Student Impressions of Elements of a S-STEM Program

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Abstract

A state university received an NSF S-STEM grant to provide scholarship funds and enhanced wraparound programmatic activities for engineering and computer science students. Some of the enhanced activities available to the scholarship recipients are faculty mentoring, meetings of the cohort students, the ability to attend professional workshops and participate in STEM outreach activities, and the opportunity to attend and participate in the Emerging Researchers National (ERN) conference in Washington, D.C. Some of these activities are similar to what other schools have in their S-STEM programs. While the effectiveness of the different program activities is often studied at institutions, it is often less clear how students view the usefulness of various program activities.

In this paper, we describe in more detail the scholarship program at the University of Wisconsin-Milwaukee and provide explanations of the different programmatic activities available to the students in the program. We will then provide the results of a survey of the students in the program, where they were asked to provide their impressions of the program activities. The results of the survey can be beneficial to other schools developing S-STEM programs, as it sheds light on how receptive students may be to possible common program elements. The paper will also contain some discussion on the importance of the group activities in a virtual environment during the COVID-19 pandemic. Finally, we will provide some suggestions based on our experiences on how to improve the program activities to make them more beneficial to the students.

Introduction

The College of Engineering and Applied Science (CEAS) at the University of Wisconsin-Milwaukee (UWM) was awarded an NSF S-STEM grant in 2016 with the purpose of creating two cohorts of academically-talented, financially-needy students to pursue engineering studies. UWM is an urban research institution, and CEAS offers nine undergraduate majors. Currently, there are approximately 1700 undergraduates in CEAS. The Preparing Engineers and Computer Scientists (PECS) program was established, with a plan of creating two cohorts of ~10 students each. The program includes encouraging the students to take advantage of programs available to all students in CEAS as well as provides special opportunities to the scholarship recipients. Students receive scholarship money to help them meet their college costs. In this paper, we describe the program elements beyond the scholarship money. Additionally, students have been surveyed on their opinions of the value of the different on-going program elements and their level of enjoyment in the program elements. We describe the results of this survey and provide suggestions for other programs to consider in their own S-STEM programs based on the survey results.

PECS Program Activities

The PECS program consists of a variety of activities for the scholarship students. Most of these activities are not unique to the PECS program, and you can find similar S-STEM program activities at many other schools [1-10]. As expected of an S-STEM program, these activities incorporate college-wide activities available to all students, and special programs that are made available to the scholarship students. Most of the activities are on-going, occurring every semester. These on-going activities are listed in Table 1. The activities that are available to all students in CEAS are the use of the Tutoring Center, the availability of office hours from the faculty and teaching assistants, participation in student organizations and a centralized advising staff where each CEAS student is assigned an adviser upon admission. The additional activities that are made available to the scholarship students are the faculty mentors, the program meetings, the STEM outreach activities, and the professional workshops. PECS program students are reminded about and encouraged to participate in the activities available to all students during the program meetings. It should be noted that while these program activities exist, and many are well attended by the PECS program students, the PECS program only strongly encourages students to participate in the activities rather than require participation.

The program activities available to all CEAS students are fairly self-explanatory. CEAS operates a drop-in tutoring center for all students. The center is staffed by experienced students who have successfully completed the courses which they are tutoring for. Students can get help in a variety of courses at the tutoring center as needed. Not every course in CEAS is represented in the center, but in general the math and science courses and lower-level engineering courses all have tutoring available in the center. Faculty and teaching assistants are required to have office hours, and students can seek out additional help from faculty and TAs during these hours. As for student organization participation, CEAS has numerous student chapters of professional organizations as well as special-interest student organizations involving engineering disciplines. The university also has other special interest student organizations. Students in the PECS program as encouraged to take advantage of all these opportunities.

The activities available only to PECS program students are designed to give students an added bonus to help them prepare for their careers (making the program more special than other scholarships in CEAS) and to build a sense of community between the students. It is hoped that these encourage students to persist in their engineering studies through graduation. One of the PECS program activities is to assign each scholarship student to a faculty mentor. The students are asked to meet with their faculty mentor at least twice a semester. In these meetings, the faculty mentors should discuss the students' progress, answer questions about school and future opportunities, and provide suggestions on things the students may want to consider to help broaden their career preparation. Each mentor has approximately 4 students from the program to work with, allowing them to be able to spend an adequate time mentoring the students.

