Supporting Students Through Peer Mentoring in Developmental Mathematics

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Abstract

Students taking developmental mathematics often need academic support to succeed in their courses, but also benefit from support in adapting to university life. In this paper we describe our experience in developing, implementing, and evaluating a peer mentoring program for developmental mathematics students at a large research university that focused on both academic and psychosocial support. We give a summary of the success and persistence rates of students in the program, compare them to non-mentored students, and discuss the results of an assessment of the project that includes student feedback and lessons learned.

Introduction

Nationally, approximately 42% of students enter college needing a developmental mathematics course (Radford, Pearson, Ho, Chambers & Ferlazzo, 2012) and lacking the necessary mathematical background to begin the mathematics courses required for their chosen majors. More than a third of students in the U.S. planning majors in science, technology, engineering, and mathematics (STEM) enroll in mathematics remediation (Radford et al., 2012), and, despite rapid growth of enrollment in STEM disciplines in recent years, the number of students graduating with a STEM degree remains relatively stagnant due to diminishing student retention rates (Hurtado, Eagan & Chang, 2010; Thompson & Bolin, 2011).

Also, as the number of developmental mathematics courses taken increases, rates of successful completion of the sequence needed to enter a mainstream mathematics track (such as calculus) decrease dramatically (Bailey & Cho, 2010). Consequently, the chances of persisting in a STEM major for this population decrease as well.

More than 5000 students enter our University each year and place into mathematics classes through national standardized exam scores or the departmentally administered placement exam. Roughly 30% of our first year students are not ready for college level mathematics (Fuller, Deshler, Kuhn & Squire, 2014). Since the early 1980s, the department has offered a developmental mathematics course focusing on basic arithmetic, pre-algebra skills, and critical thinking that serves approximately 1000 students per year. The current format of the course is a self-paced, mastery online model with in-class facilitators and its efficacy has been evaluated as it has changed formats over the past decade (Deshler & Fuller, 2016).

Despite the increase in success rates for students both in this course and in subsequent courses (Deshler & Fuller, 2016) after various revisions of the course delivery method and content, we recognized an additional opportunity to support students in this course academically as well as through enculturation into the university system. In this paper we describe the process of designing, implementing, and evaluating a peer mentoring program in a developmental mathematics course at a large university, with the goal of ultimately supporting STEM majors and STEM persistence. One of the goals with the peer mentoring program was to provide additional support to increase overall STEM persistence for students starting in developmental mathematics. Support programs meant to retain STEM-intending students in their majors often overlook those who begin their academic journey at this lowest level of mathematics and focus on those in calculus and higher level courses. The program was implemented in developmental mathematics in an attempt to retain more students in STEM majors by reaching them earlier in their careers, before they switch to majors that do not require calculus.

Literature Review

The recruitment and retention of majors in STEM disciplines has received a great deal of attention from researchers over the last few decades. As the U.S. economy has transitioned to more technically demanding industries the need for workers with skills that are affiliated with those disciplines has outstripped the supply (PCAST, 2012). These students in turn must enroll in a number of mathematics courses in order to develop the mathematical skills needed for these majors. The result is that the population of students taking mathematics courses has broadened substantially (McFarland et al., 2017) as larger cross sections of the population enter these courses.

Historically, mathematics courses have presented significant obstacles to students in general and as the population of students has increased, the need to adapt instructional methods and support structures to a more diverse population has grown. In particular, in order to foster access and success for larger, more diverse, groups of students in STEM, support structures in mathematics must provide a more diverse collection of processes to meet the needs of students (Watkins & Mazur, 2013). Meeting the needs of underrepresented groups and first-generation students, for example, requires efforts that go beyond the traditional supports provided for students in a calculus class since many of those were designed for populations with very specific backgrounds (Hernandez, Schultz, Estrada, Woodcock & Chance, 2013; Hurtado, Newman, Tran & Chang, 2010) and they may not resonate with the actual students in a given classroom. Content-focused support in the form of tutoring or help sessions can be limited in its impact (Topping, 1996; Crouch & Mazur, 2001) since tutoring is typically defined as interaction with students that is intended to focus on the acquisition of knowledge in a given subject. Mentoring, on the other hand, focuses more holistically on a number of aspects of student experience (Colvin & Ashman, 2010) including student engagement that are not strictly related to instruction. Peer mentoring, in particular, provides this support through individuals, such as other students who have taken a given course, with the intent of creating culturally and individually relevant interactions that increase the positive impact on students who are currently active in a course. Indeed, recent work has shown that peer mentoring creates a support environment that allows students to engage in learning while connecting with role models with whom they can identify more readily (Dennehy & Dasgupta, 2017; Fox & Stevenson, 2006; Morales, Ambrose-Roman & Perez-Maldonado, 2016; Rios-Ellis, Rascón, Galvez, Inzunza-Franco, Bellamy & Torres, 2015). In many cases, the peer mentoring structure is also less threatening and can provide supports that extend outside the classroom into the day-to-day lives of students where departure events may be more likely to occur.

