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Creating Opportunities to Help Students Be Prepared for Careers in a STEM Field

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As a Professor of Mathematics Education I teacher and advise with undergraduate students majoring in BSED Mathematics Education-Middle Level Specialization Track as well as the graduate students the Master of Education in Mathematics Education Elementary and Middle Level Specialization. As Director of Liberal Studies for the university, I oversee all undergraduate curriculum that relates to the Liberal Studies Curriculum at IUP. This includes reviewing all new courses and courses already on the books that are being revised. The review process includes monitoring that Student Learning Outcomes of the course(s) are aligned with the EUSLOs from the Liberal Studies curriculum, that they are measurable, and that there is an assessment mechanism in place. I also evaluate the section of departments' program reviews that pertains to Liberal Studies.

Creating Opportunities to Help Students Be Prepared for Careers in a STEM Field

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This paper reports on an ongoing National Science Foundation's (NSF's) Division of Undergraduate Education (DUE) funded project in the Department of Mathematical and Computer Sciences (MACS) at Indiana University of Pennsylvania (IUP). The program is called Scholarships Creating Opportunities for Applying Mathematics (SCOAM). A variety of activities each semester are designed to strengthen relationships within the academic and STEM communities. Ways in which the goals of the project are being met are outlined in this paper including: recruiting strategies used to get students into the program; offering of activities in the form of presentations and workshops to help students prepare for careers the STEM industry; peer-led tutoring sessions to help with academic success in mathematics classes, and monthly meetings in which participants present original research. Findings from data collected from student surveys at the end of each semester are reported. Finally, the impact of transitioning to online learning as a result of COVID-19 in the middle of a semester on a project that focuses on community development will be shared.

The program has 3 broad goals:

1. increase the number of students graduating with a major, minor, or master's degree in mathematics,
2. strengthen the academic culture of the Department of Mathematical and Computer Sciences, and
3. strengthen relationships with the broader STEM community within and beyond the university.

The project aims to achieve these goals by providing financial assistance to students in need to pursue their degree and developing a series of activities each semester designed to strengthen relationships within the academic and STEM communities. Several activities are offered including presentations by speakers from the STEM industry focused on career options for STEM graduates, workshops to develop career-needed skills, and a series of group activities designed to encourage relationships among the students in the cohort. Students are also required to attend peer-led team learning sessions and monthly meetings in which SCOAM participants present original research and have conversations about career topics (e.g. resume building, career options).

Methodology

Throughout the course of the project the number of students grew steadily from 25 in Fall 2018 to 41 new and returning students in Fall 2020. Three sources of information were used for to collect data; quantitative and qualitative data gathered from an End of Semester survey, student reflection narratives concerning their small group activities, and a report generated that summarizes and evaluates the peer-led team learning sessions. The End of Semester survey was created by the external evaluator in collaboration with the PIs and asked if participation in activities increased motivation to do well in class, provided opportunities to learn new skills, allowed for exploration of career options, and provided the opportunity to interact meaningfully with faculty and students. In addition, in an effort to capture networking skills, the survey asked

about the nature of the conversations with faculty and students inside and outside the Mathematics department and SCOAM program to determine the extent to which SCOAM students were talking about academic versus non-academic topics, specifically, internship, research, graduate school, and career options and opportunities. Because of the theorized relationship between mathematics mindset and perseverance with mathematical tasks, the survey also asked students to rate their identification with both positive and negative statements about their mathematics and science ability. A series of questions was included on the survey to target the main reasons identified in the literature for transition issues and give a sense of how students were transitioning.

Due to COVID-19, the 2020 surveys also contained questions about the impact of the pandemic on their educational and scholarship experiences for both semesters. Questions focused on opinions about remote learning, access to technology, communication with others, and the transitioning of cohort activities to the virtual environment. It was also decided in Spring 2020 to survey faculty teaching in STEM departments. Faculty survey questions focused on the experiences of faculty as they transitioned and taught STEM courses in an online format. For the purposes of this survey, a STEM course was defined as being in the field of mathematics, natural sciences, engineering, computer and information sciences, or social and behavioral sciences.

