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Impact of Peer Mentoring on Student Learning and Connection To Engineering

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Abstract

Many students who enter engineering as an academic discipline in their first year of study switch to a different major after the first or second year. The attrition rates range from 30% to 50% depending on the institution. The dropout rate is even higher for underrepresented groups. Research studies show that the significant factors of attrition in engineering programs are quantitative skill level, student study habits, commitment to the program, and connections to peers. This paper describes an approach to address some of these factors. In this approach, we positioned the use of peer mentors as an improved institutional effort to retain students in engineering. Results show that the engineering peer mentoring program was considered helpful in learning calculus by the majority of Calculus I and Calculus II student participants.

I Introduction

Experts predict that the total number of students graduating with STEM degrees will not be sufficient the next decade to meet the growing needs of the global workforce [1, 2]. The demand for engineering graduates for engineering jobs is forecasted to rise by 25 to 30% by the end of the 21st century [4] at the same time the number of engineering students' obtaining Bachelor's degrees is declining. This number has declined by almost 40% since last decade [3, 4]. This decline is due, primarily, to two factors: 1) the lack of first-year students' interest in engineering programs; and 2) attrition rates in engineering programs. Many students who enter engineering as an academic discipline in their first year of study switch to a different major after the first or second year. The attrition rates range from 30% to 50% depending on the institution [5, 7]. The dropout rate is even higher for underrepresented groups, such as Native Americans, where it reaches nearly 70% [7, 8].

Several research studies show that the significant factors of attrition in engineering programs are quantitative skill level, student study habits, commitment to the program, involvement in extracurricular activities, and connections to peers [5-11]. One of the most cited and influential factors in students' decisions has been shown to be related to their experiences studying math, specifically calculus [9]. Additionally, those who do not complete calculus in their first semester see ahead of them three more semesters of study that they perceive to be simply useless, unexciting mathematics. Even when successful, many students lose confidence in their abilities to succeed as engineers because of mathematics.

Several strategies have been proposed and used to increase retention in engineering programs. One of the most commonly used strategies consists of addressing attrition is related to studying

calculus, which has also been linked to dropping out [12-14]. Other institutions used intervention programs when poor student performance in Calculus is first observed. Intervention programs are established to help students when the calculus teacher identifies a student with a deficiency. Although these programs have produced reasonable results, the method is not commonly used because it requires the calculus teacher to assess students early and very often, which increases instructor workload and effort [15, 16]. Other institutions augmented their freshman classes with hands-on activities [17-20].

This paper describes a method that can be used to increase student retention, motivation, and eventual success in engineering. In our project, an NSF-funded initiative (Project DUE-0942270) at the University of North Dakota, we combined the use of engineering modules in calculus classes and a peer mentoring program to address some of the common barriers to retention and success. This paper describes only the peer mentoring program and the results of its assessment.

Peer mentoring is defined as "a helping relationship in which two individuals of similar age and/or experience come together … in the pursuit of fulfilling some combination of functions that are career-related and psychosocial" [21]. Peer mentors can provide frank and honest advice on effective strategies for enhancing time management and studying because they are in the same peer group as the mentees. Mentors can also help students form a connection to their colleges and their respective departments by encouraging them to get involved with student organizations such as the IEEE and the Society of Women Engineers (SWE). In addition, mentors can foster a team mentality among the student members in the class, encouraging them to spend time together and will in turn providing incentives for them to pursue deeper learning and persist in engineering [6, 22]. The use of mentors offers many additional benefits, including reduction in feelings of isolation, especially for students who identify as members of underrepresented groups, leading to increased levels of persistence and improved academic performance [23-25].

II Methodology

For our project, five sophomore/junior engineering students were hired to work as peer mentors each of the semesters, fall 2012 and spring 2013. Prior to starting, they received training on group facilitation and leadership and were guided by a member of the project team on how to create a positive and welcoming learning environment that meets the needs of individuals with different learning styles. The training involved three specific parts.