Recent work in various STEM areas including chemistry (Wamser, 2006) and long-term studies in physics (Crouch & Mazur, 2001; Watkins & Mazur, 2013) have demonstrated the impact that peer mentoring can have in courses with mathematical content that challenges students. Consistent evidence (Watkins & Mazur, 2013) indicates that peer mentoring supports higher levels of STEM retention and that this can have an impact at the developmental level (Weissman et al., 2011).

Many researchers have outlined best practices for peer mentoring of college students (Anderson & Boud, 1996: Crisp & Cruz, 2009; Jacobi, 1991; Topping, 1996). In a meta-analysis of articles from 1990-2007, Crisp and Cruz (2009) found that peer mentors had been shown to provide psychological or emotional support, assistance in goal setting and career paths, subject-specific expertise, and served as role models. Cramer and Prentice-Dunn (2007) posited that the impact of peer mentoring cannot easily be separated into neat categories and that psychosocial support is closely linked to identity formation and belonging, but these functions do not act in isolation (e.g., academic support can promote self-efficacy and thus belonging). Zaniewski and Reinholz (2016) describe a mentoring program where peer mentors provide both academic and psychosocial support. In that study, mentors were recruited from a pool of students who had the same set of majors as the mentees and the experience level of the mentors ranged from second-year to graduate students. Mentoring supported students to deal with a wide variety of topics, ranging from academic to personal, according to the needs of individual mentees. The impact of their program was both academic and psychosocial and helped mentees develop a sense of belonging and positive science identities. Kram and Isabella (1985) define a model of peer mentoring that supports both academic and psychosocial development and we based our program on this model to support students' development as mathematics students, college students and STEM majors.

Program Development and Implementation

We define peer mentoring based on Kram (1983) and as used by Terrion and Leonard (2007) as a relationship in which two individuals of similar age and experience come together (formally, in our case) to fulfill a set of functions that are career-related (e.g. information sharing, academic tutoring) and psychosocial (e.g. emotional support, personal feedback). Two mathematics faculty members and a graduate student assistant worked together to establish the following goals for the program grounded in the literature: (1) provide a support system for students in developmental mathematics, (2) increase developmental mathematics students' feelings of campus connection, (3) help developmental mathematics students navigate curriculum and locate university resources, (4) increase developmental mathematics students' confidence, involvement in learning, and retention, (5) cultivate relationships between students who have successfully completed developmental and subsequent mathematics courses and current students in the course, (6) develop current developmental mathematics students into potential future mentors, and (7) help developmental mathematics students address adjustment issues and improve decision making.

In order to build a program that would combine academic support with general university acclimation support, the first focus was on recruiting appropriate peer mentors. Many mentoring or tutoring programs that are strictly focused on supporting the academic activities of students tend to recruit their tutors from a pool of talented, upper classmen who have done well consistently in the relevant courses. Academic achievement, as expected, is one of the ten common characteristics identified in student peer mentors (Terrion & Leonard, 2007). However, upper classmen, specifically mathematics majors, are often less likely to relate to the struggles of a student in developmental mathematics than a student who started college in a similar course. Therefore, in our program we consciously chose peer mentors to be students who had started their mathematics coursework at our university in the same developmental course and who had been successful both in the developmental course and in at least one subsequent mathematics course. For consideration to be a peer mentor in our program, a student needed to have passed the developmental mathematics course with an A the previous year and have received an A or B in their next mathematics class, College Algebra. They did not necessarily have to be a STEM major or have persisted beyond College Algebra, though some were taking a subsequent College Trigonometry class when recruited to be a potential peer mentor.