Findings

As the program has 3 broad goals each goal will be addressed separately in the findings section.

Findings on Goal 1

Goal 1 of the project refers to increasing the number of students enrolling and completing a math major, minor, or graduate degree at IUP. This SCOAM goal overlaps with the departmental and university goal of increasing enrollment and retention. Students were required to participate in several types of activities throughout the semesters including small group activities, monthly meetings, presentations, and workshops. All of these activities were designed to promote connectedness among SCOAM students and/or between students and faculty within the MACS department. A set of items on the survey were designed to capture how well the activities promoted ‘connectedness’ among SCOAM students and motivated students to work hard and complete their coursework.

Small Group Activities and Monthly Meetings

Students were asked to participate in 3 small group activities each semester. In cross-generational groups (i.e., freshman, upper classman, graduate student), students were asked to seek out and attend activities on campus or create their own social event. The purpose of attendance at these activities was to encourage relationships between members of the cohort and to foster a sense of ‘belonging.’ After attending an activity, students were required to post pictures and a reflection on SCOAM’s online learning management platform. At least one of these activities had to focus on a social issue. Participants in the SCOAM program were also required to partake in monthly meetings in which they presented original research and had conversations about career topics (resume building, career options, etc.). A schedule for the

monthly meetings was created prior to the beginning of the semesters and shared with the participants.

Results across semesters are presented in Table 1. There has been a steady increase in percent agreement among SCOAM scholars concerning the social group activities. The upward trends follow the change in social group activities that has taken place over the course of the program. Initially, social groups were to seek out activities on campus to attend (e.g., a lecture on social equity) while current students can make their own social event (e.g., go get pizza together). Opinions concerning the monthly meetings have remained stable over the course of the program, and the transition to remote learning in Spring 2020 notwithstanding. Students appear to struggle with feeling connected in the online environment.

Table 1. Trends in percent agreement for social group activities and monthly meetings.

Social Group Activities	Fall 2018 % Agree	Spring 2019 % Agree	Fall 2019 % Agree	Spring 2020 % Agree	Spring 2020 Virtual % Agree	Fall 2020 % Agree
feel more "connected" to the students in the scholarship group	85.7%	84.6%	90.4%	93.4%	80.8%	90.0%
think about possible career options	33.4%	38.5%	54.8%	60.0%	69.2%	53.3%
learn new skills that will be beneficial in the future	38.1%	42.3%	51.6%	60.0%	76.9%	76.7%
feel motivated to work hard in my classes	57.2%	61.6%	71.0%	60.0%	76.9%	80.0%
feel motivated to continue as a mathematics major/minor	61.9%	73.0%	77.5%	86.7%	92.3%	83.3%
Monthly Meetings						
feel more "connected" to the students in the scholarship group	90.5%	80.7%	87.1%	81.5%		77.4%
think about possible career options	100.0%	100.0%	87.1%	85.1%		90.3%
learn new skills that will be beneficial in the future	100.0%	88.5%	96.8%	88.9%		96.8%
feel motivated to work hard	100.0%	88.5%	83.9%	81.5%		96.8%
feel motivated to continue as a mathematics major/minor	100.0%	92.3%	87.1%	81.5%		90.3%

Presentations and Workshops

Students were required to attend presentations by outside speakers (including alumni), workshops on helping students prepare for STEM careers (computer programming languages, 3-D printing). These workshops and presentations were offered by the department, the college, or the university and were open to all. Presentations and workshop were one of the areas where

students reported many comments concerning the differences between the face-to-face and online presentation environment. On of the largest issues was not being able to ask questions and the lack of the ability to foster connections better in the online environment.

Results percent agreement for workshops and presentations are in Table 2. Workshop data tends to follow the same pattern across semesters although latter semesters have seen an increase in percent agreement concerning connectedness to other students and a high rate of agreement that a new skill is learned. The presentations do not seem to be promoting connectedness among students and faculty, but rather are giving students career options and motivating in their coursework.