In the first part, the students received an overview of the project, goals and objectives, and assessment plan of the project. The second part focused on preparing students to be mentors. They participated in an exercise where they thought about their first years of college and explored their own strategies for learning, including how they best retain information as well as what they found frustrating about studying calculus.

They then reviewed characteristics that they felt were important to bring to the mentor-led study sessions: sincerity, respect, and active listening skills. We also emphasized the importance of confidentiality during this portion of the training. The third part of the training focused on how to actively facilitate mentor sessions. The mentors then participated in an informal role-playing exercise where they took turns leading each other through solving a module problem. Discussions were also held on the importance of recognizing different learning styles and how the mentors might connect students to the appropriate campus-based resources that may be needed by students.

The engineering modules were distributed online to the calculus students. The peer mentors met with them in weekly sessions and discussed in a small group setting how to work through the modules. At these sessions, mentors provided students with feedback on their problem-solving techniques and communicated the different methods used by others.

The peer mentors were instructed to:

- Create an atmosphere that is comfortable for learning
- Select a student to share her/his process for solving the problems in the module.
- Encourage other students in attendance to comment in a positive manner and ask questions as they go through the process.
- Guide the students in a discussion that will help them find the most efficient, correct method for solving the problem.

A summary of mentor responsibilities includes:

- Schedule mentor sessions with students.
- Facilitate group discussions
- Provide general support for learning engineering content
- Serve as a resource to help students connect with each other, and to engineering as a discipline
- Provide feedback to project faculty on students' levels of participation in sessions
- Provide process-related feedback to project faculty on the modules and mentor sessions

Calculus students were asked to provide feedback at the end of the semester in which they participated in the study sessions. The instrument, the Modules and Mentors (MM) Survey, was administered online at the end of the semester (fall 2012 or spring 2013) and after the study sessions were completed.

III Results

The Modules and Mentors (MM) survey was designed to learn about students' experiences in their calculus classes related to the engineering concept problems and working with the engineering peer mentors. Students were asked for feedback on working with the engineering peer mentor and on their interactions with other students in the study sessions. We also gathered information on student motivations for attending the mentor-led study sessions. The survey was distributed online to students who were enrolled in Calculus I or Calculus II and participated in the mentor-led supplemental study sessions in the fall 2012 and spring 2013 semesters. Analysis of student responses to the survey is presented in aggregate form across the fall 2012 and spring 2013 semesters for Calculus I students (n=20) and for Calculus II students (n=22).

III-1 Student Motivations for Attending Mentoring Sessions

Calculus I. As one can see in Figure 1, the majority of students (70.0%) were motivated to attend the study sessions by the opportunity to "earn extra homework points" for class, with the second most frequent response (50.0%) being to "learn how calculus is used to solve engineering problems". Very few students (10.0%) indicated that they preferred to learn in a group setting and only one student indicated that the "opportunity to get to know classmates better" was a motivation for attending the mentor-led study sessions. Qualitative responses to the question

about motivation for attending the study sessions included: "extra credit" and "I learned more there than in class".

