

RESEARCH REPORT

First Year STEM Students' Satisfaction with Peer Mentoring: A Predictor for Student Retention

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Abstract: Peer mentoring is often used as a method to help retain first year STEM students. This study addressed the following research question: Can we predict in the first semester which first- year STEM students will return as sophomores and which ones will not? And if so, what factors were the best predictors of STEM students returning? An Exploratory Factor Analysis (EFA) was first employed and identified four factors: Academic Skills, Satisfaction with Mentors, Institutional Fit, and Academic Relationships). Next a binary regression was performed, and results showed that in the first semester of study student satisfaction with the university (i.e., Institutional Fit) was the most significant and greatest contributor for predicting students returning their sophomore year, followed by forming Academic Relationships; all of which was the result of participating in the mentoring program. Gender and race were not significant predictors for retention; however, further examination of the study's effect size found the effect size to be .4, low moderate, meaning the study's results are somewhat important. It is recommended the study be replicated with a smaller sample.

Keywords: Mentoring, Peer Mentoring, STEM, STEM Education, Retention

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Over the years many universities have worked to address the STEM gap and first-year retention rates, especially in science and engineering. Studies have shown that only 40% of STEM majors actually complete their degree, (Belser, et al., 2017; Gansmer-Topf, et al., 2017; Xu, 2018) with the majority of students leaving in their first year of study. Institutions have implemented a wide variety of interventions to support first year students. These interventions include: academic tutoring, learning communities in residence halls, community building, early research experiences and peer and faculty mentoring (Dagley et al., 2016; Graham et al., 2013; Jacobi, 1991; Schneider et al., 2015; Shin et al., 2016; Spaulding et al., 2020a).

Peer mentoring has been one of the most popular approaches across campuses; however, there are multiple avenues in which first year STEM students may experience mentoring. Some students might participate in a formalized mentoring program that has a small group and problem solving base (Drane et al., 2014, Philipp et al., 2016, Spaulding, et al., 2020b), while others might participate in theme based mentoring geared toward developing psycho-social skills (Budny et al., 2010; Russomanno et al., 2010), or in short session mentoring as part of a class (Cutright & Evans, 2016). Regardless of methodology, outcomes associated with peer mentoring for first year students appear to be positive and beneficial (Holland et al., 2012).

Recent studies have shown that peer mentoring is beneficial both academically and socially for first-year students. Not only increasing passing rates of classes (Karacarl et al., 2019), but also rates of social interaction and emotional support (Gatz et al., 2018). These positive outcomes of peer mentoring result in higher rates of persistence in STEM majors. Several studies have found that first-year students participating in peer-mentoring in mathematics (Deshler et al., 2017), engineering (Ikuma et al., 2019), and chemistry (Damkaci et al., 2017) persisted in their majors at rates 5%-20% higher compared to students who did not. Additionally, Gatz, et al., 2018 found that “academic and social engagement provided by peer mentoring...may be positive predictors of retention for first year female students in science and engineering” (p.14). The purpose of this study is to determine what factors of a peer mentoring program (i.e. academic and social emotional) are the best predictors of first-year STEM students returning for their sophomore year when controlling for gender and race.

Method

The Peer Mentoring Program

In 2014 a research-intensive (R1) university secured a five-year grant from the Howard Hughes Medical Institutes (HHMI) after recognizing the need to better support first-year students. The university had an undergraduate enrollment of ~6,400 students, located in the North Atlantic Region. The purpose of this mentoring program was to provide all first-year students with weekly small group, tutoring-support sessions run weekly by a peer mentor. The

students were enrolled in one or more of the introductory STEM courses (i.e. Calculus I, Chemistry I, or Physics I). The main objectives of the mentoring program were to: improve student experiences in these three “gatekeeper” courses, help incoming STEM students develop key study and social skills shown in the literature to help students improve student academic achievement, and increase the percentage of first-year STEM students continuing at the institution. The ultimate long-term goal was to increase student persistence in STEM fields. Even though the number of incoming students has increased at the university, retention of first-year students has continued to remain stable.

Each year on average, 124 mentors were recruited to provide enough peer mentors for the incoming 1,000 first-year students. Mostly, second-or-third year undergraduates became mentors. In January each year, potential mentors applied to serve as a mentor the subsequent fall semester. A key and required component of the program was extensive training for all mentors prior to taking on their duties.