Table 2. Results in percent agreement for workshops and presentations

	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020
Workshops	% Agree	% Agree	% Agree	% Agree	% Agree
feel more "connected" to faculty members in my department other than my adviser or mentor	80.0%	46.7%	58.9%	64.7%	56.5%
feel more "connected" to faculty members outside of my department.	40.0%	80.0%	82.4%	76.5%	73.9%
feel more "connected" to the students in the scholarship group	90.0%	53.3%	53.0%	88.2%	82.6%
feel more “connected” to other math and science students	100.0%	80.0%	76.5%	88.3%	87.0%
think about possible career options	70.0%	86.6%	82.4%	94.2%	91.3%
learn a new skill that will be beneficial in the future	100.0%	80.0%	70.6%	94.1%	95.7%
feel motivated to work hard in my classes	80.0%	80.0%	88.2%	70.6%	69.5%
feel motivated to continue as a mathematics major/minor	100.0%	93.3%	70.6%	88.2%	82.6%

Mathematics Mindset and Perseverance with Mathematical Tasks

Responses showed that SCOAM students had a positive mindset towards their math abilities but less so of their science abilities. Students tended to; think they are good at math, liked going to their math classes, believed others think they are good at math, and believed they understand the relationships between different areas of math. Students were confident in their ability to explain math concepts to others but were considerably less confident in their ability to explain science concepts to others. In general, students tended to be less confident in their science abilities compared to their math abilities. Finally, a little over half of the students ‘used to think they were good at’ math and science. Since freshmen may be of particular concern, the data was analyzed again across freshmen only. Patterns across freshmen mirrored the results of the overall survey, but freshmen were much more positive in assessment of their science abilities compared to the entire SCOAM cohort and less confident in their ability to explain science concepts to others.

Trends across semesters on students' mathematical mindset are presented in Table 3 and 4. Mindset for mathematics ability was fairly stable across time. The 2018-2019 cohort appeared to improve their mathematics and science mindset in spring compared to the fall. The 2019-2020 cohort began with a similar math and science mindset compared to the 2018-2019 cohort only to experience a more negative mindset in the spring. It is noted that the spring semester was impacted by COVID-19. The fall 2020 cohort began with a more positive math and science mindset compared to past cohorts. The trend for freshmen, however, is reversed with a less positive math mindset and a more positive science mindset compared to previous freshmen cohorts. Note specifically the 91% of freshmen in Fall 2020 that reported they used to believe they were good at math. Again, the impact of COVID-19 on this mindset is difficult to ascertain.

Table 3. Trends in mindset data – overall

	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020
Mindset	% Agree	% Agree	% Agree	% Agree	% Agree
I am good at math.	95.2%	100.0%	90.3%	96.1%	90.0%
I enjoy going to my math classes.	100.0%	95.9%	93.6%	96.2%	83.3%
Others think I am good at math.	100.0%	100.0%	96.7%	88.5%	96.7%
I used to think I was good at math.	71.5%	75.0%	67.7%	61.6%	83.3%
I can explain math ideas to other students.	76.2%	91.7%	90.3%	84.6%	86.6%
Math will be useful for my future.	95.2%	100.0%	96.8%	96.2%	100.0%
I understand the relationship among different areas of mathematics.	85.7%	91.7%	93.5%	96.1%	96.7%
I am good at science.	85.7%	91.7%	80.6%	73.0%	93.4%
I enjoy going to my science classes.	76.2%	83.3%	74.2%	65.4%	86.7%
Others think I am good at science.	80.9%	83.3%	80.7%	76.9%	83.3%
I used to think I was good at science.	66.7%	58.3%	67.8%	57.7%	90.0%
I can explain science concepts to other students.	76.2%	70.8%	67.8%	65.4%	80.0%
Science will be useful for my future.	90.5%	91.7%	90.3%	88.5%	80.0%
I understand the relationship among different areas of science.	95.2%	87.5%	87.1%	77.0%	90.0%