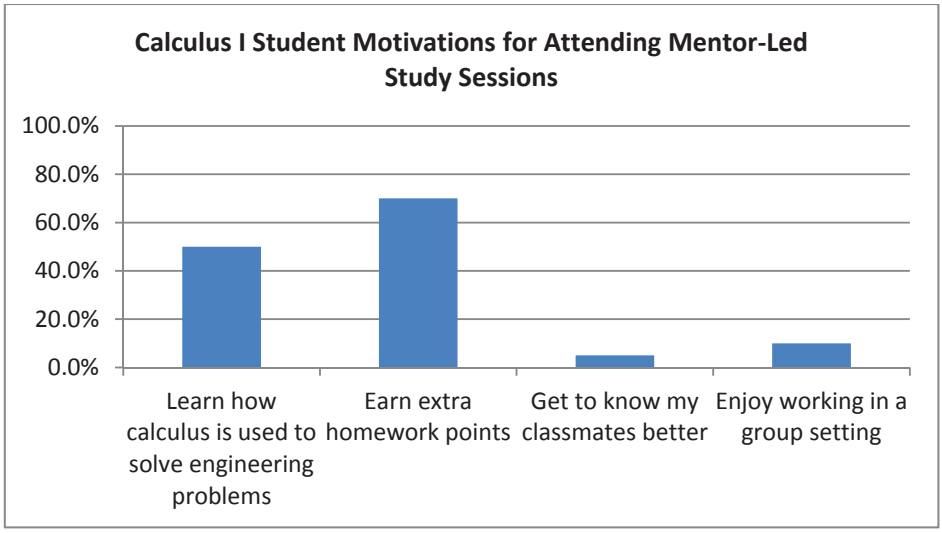

Figure 1: Student motivations for attending Calculus I mentor-led study sessions.

Calculus II. As shown in Figure 2, the majority of Calculus II students (75.0%) were motivated to attend the study sessions by the opportunity to "earn extra homework points" for class. A significant percentage of Calculus II participants (35.0%) also attended to "learn how calculus is used to solve engineering problems". Very few students (10.0%) indicated that they attended the study sessions in order to get to know classmates better, and even fewer (5.0%) listed "enjoy working in a group setting" as a motivation for attending.

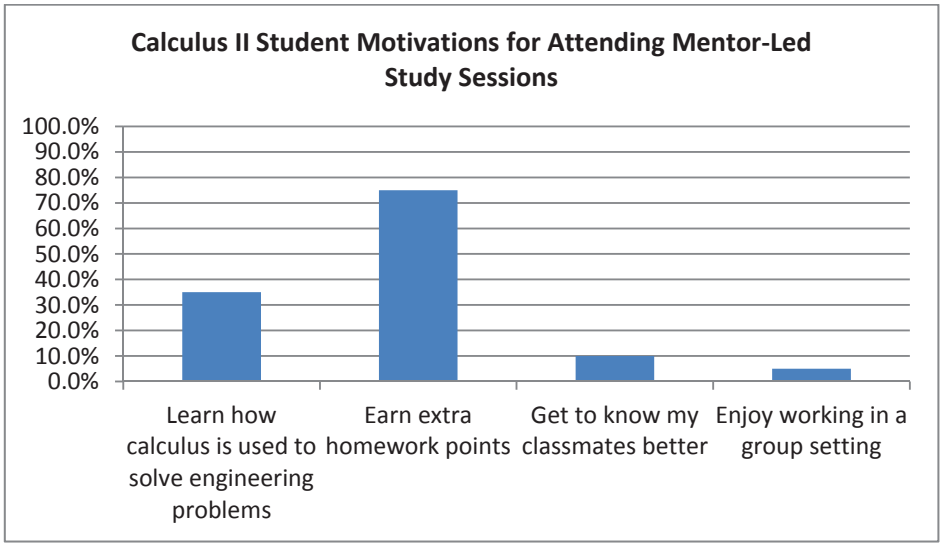

Figure 2: Student motivations for attending Calculus II mentor-led study sessions.

III-2 Helpfulness of the Peer Mentors in Learning Calculus

Calculus I. Figure 3 shows the results related to how the peer mentors were helpful in learning Calculus I concepts. The participating Calculus I students found working with the engineering peer mentors in the study sessions to be "somewhat helpful" (14.3%), "helpful" (42.9%), "very helpful" (28.6%), or "extremely helpful" (14.3%) in learning calculus.

