that program participants outperformed the control group ($p = 0.12$, or 88% significance) and more closely sustained their high school level of academic performance (Kaul et al. 2019). Although the results listed in Table 6 cannot be claimed to be conclusive due to a small sample size, it can be stated that students in the pilot program

Table 6. GPA Comparison between Pilot Program Participants and Control Group.

	Pilot program group (mean)	Control group (mean)	*p value*
Unweighted high school GPA	3.57	3.49	0.46
University GPA	3.51	3.31	0.12

benefited in their overall academic standing due to their participation in the program. In addition to graduating with a higher GPA, students in the pilot program significantly benefited from their involvement with student clubs, out-of-classroom projects, undergraduate research, etc. It can be claimed that these experiences gave students in the pilot program a holistic understanding of the different aspects of their major, therefore enhancing their engagement.

Table 7 provides survey questions relate to job/career self-efficacy (and its relationship to knowledge and skills gleaned from the undergraduate program) and aspirations toward graduate education. The data show that pilot program participants perceive a much higher level of personal self-efficacy than the control group in their ability to conduct professional interactions, in their preparedness for an industrial career, in seeking job opportunities and handling interviews. More generally, they felt a greater comfort in managing engineering problems, and in driving/leading the search for a solution. Cohort interactions may have led to this increased confidence through triangulated mentorship among faculty and students, as well as group problem solving sessions in which they engaged.

In order to quantitatively evaluate some of the responses to the survey questions in Table 7, a *t*-test has been used. Some of the responses indicate a statistically significant difference between the responses of the two groups. For instance, students in the pilot program express a relatively higher level of confidence in their ability to present their work to peers in the industry as well as their ability to present technical information ($p = 0.01$, or 99.99% significance). This can be directly attributed to the high emphasis on undergraduate research and presentation skills in the pilot program. Similarly, students in the pilot program express a very high level of confidence in their ability to manage and solve complex engineering problems. This can be ascribed to the constant exposure to open-ended problems in undergraduate research in the pilot program. These results clearly exhibit the benefits of student participation in the pilot program. However, the results also indicate the deficiencies of the pilot program in certain areas. For instance, the t-test shows no statistically significant difference in the confidence expressed by the two groups with regards to their preparation to enter the workforce. Since the pilot program did not have a mandatory internship requirement, the experiences of the control group can be expected to be pretty similar to the students in the pilot program, who may not have benefited from technical internship experiences.

Pilot program participants also had a much higher likelihood of considering, researching, and applying to graduate education. This may be attributable to their exposure to scholarly research at the undergraduate level as a program requirement. Further, the demands of the cohort to actively maintain a high GPA may have defused some anxiety about seeing themselves as candidates for graduate degrees.

4.3. Interviews

Near the end of the final academic year of the pilot program, five participants were invited to sit for personal interviews with the program directors. Two of the students were female. Three were from under-represented groups. Students represented both engineering and engineering technology degrees from electrical and mechanical disciplines. All interviewees were asked the same set of questions but were invited to expound on their personal perceptions, interests, and other commentary. Questions were not provided to the students prior to the interview with the goal of their obtaining candid, unrehearsed responses. Selected responses to interviewer questions spanning the range of engagement themes are given in Table 8. It can be seen that students had a favorable perception of the program and were enriched in areas relevant to their academic immersion.

5. Conclusions

As Kuh notes (2003), a compact of disengagement between student and faculty frequently prevails: “I’ll leave you alone if you leave me alone.”

Table 7. Survey Response: Engagement Outcomes Related to Career Self-efficacy or Aspirations toward Graduate Education. Percentages Are Those of Students in Their Respective Groups Who Responded Within the Noted Reporting Criteria.