The mentor recruiting materials were created, and the peer mentor training was then established based on the goals and on existing literature on best practices. The graduate assistant was tasked with the day-to-day operation of the peer mentoring program, including the recruitment and training of the mentors, with the faculty members overseeing all activities. The graduate student assistant emailed all qualified potential peer mentors to recruit them to the program, sent them an application, screened and interviewed all applicants, and chose eight mentors for the first semester of the program. Seven of the eight were retained as peer mentors in the second semester. Selection criteria included not just the academic requirements, but also considered the student's desire and potential to help others. The mentors met with small groups of mentees (average six) twice weekly in one-hour sessions. Mentors were paid the standard undergraduate hourly rate for jobs on campus, including those who tutor in our Mathematics Learning Center.

The training materials for the mentors included activities for each week that would help them learn to work with students and understand what topics to emphasize during their weekly small-group meetings. The mentors met with the graduate student assistant weekly and, as the semester went on, the meetings also helped address issues that arose during the meetings they had with their mentees. The mentor training meetings covered such topics as what it means to be a peer mentor, guidelines for mentor/mentee meetings, how to get a group to interact (such ice breakers), an introduction to university resources, how to set and achieve short term goals, and other such topics. The training materials did not include mathematics topics, since the mentors had all recently passed the course the mentees were taking, but they did include ideas about how to help students understand mathematics in general. Also, instead of preparing all materials for the mentors, the graduate student assistant would occasionally assign different topics to each mentor to research and report back information to share with the group. This allowed the mentors to build communication skills within their small group that could be translated to their mentor/mentee meetings.

Research Methods

During the first semester we offered the peer mentoring on a strictly voluntary basis. We did this so that any issues that arose throughout the pilot semester for a smaller group of students could be addressed before a larger implementation. All students in the developmental mathematics course were emailed and offered the opportunity to meet with mentors outside of class for two hours per week to work on mathematics and also to learn about resources available to them on campus for any issues they may have while adjusting to their first year in college. In the first semester of the mentoring program, there were 696 students enrolled in the course and only 24 asked to be part of the peer mentoring groups. For the pilot and followup implementations described in this paper, we considered a mentee to have participated actively if they missed at most four peer mentoring sessions (two weeks of the semester). Only eight of the 24 students in the pilot project attended enough meetings to be considered to have fully engaged in the peer mentoring. Though this number was smaller than we had hoped, we were able to discern from this small pilot what some of the issues and obstacles to a full implementation may be and address them in the subsequent implementation.

Because the goal of the program was to support all students in the course, our ultimate plan was to implement the program for all students, requiring attendance. To move toward this model, in the second semester, we required participation in the peer mentoring process for students in two sections of the course, and used two sections offered at the same times and taught by the same instructors as a control group. Each set of instructors taught back-to-back sections, one with peer mentoring and one without. For the two treatment sections, the peer mentoring was a required part of the coursework. Again, we considered a student to be fully engaged in the peer mentoring process if they missed no more than four peer mentoring sessions.

In that semester, there were 450 students enrolled in the course, and 87 students in the two treatment sections were required to participate in peer mentoring. Of the 87 who were required to attend, 54 actively participated the peer mentoring program (missed at most four peer mentoring sessions).

Program Evaluation & Participation

In order to more fully understand the impact of the peer mentoring program on the participants, an assessment plan was developed that included the administration of a follow-up survey and focus group interviews. The survey instruments and processes were developed by an independent evaluator for the project based on a peer mentoring evaluation toolkit (Clark & Andrews, 2009) and questions were all rated on a 5-point Likert scale from Strongly Agree to Strongly Disagree. Of the 87 students in the original mentee group of the second semester, 54 finished the program; 19 (35%) of those responded to the survey; and 12 (22%) participated in focus groups. Unfortunately, since the pilot treatment group population was initially only 87 students, the resulting population of followup survey respondents was quite low and the focus group population lower still. The survey and two follow-up reminders were sent to the mentee's email near the end of the semester; the low response rate could be explained by the fact that some of the students finished the course early.