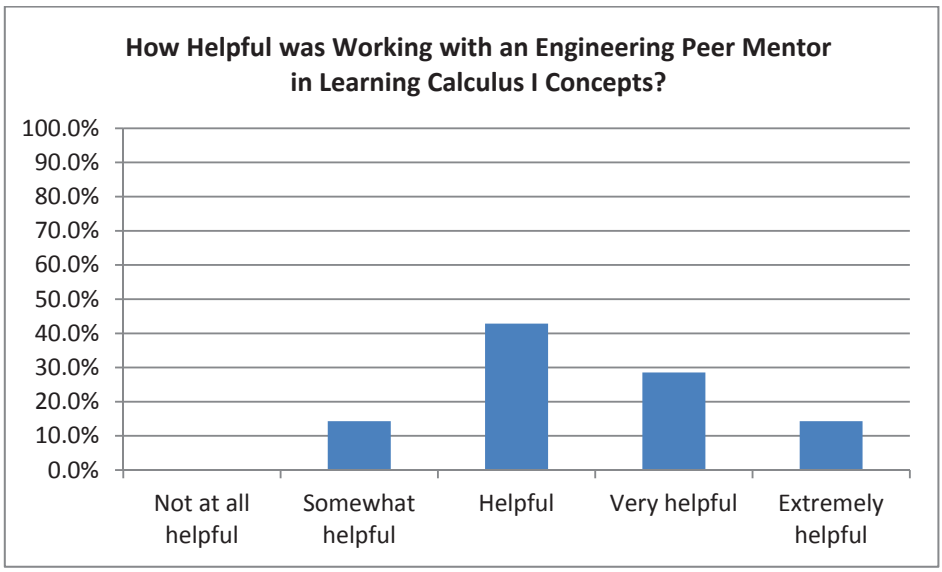

Figure 3: Results related to how the peer mentors were helpful in learning Calculus I concepts.

Calculus II. Figure 4 shows the results related to how the peer mentors were helpful in learning Calculus II concepts. The participating Calculus II students found working with the engineering peer mentors in the study sessions to be "somewhat helpful" (26.7%), "helpful" (66.7%) or "very helpful" (6.7%) in learning calculus.

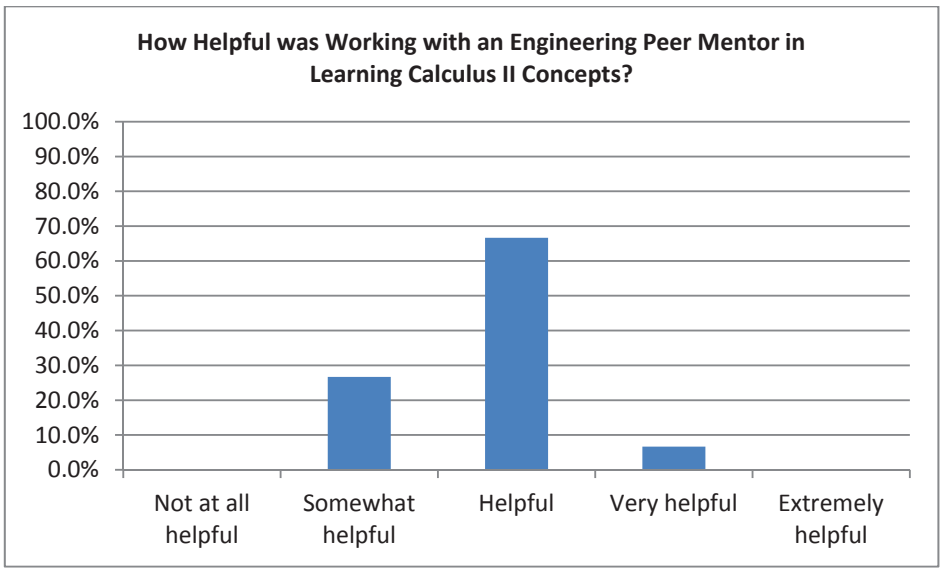

Figure 4: Results related to how the peer mentors were helpful in learning Calculus II concepts.

III-3 Student Connectedness

Calculus I. As shown in Figure 5, participating Calculus I students felt "somewhat connected" (28.6%), "connected" (28.6%), or "very connected" (28.6%) to other students in math and engineering after taking Calculus I and participating in the mentor-led study sessions.