Table 4. Trends in mindset data - freshmen only

	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020
Mindset	% Agree	% Agree	% Agree	% Agree	% Agree
I am good at math.	100.0%	100.0%	85.7%	80.0%	81.8%
I enjoy going to my math classes.	100.0%	83.3%	85.8%	80.0%	72.8%
Others think I am good at math.	100.0%	100.0%	85.7%	80.0%	90.9%
I used to think I was good at math.	83.4%	83.3%	71.5%	60.0%	90.9%
I can explain math ideas to other students.	66.7%	100.0%	85.8%	80.0%	81.8%
Math will be useful for my future.	83.3%	100.0%	85.7%	80.0%	100.0%
I understand the relationship among different areas of mathematics.	100.0%	100.0%	85.8%	80.0%	90.9%
I am good at science.	83.4%	100.0%	85.7%	60.0%	100.0%
I enjoy going to my science classes.	66.7%	83.3%	57.2%	60.0%	100.0%
Others think I am good at science.	83.4%	100.0%	85.7%	60.0%	90.9%
I used to think I was good at science.	83.4%	66.7%	71.4%	40.0%	90.9%
I can explain science concepts to other students.	83.4%	66.7%	85.7%	40.0%	81.8%
Science will be useful for my future.	83.3%	100.0%	71.4%	80.0%	81.8%
I understand the relationship among different areas of science.	100.0%	100.0%	71.5%	80.0%	72.8%

Transition and Retention

Additionally, research into retention of college students suggest that some students have trouble transitioning to college and this difficulty may impact graduation rates. Eleven of the End of Semester Survey items were devoted to asking students about issues that typically are associated with transition difficulties.

More than half of undergraduate students found college to be as expected and felt they fit in with other students in their major. Most felt their high school classes were less challenging than their college classes and most agreed that they spent more time studying in college and had to teach themselves new information. Only half of the students were scheduling time to study during the week unless a test was upcoming even though students seemed to plan their week to get everything done. On a positive note, students overwhelmingly felt they knew professors and students whom they could ask for help. Most students believed their professors were giving them sufficient reminders about due dates and believed their professors were interested in their academic progress in class.

Freshmen are of particular concern with regards to transition, so data were examined across freshman only. The distribution mirrored that of the rest of the undergraduate sample. However, again, there are a few notable differences. First, freshmen tended to spend less time planning their week. Second, more freshmen noted that they do not know professors to whom they can go for help. Finally, a larger proportion of freshmen reported that their high school classes were less

challenging than their college classed. In general, freshmen seem to be struggling more with the transition from high school to college during Fall 2020.

Trends across semesters are presented in Table 5. Prior to COVID-19, certain trends in transition items were emerging; more students learned to schedule time for studying regardless of upcoming tests by the spring and most students felt their instructors were interested in their course progress by spring. Since COVID-19, more students seem to be struggling with adjusting to college. Specifically, they do not know instructors or students to whom they can go to for help and are more likely to struggle with due dates. Freshmen in 2020 particularly report difficulty with planning their week, carving out studying time, and remembering due dates. One notable trend across all semesters is the continuing decrease in percent of students who feel like they fit in with their peers.

Table 5. Trends in undergraduate transition items

Transition - Undergraduate	Fall 2018 % Agree	Spring 2019 % Agree	Fall 2019 % Agree	Spring 2020 % Agree	Fall 2020 % Agree
College is how I expected it to be.	73.3%	58.9%	66.7%	65.0%	50.0%
My high school classes were just as difficult as my college classes.	26.7%	41.2%	29.2%	20.0%	16.7%
I plan my week to make sure I get everything done.	93.3%	88.2%	87.5%	90.0%	83.3%
I schedule study time every day even if I don't have a test that week.	40.0%	47.1%	29.2%	50.0%	33.4%
My instructors do NOT remind me about due dates for assignments and tests enough.	13.3%	17.7%	12.5%	5.0%	33.4%
I have to teach myself new information for my classes.	86.7%	94.2%	75.0%	75.0%	87.5%
I have to spend more time studying than I did in high school.	93.3%	88.3%	95.8%	95.0%	91.6%
I feel like I fit in with the other student in my major.	80.0%	82.3%	79.1%	70.0%	66.6%
I know instructors I can ask for help.	100.0%	100.0%	83.4%	90.0%	79.2%
I know students I can ask for help.	93.3%	82.3%	91.7%	85.0%	79.2%
My college instructors are NOT as interested in how I am doing in their class compared to my high school teachers.	40.0%	23.5%	33.4%	10.0%	45.8%