Survey Question	Response Options	Reporting Criteria	Pilot Program Participants (N = 12)	Control Group (N = 24)
I feel confident in my ability to present projects to leaders and engineers working in industry.	SA/A/SD/D[1]	SA/A	91.7% (11)	12.5% (3)
I am confident in my ability to present technical outcomes of my research in an effective and professional manner.	SA/A/SD/D	SA/A	91.7% (11)	12.5% (3)
How comfortable are you that you are well prepared to enter the workforce in your chosen field?	EC/C/MC/ MU/U/EU[2]	EC/C	83.3% (10)	70.8% (17)
How comfortable do you feel with participating in job interviews?	EC/C/MC/ MU/U/EU	EC/C	83.3% (10)	58.3% (14)
Rate your perception of preparation for seeking career opportunities.	VP/P/NP[3]	VP/P	91.7% (11)	79.2% (19)
Rate your comfort level with - Solving complex engineering problems with little to no help from others.	EC/C/MC/ MU/U/EU	EC/C	91.7% (11)	45.8% (11)
Rate your comfort level with - Engineering problems that have multiple possible solutions and no clear path to the solutions or project completion.	EC/C/MC/ MU/U/EU	EC/C	66.7% (8)	41.7% (10)
Rate your comfort level with - Managing engineering problems that are not well defined or problem with no clear solutions.	EC/C/MC MU/U/EU	EC/C	83.3% (10)	37.5% (9)
I enjoy taking charge of a project while encouraging others to actively participate.	EC/C/MC/ MU/U/EU	EC/C	100.0% (12)	87.5% (21)
I enjoy leading others in completing a shared goal.	SA/A/SD/D	SA/A	100.0% (12)	87.5% (21)
I plan on attending graduate school after graduation	Yes/No	Yes	58.3% (7)	29.2% (7)
Undergraduate research activities have caused me to consider the possibility of going to graduate school in the future.	SA/A/SD/D	SA/A	83.3% (10)	8.3% (2)
Have you researched potential graduate school for potential application?	Yes/No	Yes	41.7% (5)	16.7% (4)
How many faculty members have you sought advice from with regards to attending a graduate school?	Numeric	Average (# faculty)	0.58	0.38
How many graduate schools have you visited with regards to gaining a better understanding of fit and opportunities?	Numeric	Average (# schools)	0.42	0.13

1. Strongly Agree/ Agree/ Disagree/ Strongly Disagree.
2. Extremely Comfortable/ Comfortable/ Moderately Comfortable/ Moderately Uncomfortable/ Uncomfortable/ Extremely Uncomfortable.
3. Very Prepared/ Prepared/ Not Prepared.

Student engagement is a passive activity for neither students nor faculty. This study examines a pilot program that sought to enhance student engagement through intensive mentorship and both invited and required activities, to direct participants affirmatively in the four major theme areas. The

Table 8. Interview Responses.

Student	Responses
Student A (Engineering)	- I was excited about being able to meet people. I didn't have any engineering courses, and I wanted to meet classmates, and I was able to do that. - I think the most beneficial thing to students is getting more involved with the faculty because everyone here at least has spent time in industry and academia, so it doesn't matter what career path set yourself on. Communicating with faculty is a good way to do that. - I think I changed as being a part of [the program]. I don't think I'd be going to grad school if I had never been involved in undergrad research.
Student B (Engineering Technology)	- My mentor was always open with me coming and dropping in throughout the week. If I had any questions I could come to him. - Going to Career Services and having their people look over [my resume and cover letter] was incredibly beneficial.
Student C (Engineering)	- I feel that being in an environment where you can talk openly with faculty advisors takes away that threat that you can't ask them a question. - I've loved doing the research that I've been working on and it's been beneficial. I'm able to say that I presented research at a national conference which not too many students can say. - I believe there were several events that we did in the [the program] that helped develop us professionally. I think that it has helped me continue to grow in leadership skills and public speaking. I don't think there's a single person in the [the program] scholarship who came out less confident than they went in.
Student D (Engineering Technology)	- There are definitely benefits to talking to other students at different levels of their education; learning from their mistakes and how to apply that to your own education. - I know how to go about doing research and how to avoid making mistakes.
Student E (Engineering Technology)	- I think it was helpful to know the different avenues that the campus had and different places to go whenever I needed certain things. - I'm thinking the undergraduate [research exposition] on campus, and the different opportunities we've had to present in front of our peers are good examples of that where [the program] has benefited me more than my peers. - Going to all the different career fairs has benefited me a lot. I know I've received calls for interviews from companies that I probably would have never seen, known about or applied to. - I know that I wasn't even really thinking about grad school until [the program]. I know grad school is definitely still something that I'm very interested in and want to pursue.

study compares student-reported outcomes and perceptions as evidence of the relative level of involvement compared to similar students of the general population and asserts the effectiveness of the applied interventions.

The number of students who participated in the pilot program comprises less than 5% of students in the host department. Thus, it is acknowledged that the sample size is small. Outcomes may not readily scale to larger populations. Participants in the pilot program reported heightened levels of engagement in nearly every evaluated metric including help seeking, interaction with faculty, participation in student organizations, and use of campus resources. These relationships were consistent and frequently pronounced. It can be stated that this consistency affords confidence in the conclusion that the pilot program's efforts were effective in promoting student academic immersion and self-efficacy. Longer term outcomes of increased self-efficacy stemming from improved technical confidence is reflected in perceptions of career readiness and plans for graduate education.

It is also acknowledged that students receiving a monetary award, with requirements to attain a minimum GPA and to participate in engagement-promoting activities, will be motivated to do so to an extent that other students may not. Thus, efforts to increase engagement with academic challenge may not be generalizable across a population of students who may not be receiving such an award. Future work should include efforts to transmute the activities prescribed for program participants to larger, more academically diverse group of students in the general population.

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