Five focus groups were held for mentees; 12 mentees attended these sessions with one, two, or three in each session. The focus groups were held near the end of the semester during one of the regular peer mentoring sessions, without the peer mentors present. No additional meetings or plans had to be made as this was a regular meeting time. By the end of the semester there were only a few students still coming to the sessions, because many had finished. It may be the case that the respondents to the survey, like the mentees attending the focus groups, were the students who took the longest time to finish the course. To begin the discussion, some questions were asked about why they decided to study at the university, what their main concerns were when coming to the university, and how they prepared for their transition to the university. The remaining questions came from the Peer Mentoring Evaluation Tool Kit (Andrews & Clark, 2011). Focus group meetings were facilitated by the program's external evaluator, who audio recorded the meetings for data collection and later analyzed the data.

The mentees who completed the survey were from various majors including three STEM majors (one Forensics and two Biology) with the rest from Business, Finance, Athletic Training, Occupational Therapy, Psychology, Elementary Education, Exercise Physiology, Wildlife Management, Health Professional, Information Systems, and Undecided. Of the survey respondents, six were male; 13 were female; one was black or African American; 18 were white; and all were U.S. citizens. None of the 19 identified as having a disability. They ranged in age from 18 to 20, with most (11 of the mentees) being 18 years old. Sixteen of the mentees were freshmen; two were sophomores; and one was a junior. Seventeen were full-time students and two were part-time. Twelve mentees lived on-campus and seven lived off-campus. We collected information about their perceptions of the peer mentoring program and of the benefits they received from being involved as a mentee.

Major persistence. For this study we were also interested in the persistence of students in STEM majors. Using the National Science Foundation (NSF) list of CIP codes for majors considered STEM, we coded student majors as either STEM or non-STEM while they were in the developmental mathematics course. We then coded the same students' majors as of the fall term of the following academic year in the same way and, following the analysis in Rasmussen & Ellis, (2013), we consider four different patterns for major choice among students (Table 1).

Table 1. Patterns of Major Choice Over Duration of the Study

Category	Description
Persister	A student who began the study in a STEM major and was still in a STEM major in the fall term of the following academic year
Switcher	A student who began the study in a STEM major and was not in a STEM major in the fall term of the following academic year
Culminator	A student who began the study in a non-STEM major and was still in a non-STEM major in the fall term of the following academic year
Converter	A student who began the study in a non-STEM major and changed to a STEM major in the fall term of the following academic year

Study limitations

Participants. As is often the case with educational studies, students were consented and enrolled in this study on a voluntary basis. Therefore, it is expected that there is some self-selection bias but that this is the norm in voluntary educational studies.

Departmental changes. During this study, changes beyond the control of the research team were implemented in the department and these affected some aspects of this work, including success rates. In the Fall of 2016, the same semester we implemented the peer mentoring program, the placement test that guided students into mathematics courses at our University was changed to a more rigorous, adaptive, mastery-based testing system. The stronger diagnostic resulted in more students being placed into the developmental course being studied (instead of College Algebra) than in previous semesters. Consequently, the success rate of students in this course changed from year one to year two of the research project. This affects the results presented later in this paper but is also representative of the continual need to assess and adjust placement policies and procedures within a large mathematics department offering many classes to a large number of students.

Incentivizing participation. One of the greatest difficulties with the design and implementation of the peer mentoring program was determining how to incentivize participation, both during the first semester when participation was voluntary and in the second semester when some students were required to attend, but many other students (in other sections) were not. A decision was made to incentivize completion of the program the first semester with a gift card. The small number of students who completed the entire peer mentoring program that semester with no more than four absences were awarded a small gift card to the campus bookstore. The small number of students who earned gift cards (the eight who actively participated) that semester is indicative of the difficulty we had in getting students to show up to the meetings. We decided that required attendance would be the best way to get students to participate in the meetings.

Since providing a financial reward is not a sustainable method of incentivizing student participation, it was decided instead to establish an attendance policy with consequences for missing peer mentoring meetings. The mathematics class met four days per week and students were allowed to miss up to six class meetings before the absences would affect their grade. For each class absence after six, the final grade was reduced by a letter grade. Given that the course already had this mandatory attendance policy in place, the peer mentoring program adopted a similar policy to require students to attend the peer mentoring meetings in the second semester. For each meeting absence after four the final grade was reduced by a letter grade. This structure was further complicated by the self-paced nature of the course. A number of students who complete the course do so earlier than the end of the term. If they complete the mathematics material, they are no longer required to attend class and may miss class without penalty. For the peer mentoring program, if a student completed the course at some point prior to the end of the term and stopped attending the peer mentoring meetings, they were still considered to have actively participated in the peer mentoring program.