Trends across semesters for graduate students are presented in Table 6. In general, trends in transitioning to graduate school are stable across time, especially prior to COVID-19. However, even graduate students appear to be struggling with due dates and feel as if their instructors are not interested in their course progress. Of note is the continually increasing trend of more graduate students carving out study time during the week even if there is not upcoming exam. It should also be noted that there are only around 6 graduate students in a cohort.

Table 6. Trends in freshmen transition items

	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020
Transition – Freshmen	% Agree	% Agree	% Agree	% Agree	% Agree
College is how I expected it to be.	83.4%	66.7%	57.1%	40.0%	45.5%
My high school classes were just as difficult as my college classes.	33.4%	66.7%	42.9%	40.0%	36.4%
I plan my week to make sure I get everything done.	100.0%	100.0%	100.0%	80.0%	63.7%
I schedule study time every day even if I don't have a test that week.	50.0%	50.0%	42.9%	40.0%	36.4%
My instructors do NOT remind me about due dates for assignments and tests enough.	16.7%	16.7%	28.6%	0.0%	45.5%
I have to teach myself new information for my classes.	83.3%	100.0%	42.9%	40.0%	72.7%
I have to spend more time studying than I did in high school.	100.0%	100.0%	85.7%	80.0%	90.9%
I feel like I fit in with the other student in my major.	83.4%	100.0%	85.7%	80.0%	54.5%
I know instructors I can ask for help.	100.0%	100.0%	57.2%	80.0%	63.6%
I know students I can ask for help.	83.4%	66.7%	85.7%	80.0%	72.7%
My college instructors are NOT as interested in how I am doing in their class compared to my high school teachers.	50.0%	33.3%	57.2%	0.0%	45.5%

Findings on Goal 2

Goal 2 addresses strengthening the academic culture of the Department of Mathematical and Computer Sciences. This goal is addressed by working to increase the number of students participating in research activities and internships, encouraging conversations with faculty on research related topics, and providing opportunities for students to improve their academic performance. This is done by using Peer-Led Team Learning Sessions.

Participation in Research Activities

Survey results suggested that some SCOAM students continued to participate in research conferences/ colloquia throughout the program. Several students reported that they would not have participated in the research conference/colloquia if they were not in the SCOAM program. Additionally, during the semester breaks, all students reported plans to do some activity related to academics or work; preparing for GRE exam or graduate school, applying for or continuing to work at an internship or job, or taking classes.

Conversation with Faculty

SCOAM students reported that most conversation between themselves and other students and faculty, as expected, were about class assignments and other academic topics. The lowest

proportion of those conversations were with non-SCOAM students in their activity group and the highest proportions were with faculty in their department, faculty mentors/advisors and faculty outside their department. Conversations concerning research opportunities were somewhat similar between SCOAM students and all faculty and peer groups with the highest proportions being between SCOAM students and their faculty mentors/advisors or social group members. For career opportunities, SCOAM students turned to all faculty and peer groups relatively similarly.

Trends in conversation data across semesters in conversation data is presented in Table 7. There has been an increase in student conversations about academic topics with faculty in other departments and a decrease in student conversations about academic topics with students in their social groups. There has also been an increase in student conversations about other academic topics with their faculty advisor/mentor. Whether this is due to COVID-19 cannot be determined. Student conversations with faculty outside their department about non-academic topics has decreased dramatically. This could be due to COVID-19. Also, there has been an increase in non-academic conversations with SCOAM students whether in their social group or not in Fall 2020 despite the online environment.

Table 7. Trends in conversation topics among faculty and peers.

