A MATHEMATICS MENTORING PROGRAM: POST-PANDEMIC

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The purpose of this report is to share the supports created as part of a mathematics mentoring program in a mid-sized western university. The research is longitudinal, and the current paper will share results from the fourth (of six) years of a project. I use a mixed method approach to examining the efficacy of the mentoring program, and the results indicate that the program may have helped students through the pandemic and to shift back afterwards.

Keywords: Instructional Leadership; Undergraduate Education, Equity and Justice

Increasing retention in mathematics majors for people of color and women remains essential. One way to advocate for this issue is to develop more supportive undergraduate mathematics departments through mentorship programs (Mondisa & McComb, 2018). Research shows many STEM majors leave because they have a bad experience, and more troubling that people of color and women are more likely to leave than their white counterparts (e.g. Anderson & Kim 2006; Hill, Corbett, & Rose, 2010; Griffith, 2010). These results and experiences indicate that research is needed on how mathematics departments might be more inclusive, and that mentoring programs might be a good way to approach this issue (Mondisa & McComb, 2015).

The mentoring program in this proposal was set at a mid-sized western comprehensive university. The supports created for the program were designed to address challenges faced by low-income students, students of color, and women in our mathematics department. The purpose of this report is to share ongoing research results of what's working and what's not, and to describe alterations to the mentoring program that have been made over time, particularly in response to the pandemic, and the resulting effects.

Literature Review

There are two important facets of literature to examine around mathematics mentoring programs: (1) which supports are most helpful to students, and (2) what qualitative and quantitative measures are valid in examining the efficacy of support programs?

In studying facets of support programs for STEM majors, Lisberg and Woods (2018) found four areas that were essential: (1) peer and faculty mentorship, (2) familiarity with programs and faculty, (3) student mindsets, and (4) student learning techniques. In the first, peer and faculty mentorship, it is essential that students are paired with a peer or faculty that they see as a mentor. Other research indicates that having mentor(s) increases retention rates in STEM programs (Campbell & Campbell, 1997). The second category is about becoming familiar with the college structure and connecting students with the necessary resources on campus. For example, many first generation college students could struggle with applying to financial aid. The third category, student mindset, is about educating students on growth mindsets (Dweck, 2008) as well as providing students with examples of how individuals could overcome academic difficulties (Walton & Cohen, 2011). The last category, student learning techniques, focuses around the idea that many students do not know *how* to study for STEM classes, and that given specific instruction in that area, students can improve their learning. These results mirror previous results in mathematics indicating the importance of study groups (Triesman, 1992). Lisberg and Woods (2018) found that students in their support program were more likely to pass mathematics

courses in their first year, and, if they did not pass them, were two times as likely to retake them.

In a metanalysis of non-academic supports that were most helpful to retaining STEM community college students, Karp (2011) found they could be sorted into four main categories: *social relationships*, *career options*, *college structure*, and *life issues* (italics added for emphasis and to denote each category). The *social relationship* category included those supports that helped students connect with one another and faculty members on campus, which echoes the mentorship category from Lisberg and Woods' (2018) study. The second category included educating students about *career options* both in terms of helping them choose appropriate majors, but also providing information on what careers were possible with which majors. The *college structure* category aligned with the familiarity with programs category from Lisberg and Woods (2018). Lastly, the *life issues* category was identified as the most difficult one to support students through. However, when students had resources to connect to on campus, they were more likely to persist and remain enrolled.

Having examined research on the supports that were helpful, I will move on to discuss the how these programs have been studied and compared. Karp (2011) remarked that the majority of the research from the metanalysis made use of Likert-style questions that asked how helpful the students thought particular supports were. The students were not asked why the supports were helpful. Similarly, Mondisa and McComb (2018) commented on how many support programs relied solely on quantitative comparisons like comparisons of students' GPA or attrition rates. Both papers noted that there is a lack of research on support programs as a whole because they often are created, but not studied, and so more research is needed on support programs. Lastly there was evidence that there is a need for more qualitative data to examine what is most helpful and why for supporting underrepresented students in STEM majors (Estrada et al., 2017).

In designing our program, we centered our supports around Karp's (2011) four categories: *social relationships*, *career options*, *college structure*, and *life issues*, while also including mindset and study skills from Lisberg and Woods (2018) categories. The research design includes quantitative methods, such as comparison of graduation rates, and qualitative methods to examine the social aspects of the program.

Context

The support program was created at a mid-sized western comprehensive university where the overall student population consisted of 67% first generation students, 61% Pell-eligible, and has overall student population demographics 3% African American, 14% Asian (mainly Southeast Asian: Hmong and Cambodian), 49% Hispanic, 6% non-resident students, 3% two or more races, 5% unknown, and 20% white.

During the preparation year, focus groups were held with current students to identify areas of support for our student populations (Tague, 2021). The focus groups were analyzed for overall themes and those themes informed how the supports were built around Karp's (2011) categories. The team consisted of three mathematicians, who I will refer to as mentors, and myself. The mentoring program began in Fall 2018, and has shifted to meet the students' needs over time.