Overview of Mentoring Sessions

Each mentor held weekly one-hour sessions with an assigned two groups of eight to 10 students. The small group sessions were mostly held in classrooms and meeting rooms throughout campus. During the weekly mentoring sessions, mentors worked with their first-year students to reinforce material and concepts covered in course lectures. Mentors also included lessons in first-year transitional content found traditionally in first-year seminar courses (study skills, time management, test taking strategies, etc.). In addition, mentors held two-hour long office hour sessions on a weekly basis, to provide students with individual time to ask content related questions.

Mentors received “just-in-time” professional development throughout the academic semester to augment the summer training. Staff from the Office of Student Life and subject area faculty met weekly with mentors. These meetings allowed mentors to report back on the progress and outcomes of their sessions and receive information about upcoming lesson plans. These meetings also allowed mentors to provide faculty and staff with feedback about students who were absent, appeared unengaged, or seemed to be struggling. Follow up by staff then could be provided to these targeted first year students to get them back on track. Mentors used an electronic form that created a report of at-risk students in a timely manner.

Participants

Data for this study comes from a larger grant-funded initiative at a private North Atlantic university. This study is a secondary analysis of the university’s archival data set for first-year students enrolled in one or more of the introductory courses and receiving small group, weekly peer mentoring sessions run by an sophomores. In examining response rates to the survey, 2015-

16 had an incoming freshman class of 1,379 and 2016-17 1,691 students (see Table I). The dependent variable (i.e. students returning their sophomore year) used enrollment data from 2016-17 and 2017-18 data.

Throughout the literature on STEM student retention, gender and students who are URM continue to leave at higher rates than males and non URM first year students. Recognizing this, gender and race were used as control variables for statistical analysis.

Table 1.

Response Rate for Sample Versus Incoming First-Year Classes with Enrollment Data

Totals	Year 1 (2015-16)	Year 2 (2016-17)
Total First-Year Class	1,379	1,691
Total Response to Survey	1,448*	1,532

*Total surveys exceed total number of incoming freshman class because students had the option of filling out survey for introduction to physics, calculus, and chemistry, if they enrolled in those courses their first semester

Instrument

While this study was a secondary analysis of archival data, student data was originally gathered by the institution using an electronic survey. The survey was administered annually around week 12 of students' first semester (i.e. fall 2015 & 2016) as part of its ongoing program improvement process. At the end of each fall term students enrolled in one or more of the gateway courses receive the survey. This instrument was developed through a collaborative effort among principal investigators, the external evaluator, faculty, institutional research, and student support services. The survey consisted of 29 closed-ended items that utilized a six-point Likert scale where 1=Strongly Disagree, 2=Disagree, 3=Somewhat Disagree, 4=Somewhat Agree, 5=Agree, and 6=Strongly Agree. Four components comprised the survey. Section one gathered student perceptions of the academic skills they had acquired through participating in the peer mentoring program. Section two measured student overall satisfaction with their peer mentor. Section three measured student overall satisfaction with the institution and having a sense of belongingness. Section four measured student ability to make connections with faculty, TAs, and other students as a result of participation in peer mentoring. Total scores from each of these four sections were used as predictor variables.

Results

This study has two phases. Phase one focused on conducting an Exploratory Factor Analysis (EFA) to identify how many factors could be found within the instrument. Phase two examined whether any of these factors were predictive of students returning their sophomore year. Working with a large sample size, the Kaiser-Meyer-Olkin (KMO) was excellent at .972, showing the sample size was more than adequate for a factor analysis. Next, the Bartlett Test of Specificity was significant a $p < .000$. Based on this further examination of the factor analysis was warranted.