	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020
Courses or Assignments					
Faculty Mentor	32	36	39	36	37
Faculty in Department	58	48	55	57	55
Faculty Outside Department	29	41	15	34	43
SCOAM Students in Social Group	34	20	21	16	24
SCOAM Students not in Social Group	41	37	28	33	36
Non-SCOAM Students	27	32	32	24	36
Other Academic Topics					
Faculty Mentor	17	23	18	28	37
Faculty in Department	13	14	13	15	13
Faculty Outside Department	13	19	25	20	20
SCOAM Students in Social Group	14	17	19	32	16
SCOAM Students not in Social Group	12	17	16	16	15
Non-SCOAM Students	14	20	16	14	13
Research, Internships, Careers					
Faculty Mentor	43	32	32	31	18
Faculty in Department	16	26	19	19	17
Faculty Outside Department	33	17	29	20	23
SCOAM Students in Social Group	29	26	22	29	23
SCOAM Students not in Social Group	25	20	20	20	15
Non-SCOAM Students	21	20	17	22	12
Non-Academic Topics					
Faculty Mentor	8	10	10	6	8
Faculty in Department	13	13	13	10	14
Faculty Outside Department	25	22	30	27	15
SCOAM Students in Social Group	23	36	38	23	37
SCOAM Students not in Social Group	22	26	36	31	35

Non-SCOAM Students	38	29	35	40	39

Peer-Led Team Learning Sessions – Student Perspective

Peer-led team learning (PLTL) sessions were designed to deepen a student's understanding of and ability to apply mathematical concepts being learned in mathematics courses. All students in eligible classes were asked to complete a survey. Participating students were asked their agreement with statements about the impact of the sessions and non- participating students were asked about the reasons why they did not participate and if they participated in other department offered tutoring experiences. The COVID-19 pandemic forced the suspension of the PLTL sessions in Spring 2020. Sessions were conducted virtually during the Fall 2020 semester.

The survey was sent to all students enrolled in selected math classes during the Fall 2020 semester. All students attending the sessions felt the PLTL session better prepared them for math class while most felt the sessions were a valuable resource. A majority of students also remarked that the sessions increased their confidence to take exams and quizzes and helped them with completing homework assignments and improved their final exam performance. A percentage stated the sessions influenced how they prepared for exams and quizzes. Overall participants were satisfied with their sessions' leaders and agreed that the leaders allowed them to express their opinions. A majority of students suggested continuing to offer the learning sessions. A percentage of students stated the sessions encouraged them to seek out other peer-led opportunities, increased their willingness to seek out internships, or research opportunities in math.

Open-ended comments concerning benefits of the session focused on the real-world application of problems studies in class and the opportunity to ask questions. Comments concerning peer leaders remarked on the knowledge and ability of leaders to explain concepts well and increased approachability because they were a peer.

The main reason given by non-participants for not attending the sessions was scheduling conflicts. Interestingly, two comments given by non-participants suggested that they also felt the sessions were tutoring sessions that they did not feel the need to attend or found resources elsewhere. The survey items and open-ended comments seemed to suggest participating students believed the learning sessions were valuable in that they provided opportunities to apply and extend their mathematical understanding.

Peer-Led Team Learning Sessions – Peer Leader Perspective

The PLTL sessions were designed to help students, but to also providing select math majors the opportunity to lead and teach encouraging their own academic growth. Peer leaders (n=3) were interviewed for 30-40 minutes using a series of 13 questions about their experiences leading the team learning sessions.

All peer leaders used the flipped model mentioned above during the sessions when the university transitioned to remote learning in Fall 2020. PLTL sessions were cancelled in

Spring 2020 following the university going to remote learning. The peer leaders enjoyed this model more than the teaching model used previously. All leaders remarked on the lack of attendance for the sessions but felt that there was a slight improvement when the sessions were remote. All peer leaders enjoyed the teaching opportunity and felt that students were beginning to see the value of the application problems used in the sessions.

Findings on Goal 3

Goal 3 explored strengthen relationships with the broader STEM community This goal is defined very broadly as exploring workforce and career options, increasing the number of students taking entry-level licensing exams or the GRE/GMAT exam, and improving communication and networking skills. Students were required to participate in several types of activities throughout the semester: monthly meetings, presentations, workshops, and small group activities. All these activities were designed to encourage relationships between SCOAM students and other math and science students as well as between SCOAM students and faculty outside of their department and professionals outside of the university. A set of items on the survey were designed to capture how well the activities promoted these connections and introduced students to career possibilities.