Communication with instructors

In order to ensure effective and consistent implementation of the various core components of the peer mentoring process, a great deal of communication was developed among instructors, the peer mentoring leader, the mentors, and the project leaders. Since the research team was leading the peer mentoring sessions outside of the classroom, and none of the instructors were part of the research team, our goals for the program were communicated to instructors via regular emails, program documentation including the peer mentoring manual, and regular meetings of the mentors with the peer mentoring leader. The instructors were generally focused on helping students get through the course while the mentors were focused also on enculturating them into university life and helping them navigate the course successfully. One aspect of the intent of this program was to articulate concerns across this boundary so that each group (instructors or mentors) would be aware of the other group's progress and concerns.

As noted above, the self-paced nature of the course made the attendance tracking process more challenging since students who completed all the online modules prior to the end of the semester were able to stop attending both the class and the mentor meetings. Consequently, it was important for us to have continued communication with the course instructors about this issue as well. They would let us know when students finished the content and we would report back to them the number of absences from the peer mentoring meetings up to that point to use when determining student final grades. Instructors were ultimately responsible for assigning student grades based on the information we provided them about the total number of absences.

Results & Discussion

In the self-paced model of this developmental mathematics course, students may move on to College Algebra once they have completed six mastery exams (out of 8) in the sequence. Using this as the definition of success in the course, we have the success rates over a 2-year period as presented in Table 2. The 2015-2016 data was collected as a baseline before the peer mentoring program was implemented. However, there was another change that affected the data – the placement process for students was changed this year as described in the limitations section above. Therefore, we will focus on data from the second year for analysis. In total, over the two-year period of the study with 2421 students enrolled the pass rate was 70.8%.

Table 2. Success rates in Developmental Mathematics Fall 2015 – Spring 2017 by Percentage

Semester	Success	Fail
Fall 2015	45.6	54.4
Spring 2016	68.7	31.3
Fall 2016	81.8	18.2
Spring 2017	74.9	25.1

During the first implementation of the peer mentoring program, participants volunteered. Students were required to meet with mentors twice per week for approximately 14 meetings during the semester. Out of the total cohort of 696 students enrolled in the course, only 24 signed up for mentoring and of these only eight persisted to the end of the program by attending at least 10 weeks' worth (20 meetings) of the peer mentoring sessions, and only six passed the course.

Table 3. Success Rates for Fall 2016 Pilot by Peer Mentoring Status by Number and Percentage

	Success		Fail		Total
	N	%	N	%	N
Not Mentored	550	81.8	122	18.2	672
Began, Did Not Complete Mentoring	13	81.3	3	18.8	16
Completed Mentoring	6	75.0	2	25.0	8

Outcomes from the pilot implementation were mixed and are presented in Table 3. The success rate was higher for the mentored group than the general population from previous semesters, but lower than the general population for that semester. The small number of students suggested that we needed to recruit participants differently and could not draw conclusions based solely on this implementation.

For the treatment group of the second semester implementation, we assigned 87 students from two sections to mentors and ended the study with 54 of them completing the peer mentoring program. Table 4 shows the success rates for these students and the entire population, as well as for the control group.

Table 4. Success Rates for Spring 2017 by Peer Mentoring Status by Number and Percentage

	Success		Fail		Total
	N	%	N	%	
All Non-Mentored Sections	216	75.2	70	24.8	286
Paired Instructor Control Group	56	74.0	21	26.0	77
Mentoring Treatment Sections	45	83.3	9	16.7	54

During this semester, mentored students who completed the peer mentoring process with no more than four absences outperformed students both in the larger population that received no peer mentoring and in the matched sections of the control group. The measured effect on success is strong but was not found to be statistically significant using a chi-square analysis of the 3x2 table ($\chi^2(2)=2.081$, $p=0.353$).

Persistence. Students who participated in the peer mentoring process in either of the implementations were more likely to persist in a STEM major. In particular, for the Spring 2017 implementation, 5% more of the mentored STEM majors persisted than observed in the larger, non-mentored population over the course of the program. Moreover, students converted to STEM in the mentored group at almost twice the rate as in the larger population and switched out of STEM majors at a rate that was one third less than the non-mentored.