In the *social relationships* category, we designed scholarships, weekly meetings, and required office hours or tutoring. It may strike the reader as odd to include scholarships in this category, however, we have found that without financial support, students work two or more jobs, which prevents them from spending time on campus and making connections. We work on educating students on *career options* through advising sessions, workshops, and guest speakers. These became more prevalent in the last few years as the students reached their junior and senior years. The workshops in the later years have been focused on graduating, and research

experiences to emphasize the *college structure*. Lastly, it is difficult to plan ahead for what *life issues* students might face, however, we hoped that through the community building, students would have the social network to persevere through these.

Theoretical Framework and Methods

I used a mixed methods approach to this research. For the quantitative methods, I have been tracking longitudinal data including graduation rates. For the qualitative methods, I used the framework of Social Community (Mondisa & McComb, 2018) to measure the impact of the program at an individual level in terms of *connectedness, resiliency,* and *communities of practice*. I measured how *connected* each student was to the program by asking, for example, do you have a mentor? I measured *resiliency* by asking the students, for example, if they faced any obstacles and if so, how they worked to overcome them. The framework defines *communities of practice* as "collections of like-minded individuals sharing similar experiences and social resources as they interact with and support each other (Eckert, 2006; Wenger, 2000)" (Mondisa & McComb, 2018, p. 98). For this question, I asked students if they felt like they belonged as part of the mathematics department, and why or why not. All interview questions were adapted from Mondisa and McComb's (2018) framework.

The current report is from the fourth (out of six) years of the program. In this year, there were 14 scholars (5 seniors and 9 juniors). There were 12 students recruited in the control group (6 juniors and 6 seniors). All participants in the study were mathematics majors and both groups consisted of a majority of people of color. All participants, scholar or control, participated in semi-structured interviews, which, on average, lasted 27 minutes during October 2021-January 2022. The interviews were recorded, transcribed verbatim using software, and then altered for correctness. The resulting transcriptions were organized into a spreadsheet and then separated by theme: *connectedness*, *resiliency*, and *communities of practice* (Mondisa & McComb, 2018).

Results

I will present the quantitative results first, followed by the qualitative results by theme. Because of the longitudinal nature of the study, this was the first year that I could report graduation rates. They are shown in Table 1 below, where the starred year represents the first year the program was running. It shows that the support program might be helping a larger percentage of mathematics students graduate in four years.

Table 1. Rate of Mathematics Majors Graduating in Four Years

Year of Entry	Percent of Majors Graduating in Four Years
2013	11.1%
2014	18.2%
2015	27.6%
2016	27%
2017	21.6%
2018*	37.8%

Connectedness

In previous years, the scholars were significantly more likely to show connectedness by stating that they had a mentor that was a faculty member (Tague, 2021; 2022). However, in the current year 11 of 14 scholars versus 8 of 12 control students reported having a faculty member as a mentor (χ^2=0.1153; p=0.7341), which was not significant. It makes sense that in the later

years of the majors, the students who have persisted would have a connection to a faculty member. There was a difference between how the control group talked about their faculty mentors versus how the scholars did. The control group mainly stated that they could go to the mentor if they had questions about their academic paths or about a course. For the scholars, many mentioned that they felt they could talk to their mentor "about anything". One even stated, "*I feel like he's my academic dad*." In summary, there was no difference in the connectedness as measured by if they had a mentor, but qualitatively the scholars described closer relationships with their mentors.

Resiliency

Both groups struggled with time management and switching back to in person from being online. Many of them described how they struggled the previous year with a lack of socializing and how they valued being back in person for their math courses. Much of the new time management issues had to do with readjusting to commuting to campus again. One theme that appeared in the control group was that of mental health linked to motivation. The majority of the control group mentioned that mental health centered around motivation was an obstacle for them in the current semester, whereas only two of the scholars mentioned these specific obstacles. These results indicate that both groups displayed resiliency, however the scholars seemed to have used their social networks to overcome motivation struggles.

Communities of Practice

In previous years, there was no difference in the rate of belonging between the control group and scholars. This year, out of 14 scholars, 12 stated they felt like they belonged versus 6 out of 12 of the control group. This indicated a statistically significant difference in communities of practice between the groups (χ^2=3.869; p=0.0491). There was also a difference in how the groups talked about belonging. The control group referenced that some of their belonging was based on academic achievement, whereas for the scholars, their belonging was based on their involvement and contribution to the department community. As a representative sample of the control group, one student articulated, "*Do I have the credentials to be in the math department? I'm just a student here.*" This contrasts with the representative sample from the scholars saying, "*I didn't in the beginning, but I feel like I do now…I feel like I contribute a part of the department*."

Conclusions

All of the students, scholar and control group, displayed connectedness and resiliency. The scholars' connectedness was deeper in their descriptions of what issues they could ask their mentors about. The scholars' resiliency in coming back after the pandemic was less plagued with motivation issues than the control group. Lastly, the scholars displayed significantly higher levels of communities of practice than the control group. These results are consistent with results from the prior three years in the project (Tague, 2021; 2022) where the scholars were more comfortable in the first year going to office hours, and in the second year were more likely to have a faculty member as a mentor. Results from each year of the study are promising, and provide evidence that with support, students might feel more belonging and persistence in mathematics departments.

Acknowledgments

The funding for this research was provided by grant 1742236.

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