The PECS program meetings are held twice a semester and are meant to build community between the students in the program as well as answer general questions the students may be having. The professional learning activities are held less frequently, and focus on career skills. The purpose of these activities is to broaden the students' knowledge of opportunities in their fields, recognize contexts to make your coursework more meaningful and to network with other

STEM professionals. The STEM outreach activities are programs where PECS program students can go into the community (such as a local school) and run simple programs to help the public gain a deeper understanding of STEM.

In addition to these on-going activities, there were special one-time activities that were made available to the PECS program students. One of these was a trip to Washington, D.C. to attend the Emerging Researchers National Conference in February 2020. A second recent one-time activity was a pitching and story-telling exercise using the story arc strategy, where the students had to tell a story about themselves, and then this was used to generate a personal statement that the students can use as they apply for jobs or graduate studies.

Results and Discussion

Results from the student survey are presented in Figures 1 and 2. In these figures, the students were asked to rank how valuable they found various ongoing program activities and how much they enjoyed these program activities. The program activities are lettered A-H, and Table 1 contains information on which program activity corresponds to each letter. Table 1 also includes the number of students who indicated that they could not comment on the program activity because they did not participate in it. The data in Figure 1 are the ratings that students gave on how valuable they found each activity, with "1" corresponding to "not valuable at all", "3" being "somewhat valuable", and "5" being "extremely valuable". The data in Figure 2 are the ratings that students gave on how much they enjoyed each activity, with "1" corresponding to "not enjoyable at all", 3 being "somewhat enjoyable", and "5" being "extremely enjoyable.

Receiving input from students on both value and enjoyment can provide insights on how a program may need to modify activities. Clearly, it is desirable to have a program activity be both highly valuable and highly enjoyable. Conversely, if an activity is deemed to be both not valuable and not enjoyable, the organizers of the program may wish to consider eliminating the activity, or at the very least completely restructuring it. If a program activity is recognized as enjoyable, program organizers may wish to evaluate more deeply what elements of that activity make it enjoyable, and try to incorporate those elements into activities that are seen as valuable but not as enjoyable. Meanwhile, if you have an activity that is enjoyable, but not seen as valuable, it is likely an indication that the students are doing something that is fun but not useful to them as students.

Before looking at the results in Figures 1 and 2, consider the number of students who did not participate in certain activities, as shown in Table 1. By far, the activity that had the least amount of student participation was using the tutoring center. This is not surprising, as the students chosen for the PECS program demonstrated strong academic abilities in high school. While strong students can occasionally benefit from tutoring, and while the PECS has encouraged students to use the tutoring center if they are struggling in a course, society as a whole often views tutoring as being necessary for only weak students. Therefore, it is not surprising that fewer than half the respondents used the tutoring center. Along those same lines, it can be seen from Table 1 that a few students have not taken advantage of Professor and/or Teaching Assistant Office Hours. If students are understanding the course material, they will have less need to ask additional questions in office hours thereby reducing the number of students visiting office hours.

Table 1: Key to On-Going Program Activities, and the Number of Respondents who Did Not Participate in Each Activity

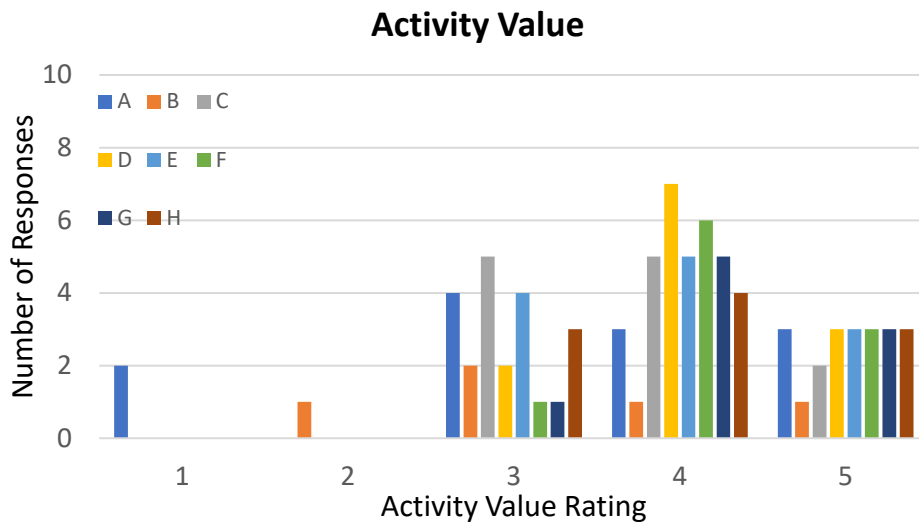| Identifier	Program Activity	Number of Non-Participants
A	Faculty Mentoring	0
B	Tutoring Center	7
C	S-STEM Program Meetings	0
D	Professional Learning Activities	0
E	STEM Outreach Activities	0
F	Attending Professor's Office Hours	2
G	Attending Teaching Assistant Office Hours	3
H	Participating in Student Organizations	2