For extraction purposes visual inspection of the scree plot was used to set the number of factors at four. Varimax rotation was employed due to the individual factors not being correlated. Presented below in Table II are those factors, their names, number of items, and range of loading correlations. Factor one gathered first-year students' perception of the academic skills they acquired through participating in a peer mentoring program. Factor two measured students' satisfaction with their mentor. Factor three measured students' satisfaction with the institution in general, and factor four measured students' ability (as a result of participating in peer mentoring) to approach faculty and TAs, and their ability to form relationships with peers. The four established factors and their ranges for loading correlations are as follows: Factor 1: Academic Skills consisted of 10 items (.878 to .4478); Factor 2 Satisfaction with Mentors considered of nine items (-.887 to -.400); Factor 3 Institutional Fit, consisted of four items (.710 to .388); and finally, Factor 4 Academic Relationships consisted of six items (.710 to .486). Content validity was established through a panel of faculty, program staff and the external evaluator for the original project. Internal consistency was also established. In addition, each item was examined for item validity (i.e. Does the item pertain to the project or STEM?), as well as the breadth of items and the content the items covered (i.e. content validity).

Table 2.
Results of Factor Analysis

	1	2	3	4
I was better able to meet my academic goals.	.878			
I felt better prepared for my exams.	.876			
I learned how to improve my study skills.	.845			
The mentoring aspects of the mentoring sessions were beneficial to me.	.754			
I improved my time management skills.	.702			
I had greater motivation to be successful.	.689			
I feel the mentor program had a positive impact on my college experience.	.676			
I was able to stay on top of my coursework.	.662			

My ability to cope with academic stress improved.	.575	
I completed my homework on a consistent basis.	.447	
I felt comfortable talking to my mentor about the subject.		-.887
My mentor was supportive and cared about my success.		-.864
Overall, my mentor did an excellent job this semester.		-.839
My mentor was able to engage the group.		-.801
My mentor knew the material well and was able to explain it to me in a way that made sense.		-.784
I think my mentor gave clear explanations of the subject.		-.769
I felt comfortable talking to my mentor about non-subject topics.		-.768
I would seek out my mentor for guidance in the future.		-.607
I spent more time before classes due to my mentor's advice.	.	-.400
Overall college experience.		.931
Overall sense of community among students.		.863
Overall academic experience.		.836
I feel the College is invested in my academic success.	.	.388
I formed a study group.		.710
I felt more comfortable approaching my TA.		.563
I felt more comfortable approaching faculty.		.532
The College seems like a more friendly place.		.512
My ability to cope with social stress improved.		.502
I developed a positive relationship with other students in my mentoring session.		.486

Following establishment of the factors, phase two of the study worked to examine whether any of the four factors were predictive in nature of students returning for their sophomore year. All four factors were entered into the model as predictor variables and treated as continuous or scale variables. In addition, gender (male/female) and race (white/not white) were loaded into the model as well, as dichotomous variables. The dependent variable was STEM students returning sophomore year, a dichotomous variable (yes/no).

Across all four areas, students who returned their sophomore year had higher means than students who did not return, with relationships that were established as a result of participating in peer mentoring to be the greatest difference (Returned: $M = 27.59$, $SD = 5.31$ compared to Did Not Return: $M = 25.78$, $SD = 5.73$) (see Table III).

Table 3.
Return by Four Areas: Descriptive Statistics

Variable	Outcomes	N	Mean	SD
Did not return	Academic Skills	237	46.20	9.37
	Satisfaction with Mentor	237	41.94	5.75
	Institutional Fit	234	14.01	2.43
	Academic Relationships	237	25.78	5.73
Returned	Academic Skills	2743	48.01	9.11
	Satisfaction with Mentor	2743	42.31	5.91
	Institutional Fit	2713	14.80	2.28
	Academic Relationships	2743	27.59	5.31

Following this, a binary logistic regression was performed to determine which factors best predicted first-year STEM students returning for their sophomore year. A binary logistic regression was most appropriate since the dependent variable (i.e. return sophomore year/did not return sophomore year) was binary. A traditional multiple regression would not be appropriate in this situation since it requires a dependent variable to be continuous. Overall, the entire model was significant $X^2(6) = 39.859, p < .000$. This indicates that the model was able to discriminate between first year STEM students who did and did not return sophomore year. The model explained between 1.3% and 3.2% of the variance between satisfaction and retention and correctly classified 92.1% of the cases.