Table 5. STEM Persistence Tracking for All Students in the Study

	Switcher		Culminator		Converter		Persister		Total
	N	%	N	%	N	%	N	%	
Not Mentored	345	14.6	1611	68.3	50	2.1	353	15.0	2359
Fall 2016 Mentored	0	0.0	6	75.0	0	0.0	2	25.0	8
Spring 2017 Mentored	5	9.3	36	66.7	2	3.7	11	20.4	54
Total	350	14.5	1653	68.3	52	2.1	366	15.1	2421

Interestingly, students in the smaller pilot cohort persisted at a higher rate (25%) than any other, even though the peer mentoring process was not implemented as completely as it could have been. It is likely that the smaller number of students overall in this cohort (*N*=24) led to outcomes that are more variable than would be expected in a larger group, or that the more focused attention on the group (higher mentor to mentee ratio) that actually completed the program (*N*=8) tended to reinforce persistence even more. Similar to the success analysis, the impact on this outcome was not observed to be statistically significant ($\chi^2(2)=4.745$, $p=0.577$). Overall, these results indicate that mentoring had a slightly positive impact on persistence but given the small sample size our results cannot distinguish this impact from the variance determined by other underlying variables such as course structure, demographic factors or student personality.

Non-academic results for participants. In Table 6, we see that the mentees have a somewhat positive perception of the program and the benefits they gained from the program. The scale was from strongly agree (5) to strongly disagree (1). The highest agreement occurred with the statement "As a result of participating in the peer mentoring program, I am more committed to completing my course of study." Over half (58%, 11 students), agreed with the previous statement. This could be interpreted that as a result of participating in peer mentoring, the students are more dedicated to persisting in their chosen major. While the learning outcomes for the course focus primarily on knowledge acquisition within the college algebra spectrum, it has been observed that in many cases students abandon the course when they begin to perceive that the difficulty presented by either the course or the process of being a university student in general becomes unmanageable. In order to ascertain the impact of the mentoring program on student perceptions of their connection to the university and their mathematics program, we administered a survey with the items in Table 6 to measure a number of aspects of this sense of belonging, hypothesizing that strong agreement with these statements would in turn indicate that the mentoring program was providing supports that would enhance student engagement and academic progress in general.

Table 6. Mentee Perceptions of Benefits of Participating in Peer Mentoring Program by Response to "As a result of participating in the peer mentoring program..." Questions

Question	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	N	Average Value
...I feel part of the university	0	8	6	2	3	19	3.00
...I feel I am making more use of the opportunities available at university	0	8	7	2	2	19	3.11
...I am finding my time at university more enjoyable	1	7	6	3	1	18	3.22
...I feel my communication skills are more developed	0	9	4	4	2	19	3.05
...I am more committed to completing my course of study	0	11	4	2	2	19	3.26

In Table 7, we see perceptions of the mentees on other possible benefits of participating in the program. The scale for this set of statements was from significantly increased (5) to significantly decreased (1). The highest scoring statement in this set was "As a result of participating in the peer mentoring program, my subject knowledge has...." Over half (53%), reported that their subject knowledge had increased or significantly increased as a result of participating in the program. For all of the statements, only two or three of the mentees had negative responses; most responses to the statements were either positive or neutral.

Table 7. Mentee Perceptions of Benefits of Participating in Peer Mentoring Program by Response to "As a result of participating in the peer mentoring program..." Statements

Question	Signif-icantly Increased	Increased	Not Changed	Decreased	Signif-icantly Decreased	N	Average Value
...my confidence in succeeding in my studies has...	1	7	10	0	1	19	3.37
...my confidence about my academic skills has...	1	5	11	1	1	19	3.21
...my subject knowledge has...	2	8	8	0	1	19	3.53
...my confidence in using student services has...	1	8	8	1	1	19	3.37
...my ability to form new connections with other people has…	1	8	7	2	1	19	3.32
...my ability to make positive decisions has...	2	6	10	0	1	19	3.42

In Table 8, we see that the mentees have a somewhat neutral or even slightly negative perception of the program related to the learning experience in the program. The scale was from strongly agree (5) to strongly disagree (1). Slightly less than half (47%) agreed or strongly agreed that "Working with a peer has been a positive learning experience." Only 32% disagreed or strongly disagreed with this statement. Forty-two percent (42%) agreed or strongly agreed with "Peer mentoring has helped me learn independently," while only 32% disagreed or strongly disagreed with this statement. On the slightly negative side, 47% of mentees disagreed or strongly disagreed with the statement, "I feel my grades will improve as a result of peer mentoring."