Figure 1: Results of survey of PECS program students with respect to the level of value they place each program element. A rating of "1" corresponds to "not valuable at all", "3" to "somewhat valuable", and "5" to "extremely valuable".
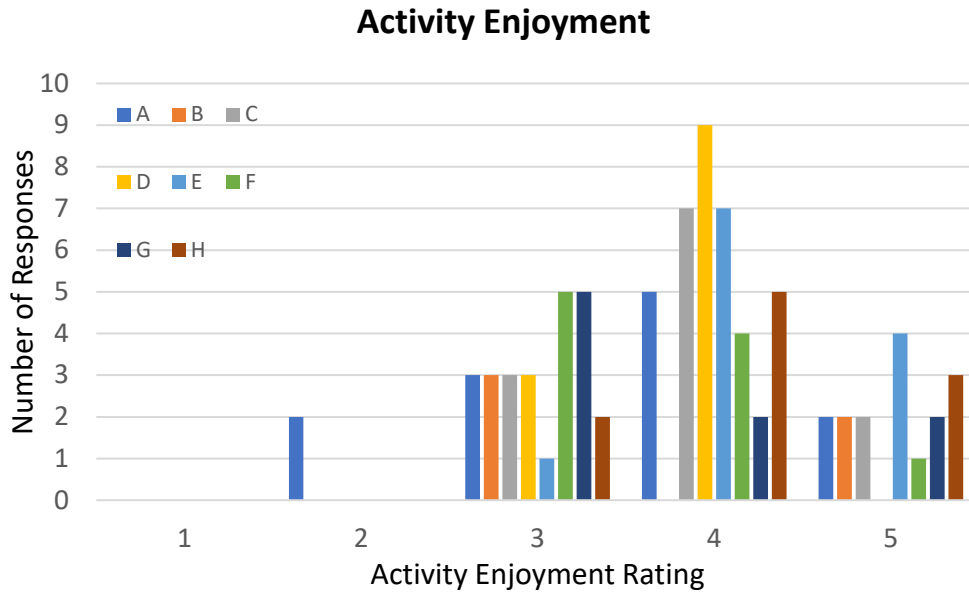
Activity Enjoyment

Figure 2: Results of survey of PECS program students with respect to the level of enjoyment they found each program element to be. A rating of "1" corresponds to "not enjoyable at all", "3" to "somewhat enjoyable", and "5" to "extremely enjoyable".

Looking at the data shown in Figure 1, if we consider the average evaluation of each of the on-going activities by those who participated in it, Attending Professor Office Hours and Attending Teaching Assistant Office Hours had the highest value. Also receiving consistently high ranking for value were participating in STEM Outreach Activities, Participating in Student Organizations, and Participating in the PECS program's professional workshops. Being involved in STEM Outreach Activities and in Student Organizations are similar in that they give students an opportunity to apply what they are learning in school, often in a fun activity. They help students better connect with their fellow students, and can make them feel like they are making valuable connections to the school or helping the community. As for the Professional Learning Activities offered through the PECS program, it is likely that students are finding value in gaining skills that will prepare them for getting a job after graduation.

Less value was found in the faculty mentoring component of the program, and the general program meetings. The general program meetings were designed to build a sense of community among the students in the program, and help guide them through the university. While students, on average, still found these meetings having at least some value, they are not as highly valued as other program elements. The faculty mentoring component is also noteworthy. The student experiences with the faculty mentoring may have been significantly variable. It can be noted that 6 students found the faculty mentoring either highly or extremely valuable, but 2 found it to have no value. What this suggests is that there is a need for there to be sufficient training for faculty mentors and ideas need to be given to faculty as to what to talk about with the students. Faculty mentoring is a key element of S-STEM programs nationwide, and so care needs to be taken to assure that students are receiving value from faculty mentoring. Lastly, it can be noted that the tutoring center was

also not seen as particularly valuable on average, but this is based on fewer than half the students who responded to the survey saying that they used the tutoring center.