End of the Semester Survey results suggested that the workshops and presentations helped students feel more connected to faculty outside their department and students outside of the SCOAM program. Additionally, the workshops helped students to think about possible career options more than the presentations did.

Effects of Moving to Online Instruction on Students

In March 2020, a global pandemic forced universities across the nation to transition to online learning for the safety and well-being of their students. The Spring 2020 semester transitioned to remote learning after starting with traditional face-to-face classes while the Fall 2020 semester featured remote and/or hybrid learning with very few face-to-face courses from the beginning of the semester.

Impact of moving to an online environment on student learning was of particular interest. Several domains that had the potential to negatively impact student learning were identified: access to technology, comfort level with technology, changes in motivation, and difficulty in adapting to the remote learning environment. Also, STEM students often take a mixture of lecture and lab courses (e.g., computer science, chemistry lab) and there was concern that the impact would be felt differentially based on course format. Finally, one goal of the SCOAM program is promoting connectedness among students and providing networking opportunities for students. It was hypothesized that these two aspects of the program would be negatively impacted by the transition to online learning.

Access to Technology

A large majority of students surveyed were easily able to access the internet while half reported having to share internet time with at least one family member to complete their

online courses. Almost all students were comfortable uploading and downloading documents and videos from the internet and using a learning management system (e.g., D2L, MyMatLab) to complete online assignments. Additionally, students reported being comfortable communicating with classmates and their professors electronically. In the fall semester where many courses started from the beginning of the semester with remote learning, students reported similar access and comfort with internet access.

Changes in Motivation

During and following the transition in the Spring 2020 semester, SCOAM students reported having difficulty motivating themselves to do their coursework and organizing their week to get their coursework completed after the transition to remote learning. Just over half of the students felt they needed face-to-face contact with their professor in order to learn the course content and did not feel they understood the content taught online as well as the content taught face-to-face. Students, however, did report being persistent in asking questions to better understand the content taught online.

SCOAM students reacted similarly when asked about learning in an online lecture course compared to an online lab course. For lecture courses, a large majority of students reported that remote learning was not the same for them compared to face-to-face instruction, that they had to learn more on their own in remote courses, and they preferred taking lecture courses face-to-face. For lab courses, almost all students reported that remote learning was not the same as learning face-to-face and that they had to learn on their own more in a remote setting. Only 13% of the students stated they preferred taking their lab courses online.

Regardless of whether transitioning mid-semester to remote learning or beginning the semester with remote learning as the expectation, similar proportions of students experienced difficulties with motivation and organization. Likewise, similar proportions of students reported being persistent in asking questions to further their understanding of course content, needing face-to-face contact with their professors in order to learn, and not understanding the course content as well when learning remotely.

Communication and Connectedness

In general, students felt less connected to their professors and classmates after the transition. SCOAM students struggled with feeling connected to students and faculty while learning remotely. Networking decreased during the spring semester as well. While a majority of students found it easy to communicate with their professors, students reported they communicated less frequently about academic and non-academic topics and less with professors who were not their course instructors.

The feeling of connectedness with faculty and students decreased as a result of moving courses to an online environment. Additionally, networking decreased with limited conversations with faculty focused on coursework and understanding content. Frequency of communication among students also decreased but to a lesser degree.

Effects of Moving to Online Instruction on Faculty

A survey was administered at the end of Spring 2020 to capture reactions from STEM faculty about their experiences transitioning their courses and their perceptions about student learning. Experience with teaching online courses as well as preparation to teach online and using the learning management system were determined to be relevant and were of particular interest in determining the impact of the transition on student learning. Additionally, STEM curricula often feature a combination of lecture and lab courses. It was hypothesized that transitioning these two different types of course formats would present different and unique challenges.