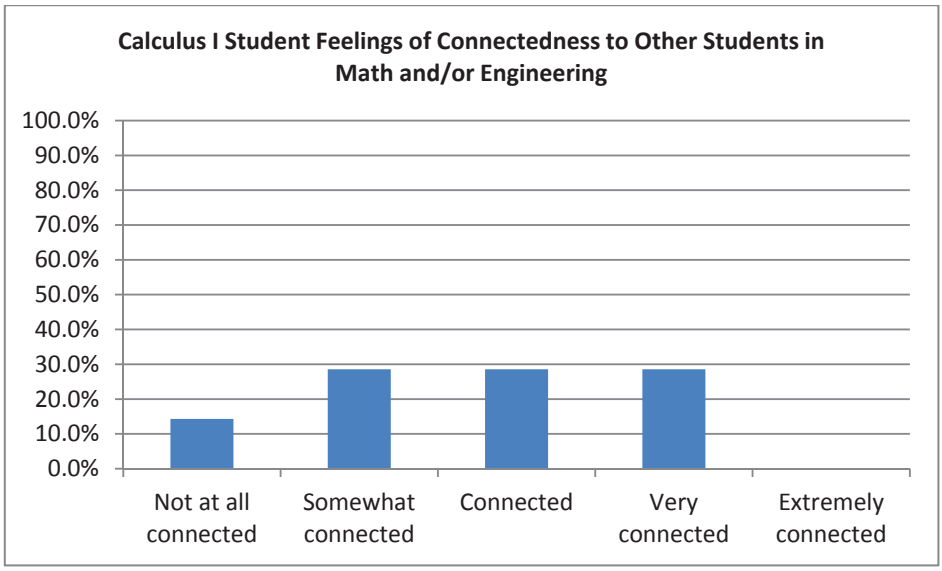

Figure 5: Calculus I student feelings of connectedness to other students in math and/or engineering.

Calculus II. As shown in Figure 6, participating Calculus II students felt "somewhat connected" (27.8%), "connected" (38.9%), or "very connected" (22.2%) to other students in math and engineering after taking Calculus II and participating in the mentor-led study sessions.

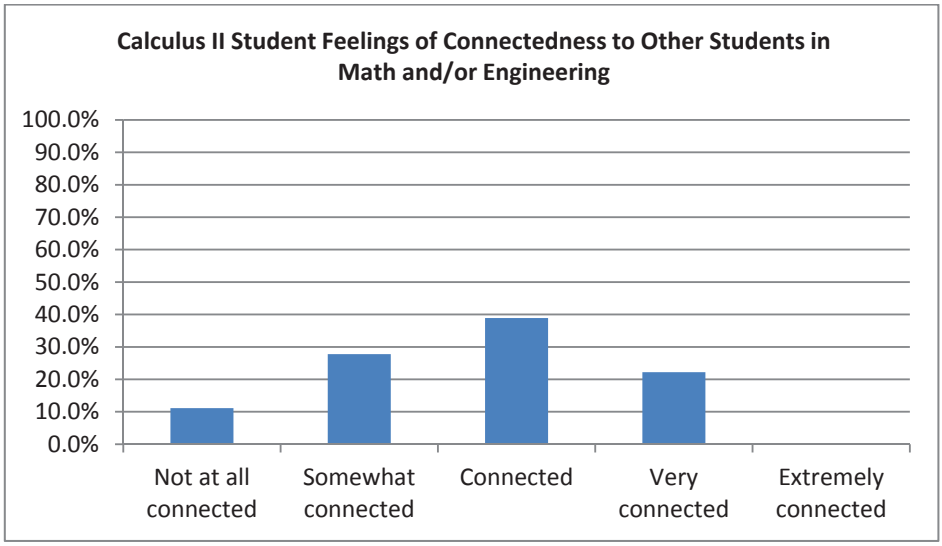

Figure 6: Calculus II Student Feelings of Connectedness to Other Students in Math and/or Engineering.

Conclusion

Peer mentoring has been shown to be a successful in promoting student retention in academic programs. In our project, we positioned the use of peer mentors as an improved institutional effort to retain students in engineering and the use of engineering peer mentors was considered helpful in learning calculus by the majority of Calculus I and Calculus II student participants. The students were primarily motivated to attend study sessions by the opportunity to earn extra homework points. This pragmatic approach served them well, as they received an added benefit of connecting with their peers as well as with the peer mentors with which they studied. As consideration of the mentor-led study sessions continues, so does the pursuit of creating a framework for best practices of peer mentoring programs that may be used by other institutions.

Acknowledgement

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