Figure 2 presents data on student responses to how enjoyable they found the on-going program activities. It should be noted, though, that all of the activities averaged at least being between somewhat enjoyable and highly enjoyable. Therefore, what we are considering here is the relative enjoyability of the activities. The two activities that were seen as most enjoyable were the STEM Outreach programs and the Student Organization participation. These were likely seen as enjoyable for the same reasons discussed above for being valuable. On the other end of the scale, the Faculty Mentoring and the attending Professors' office hours were seen as the least enjoyable activities. This suggests that faculty in general, and not just those who are official mentors, may need more training in ways to relate to the students in small group or individual settings. Furthermore, the faculty mentoring meetings are strongly recommended of the students, and some students may feel that it is an activity that needs to be done whether they like it or not. Another indication that faculty (and teaching assistants) may need additional preparation for working with students in small groups involves the differences between value and enjoyability ratings for the attending professors and teaching assistant office hours. In both of these categories, students on average found the action of attending office hours more valuable than they found it enjoyable. One other item of note is that none of the respondents indicated that the professional workshops were extremely enjoyable – but most found them highly enjoyable. That suggests that the workshops may benefit from being revised somewhat but that they aren't being disdained by the students as is.

As a general takeaway from the student survey, it appears that students most enjoy and value the activities that allow them to apply their engineering knowledge gained in the classroom in a practical setting which encourages interactions with others. This is consistent with what has been found in other programs [11]. The least enjoyment appears to come from times when they are meeting with faculty and TAs, either for help or for the expected mentoring needed in the program. However, receiving help when needed through office hours appears to be highly valued by those who utilize the opportunity.

Eleven of the PECS program scholars attended the 2020 Annual Emerging Researchers National (ERN) Conference in Science, Technology, Engineering and Mathematics (STEM) in Feb 2020. The conference was hosted by the American Association for the Advancement of Science (AAAS), Diversity, Equity, and Inclusion (DEI) Programs and the National Science Foundation (NSF) Division of Human Resource Development (HRD). One of the scholars was able to present the results of her research at the conference. This was the first trip outside of the state for many of the scholars, and for 6 of them, the first trip to the US Capitol. Not only did this trip expose the students to research activities across the country, but it also offered times for the team to build camaraderie.

Seven of the 11 students who attended the ERN conference responded to the survey of student experiences. All of these students strongly agreed that they enjoyed the trip. Students placed high value on the workshops at the conference, being able to see how to prepare a good presentation of research, and presenting their own research. The ability to attend a research conference as an undergraduate is something that has been found to be a highlight of undergraduate research experiences [12], and this small sample size agrees with those results.

When the COVID-19 pandemic struck in the Spring 2020 semester, students in the PECS program had to pivot to on-line learning as well as deal with changes in their lives related to society shutting down. Scholars reported challenging times adapting to online learning and stresses associated with the pandemic as the campus closed in March. Some of the problems cited by the scholars were a lack of motivation for studying, losing peer learning during study sessions, and difficulties arranging one-on-one meetings with instructors. However, for the most part, the students demonstrated resilience and succeeded in their courses, as only one student performed worse in the 2019/2020 academic year. Some of this success is likely attributable to the connections that they had made with others in the PECS program.

The PECS program also had to adapt with COVID-19, as many planned in-person activities in the Spring 2020 semester had to be cancelled. As a substitute, one virtual meeting was held in May 2020. At this meeting, the group engaged in discussions on scholars' transition and experiences with virtual learning, and there was a guest who engaged us in learning about entrepreneurship though the art of storytelling. Ten of 12 students who participated in this found it valuable, but only 7 of the students thought it should be repeated as a way to help them prepare for job interviews and graduate school applications. Although successful, it is possible that this type of activity would work even better in-person.

Conclusions

In this work, we have reported on the value and enjoyability from the students' perspectives of activities that are part of an NSF S-STEM program. It was found that students find the most value and enjoyment in participating in hands-on activities, such as working with student organizations and engaging in STEM outreach activities. This finding about the value of belonging to student organizations in enriching student's experience agrees with a recent survey of the UWM College of Engineering and Applied Science alumni, in which a large percentage listed belonging to a student organization as being most instrumental to their persistence and performance. Students also tended to find attending faculty office hours to be valuable, although not always very enjoyable. The expected faculty mentoring component of the program was viewed with mixed opinions by the students, suggesting that there is a need to better prepare the faculty mentors for the program. It is very likely that since the PECS program scholars are mostly juniors and seniors, they have found additional faculty mentors in their course instructors and research advisers. The program will restructure the subsequent survey to capture this detail. Students also had the opportunity to travel to a research conference, and this was found to be very well received by the students. Finally, students in the program adapted well to the virtual learning environment imposed upon them by the COVID-19 pandemic, although students did experience some difficulties. However, it is likely that participation in the S-STEM program did assist them in navigating through the transition.

Acknowledgements

recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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