The faculty sample consisted of 34 STEM faculty who completed the entire survey including demographic information. Twenty identified as male, ten identified as female, three chose not to report, and one respondent did not answer the question. Seventeen of the faculty identified as mathematics or computer science faculty, nine identified as physics or chemistry faculty, and seven identified as biology, geoscience, or Earth science faculty. One faculty member did not identify a department affiliation.

Twenty-three of the faculty reported they had been teaching at the post-secondary level for 15 years or more, five between 10 and 14 years, and six between 5 and 9 years. Most faculty ($n = 32$) had taught an online course prior to Spring 2020. However, two faculty reported that they had never taught an online course prior to the online transition. Specifically, ten faculty reported teaching at least 5 different online courses, eleven reported teaching 3-4 different online courses, and ten reported teaching 1-2 different online courses prior to Spring 2020.

Only half of faculty responding to the survey felt they were prepared to teach online. Most faculty felt online classes took more time to prepare and online teaching took more time to facilitate effectively compared to face-to-face classes. A large majority of faculty felt that online classes did not offer the same learning experiences as face-to-face classes, especially faculty teaching lab classes.

A majority of faculty reported adapting or replacing assignments and assessments to accommodate the online format. For lab classes, some assignments were eliminated. Comments concerning the elimination of lab assignments centered on the inability to find a simulation for the activity or being unable to record themselves conducting the lab. The biggest concern for faculty seemed to be monitoring cheating on exams, especially faculty teaching lecture classes. Also, of importance to faculty was monitoring struggling students and keeping students engaged. Faculty also reported having trouble developing content fast enough to stay ahead of the deadlines for posting the material for student use. If doing online classes again, the most common change would be a shift to more synchronous activities and finding a way to proctor exams. Lab instructors had a more difficult time determining what they would do differently.

Faculty were concerned about the lack of student engagement in online courses. They also felt that students did not understand the content as well as they would if taking the course face-to-face.

Discussion

Goal 1 of the SCOAM Project is to increase the number of students graduating with a major, minor, or master's degree in mathematics. In order to achieve this goal, a major effort was made in recruit and retain students in to a mathematics major or minor. This goal overlaps with the department and university goal of increasing enrollment and retention. Through the use of scholarships students were recruited into the mathematics programs. Once students were recruited, a strong sense of community was built by having students participate in small group activities, monthly meetings, presentations, and workshops. These group activities allowed for students to share their experiences, find support from fellow math students, learn about a future in a STEM career. Through the use of these activities, there was an increase in the sense of community, in being motivated to work hard, and being motivated to continue as a mathematics major/minor.

Goal 2 of the project is to strengthen the academic culture of the Department of Mathematical and Computer Sciences. This goal was addressed by working to increase the number of students participating in research activities and internships, encouraging conversations with faculty on research related topics, and providing opportunities for students to improve their academic performance using Peer-Led Team Learning Sessions. Findings indicated that there was an increase in student conversations about academic topics with faculty both advisors and mentors as well as faculty who did not serve in an advising capacity. Over the course of the project, SCOAM scholars gradually began to see the value of the application activities completed in the Peer-Led Team Learning Sessions. Participants valued the real-world applications provided to enhance the mathematics they were studying in their mathematics courses and they appreciated the opportunity to ask questions.

Goal 3 of the project is to strengthen relationships with the broader STEM community within and beyond the university. All of activities listed above were designed to encourage relationships between SCOAM students and other math and science students as well as between SCOAM students and faculty outside of their department and professionals outside of the university. Findings include that students feel more connected to faculty outside their department and students outside of the SCOAM program. Additionally, students reported that the workshops provided helped them to think about possible career options after their graduated.

Conclusion and Future Direction

The transition from learning face-to-face to remote learning certainly had an impact on the project. There were several areas identified as having a negative impact on student learning including access to technology, loss of community, and changes in motivation. While it is hoped that for the final year of the project the university will return to the traditional face-to-face method of instruction, there were still some positives that came from remote instruction.

Attendance had always been poor in the Peer-Led Team Learning Sessions but with remote learning those session began to follow a flipped-classroom model of learning. This is something that can be explored in more detail as the project continues.