Table 8. Mentee Perceptions of Their Learning Experiences

Question	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	N	Average Value
Peer mentoring has positively influenced the way I approach learning	2	4	9	2	2	19	3.11
Working with a peer has been a positive learning experience	1	8	4	3	3	19	3.05
Peer mentoring has increased my interest in my subject area	2	4	6	3	4	19	2.84
Peer mentoring has helped me learn independently	3	5	5	3	3	19	3.11
I feel my grades will improve as a result of peer mentoring	1	4	5	5	4	19	2.63
Peer mentoring has increased my involvement in my own learning	1	4	8	2	4	19	2.79
Peer mentoring has helped me understand how to self-pace my own studies	1	5	6	3	4	19	2.79
Peer mentoring has positively influenced the way I make decisions related to academic matters	1	4	7	4	3	19	2.79

In Table 9, we see that the mentees had a slightly positive perception of the value of the peer mentoring program. The scale was from strongly agree (5) to strongly disagree (1). More than half (58%) agreed or strongly agreed with the two statements "I can relate to my mentor" and "I feel comfortable working with my mentor." Also, just slightly less than half (47%) agreed or strongly agreed with the two statements "I feel I can talk to my mentor if I am worried" and "I enjoyed working in a small group with other students." We find these results to be supportive of continuing the peer mentoring, though not overwhelmingly indicative of a highly effective program.

Table 9. Mentee Perceptions on the Value of Peer Mentoring

Question	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	N	Average Value
Peer mentoring is responsive to my individual needs	1	7	6	3	2	19	3.11
I can relate to my mentor / mentee	1	10	4	1	3	19	3.26
Working with another student has been useful	2	5	5	4	3	19	2.95
I enjoy working in a small group with other students	1	8	4	1	5	19	2.95
I feel I can talk to my mentor / mentee if I am worried	2	7	5	2	3	19	3.16
I feel comfortable working with my mentor / mentee	2	9	4	1	3	19	3.32
I can talk to my mentor / mentee about things I would not discuss with a member of faculty	2	6	6	2	3	19	3.11

The mentees were also asked "Did your mentor have adequate training for the peer mentoring role?" Sixty-nine percent (69%) said that the mentor had extremely adequate or moderately adequate training; only one mentee said that the mentors had moderately inadequate training and no mentees responded that mentors had extremely inadequate training (Table 10).

Table 10. Mentee Perceptions of Mentor Training

Answer	N	%
Extremely adequate	6	31.58
Moderately adequate	7	36.84
Neither adequate nor inadequate	5	26.32
Moderately inadequate	1	5.26
Extremely inadequate	0	0.00
Total	19	100.00

The mentees were asked "During your time at [the University] have you ever thought about leaving?" The responses were divided evenly between "Yes" (9 mentees) and "No" (9 mentees), with one student saying they were "Not Sure." Students who answered "Yes," were given a follow-up question "If you thought about leaving did peer mentoring influence your decision to stay?" Only one student of the nine said that peer mentoring had influenced his decision to stay: the others answered in the negative. This result may be due to the fact, that for this peer mentoring program, they were focused on student success in a particular course and not working with students as general mentors. Students indicated things like being homesick, not liking school in general and not liking [the University] in general. No students indicated wanting to leave because they were not passing their mathematics course. These statements support the conclusion that peer mentoring should span a larger portion of student life than content support. The distinction partially manifests in the follow-up survey responses indicating that some of the quantitative improvements in success may be attributable to these soft skill support areas but the number of participants is too small to provide sufficient data.

Ten mentees responded to the open-ended question, "How can the peer mentoring program be improved?" Several of the responses addressed two or more ideas. One mentee said, "It was an awesome program that helped me a lot." Two responses said that students should receive more credit for the course if they had to attend two extra hours a week for peer mentoring. Three responses commented that the program should not be mandatory, because some students didn't need it. Four responses said that the program was a waste of their time. One commented that their mentor was not helpful nor attentive.