Presented in Table IV are the results of the binary regression. Gender and race were not significant predictors of first-year STEM students returning for their sophomore year. Academic skills acquired through peer mentoring and students' overall satisfaction with their peer mentor were also found not to be predictive; however, both student satisfaction with the institution (Institutional Fit) and the relationships that students acquired through peer mentoring were significant predictors of students' return (Academic Relationships) ($p < .01$). The greatest predictor for student return was understandably, satisfaction with the institution (Institutional Fit) with an odds ratio of 1.106. Students who were satisfied with the institution were 1.106 times more likely to return than those who were not satisfied. For the predictors related to peer mentoring, students feeling they could approach faculty and TAs and form relationships with peers, Academic Relationships was found to be a significant predictor with an odds ratio of 1.07

Students who felt that they could now approach faculty and TAs and formed peer relationships were 1.06 times more likely to return as a sophomore than students who did not establish relationships.

While the large sample size used for this study was beneficial when conducting the factor analysis, such a large sample unfortunately can inflate Type 1 error, the possibility of finding significance when no true significant difference exists. Effect size was .4, low moderate, meaning the study's results were somewhat important (Cohen, 1988). This is certainly a limitation of this study.

Table 4.
Logistic Regression Predicting Satisfaction with Retention

Predictor	B	SE	Wald	df	sig.	Odds Ratio
Gender	-.234	.146	2.579	1	.108	.791
Race	.075	.139	.287	1	.592	1.077
Academic Skills Acquired	-.011	.013	.724	1	.395	.989
Satisfaction with Mentor	-.022	.016	1.825	1	.177	.978
Institutional Fit	.101	.032	9.919	1	.002**	1.106
Academic Relationships	.066	.020	11.032	1	.001**	1.068
Constant	.787	.577	1.859	1	.173	2.198

** $p < .01$

Discussion

Peer mentoring programs have been used as one approach to addressing the gap in STEM retention. STEM students who participate in peer mentoring have overall higher rates of returning to school the following year (Ikuma et al., 2019). While we know mentoring works, we don't necessarily understand what specific activities or what combination of activities contribute to this increase in retention. It might be hypothesized that STEM students' overall satisfaction with the mentors themselves would contribute most to students returning, in this study this was found not to be true. Similarly, academic skills that students developed through participating in the program were also found not to play a role. This is an interesting finding since in higher education we often believe that if students develop better academic skills and apply those skills to improving their grades that they will be happier, more fulfilled, and thus continue with their academic studies. While this may be true to some degree, this study found that variables associated less directly with the program itself (i.e. improving academic skills) and more associated with outcomes that were indirectly related to the program (i.e. forming relationships with others and connection to the institution) were indeed those variables that predicted retention.

Today's students often struggle with forming relationships with others, particularly face to face relationships. Yet Generation Z value's face to face relationships (Seemiller & Grace, 2016). Without forming these relationships today's students often feel "unconnected." This lack of connection, no doubt, contributes to the retention problem that many institutions are currently facing; however, peer mentoring programs, by their very nature, provide a framework through their day-to-day activities that help "scaffold" students in building relationships with others and in turn, build a stronger connection to the institution. In this study, as a result of participating in the peer mentoring program students felt a sense of belonging and wanted to continue their academic endeavors. Peer mentoring has again shown to be a valuable method for increasing connection and thus increasing retention. A couple of question then become important to consider: are all mentoring programs effective?; are some kinds of mentoring programs better than others?; are there particular mentoring activities needed or essential?

Finally, while the large sample size was beneficial for conducting the factor analysis, it should be noted that it proved to be problematic when it came time to examine the study's results, in particular its effect size. Effect size for this study was .4, considered to be low moderate or somewhat important. It is recommended that the study be replicated with a smaller sample size (Cohen, 1988).

Conclusions

Peer mentoring is perhaps one of the most "popular" interventions used by colleges and universities to address first year retention issues; however, understanding how peer mentoring works to help retain students remains somewhat of a mystery. While we know that student satisfaction is a predictor of student retention, we are less knowledgeable about the "interconnectedness" between student satisfaction and what role these interventions (e.g. peer mentoring) play in helping "shape" students' satisfaction. This study examined first year students' satisfaction with a peer mentoring program and gathered feedback on four main areas from students participating in the peer mentoring experience: satisfaction with the academic skills students had gained, satisfaction with the performance of the peer mentor, satisfaction with the university, and feeling more confident about forming relationships with, and approaching faculty, TAs, and peers at the institution as a result of the experience. More importantly, this study examined if STEM students' level of satisfaction in any or all of these four areas were a significant predictor of them returning their sophomore year.

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