Mentee Focus Group Results. Students were then asked how they learned about the peer mentoring program. Most said they received an email from the graduate student assistant, then from the mentor. Some said their teacher told them about the program while others said that someone came to their class at the beginning of the semester and asked them to sign a consent form. The mentees said their first contact with their mentor was through email and the first meeting happened several weeks after the course started. When mentees were asked "How did you feel about meeting your mentor?" some answered that they were skeptical, nervous or felt strange about the first meeting. Some mentioned that they thought it might be a waste of their time or that it would conflict with other activities that they already had scheduled. The mentees were then asked, "What were your first thoughts about your mentor?" All mentees had a positive response to this question. The mentees described their mentors as "Friendly, nice, approachable, relatable" and said that they "Helped when they could", were "patient with slower students", "would give students extra time" and one said his/her mentor was "very young in the same shoes as me, understood what I was going through".

The mentees were then asked, "Was there anything that the mentor did to make the mathematics class a good one?" The responses included that the mentors helped explain topics that the teacher didn't go over, made the content understandable, gave extra help, and helped to keep unmotivated students accountable. The question was asked, "How did the mentor make sure you got what you wanted?" The mentees said that the mentors individualized the help by checking in with each student and asking about their understanding of the topic they were working on. Some of the mentors helped set schedules for pacing of the material to ensure students could finish on time. One mentee stated that the mentor would let him leave the sessions to go take tests for the course and another said the mentor would check with him about what he had missed on their tests, to help him get ready to re-test. One mentee mentioned that he would email the mentor questions and the mentor would bring materials to help him at the next session.

Mentees were asked, "What was the most valuable thing you got out of the peer mentoring?" Most of the responses to this question pertained to the idea that it forced the mentee make time to study the mathematics and get the class-work completed. Since the mathematics course is self-paced, this was a very beneficial result of the peer mentoring. Several said it provided extra help and one-on-one instruction when they needed it. Some commented that it helped them finish the class on time.

The mentees were asked to name one key aspect of the program. The responses included that it was mandatory and they had to be there, it provided extra time to focus on mathematics, it provided extra help, and it kept them from procrastinating in the course. The mentees also mentioned that being part of the peer mentoring program helped with other classes. One mentee said the mentor had taught him how to take things step by step – read and try to understand. Several responded that it helped them with scheduling and developing a routine. Others responded that it made them more accountable or made them realize they needed more discipline to get things done. Again, these responses indicate a support effect that is broader than the course-specific content support that tutoring supplies. The fact that mentoring impacts student behavior in other courses and responses to events outside the course indicated a successful effort to enable this support. More data would be needed to understand the relationship with success and persistence.

Finally, the mentees were asked if there were any issues or negative aspects of the peer mentoring program. Several suggested putting the sessions as a lab for the course, so students would know at the start of the semester and arrange other courses and obligations around the sessions. One issue that was mentioned by many of the mentees was that they did not know about the peer mentoring sessions for several weeks into the semester, they also mentioned that their instructors could not tell them much about the program. One mentee mentioned that he thought there should be more available times to choose from.

Conclusions

Students seeking to complete a university major in a number of areas will have to, as a part of that program, complete a mathematics requirement. For many students, a part of that coursework will include a developmental component that intends to bridge them from the level at which they enter the university to more advanced topics. Students potentially encounter difficulties that span both the academic nature of their degree programs as well as the underlying process of living and being a student at a university.

Peer mentoring programs offer an opportunity to support these students in multiple ways as they progress through their time at a university. By combining an academic support model with a life-skills support model delivered by students with similar experiences at the same level of coursework, the program described here seeks to promote success at the university level and persistence in STEM majors in a novel way. The data from this study indicate that peer mentoring has a measurably positive effect on student success and an impact on persistence in major choice even though these effects could not be isolated as statistically significant. Both of these effects are more complex than a simple causal relationship, and this work is an attempt to present a more holistic picture of how such a program would be developed and how students responded to it, both in terms the levels of success observed as well as in terms of the qualitative responses of the students after having participated in the program.

The next step is to implement this program on a wider scale and to possibly implement a truly randomized trial of the intervention for a larger population. These preliminary results have shown that this type of program can benefit students and the cost of implementation is rather low. In particular, students demonstrated higher levels of success and this effect appears to be supported in part by the mentoring program in a way that is broader than content focused tutoring programs or help rooms. More data would be needed to identify the specifics of this and reach stronger conclusions. We will take the lessons learned and move forward to investigate how peer mentoring can continue to improve the success of students, while helping students persist in their majors and specifically the STEM pipeline. We will also follow these mentored students to determine any long-term effects in subsequent mathematics courses from their early peer mentoring experiences.

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