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Impact of Pathways to College Level Mathematics on Success in Mathematics and Retention

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Paraskevi "Vivi" Liousas is a senior with a double major in Elementary Education and Mathematics and a minor in Art. This paper is an abridged version of her honors thesis developed under the guidance of Dr. Uma Shama with the wonderful assistance of BSU's Office of Institutional Research and Assessment. Vivi was motivated to do research in the area of math education because of her passion for teaching mathematics. She is committed to excellence in teaching and is eager to join the profession after graduating.

The importance of mathematics knowledge in this country has far surpassed merely the ability to handle one's money. The National Math and Science Initiative, Inc. (NMSI) was created in the United States to address the issue of deficiencies in mathematics and science in education, which affect the United States on an economic and global level, as explained in the NMSI brochure:

> The U.S. has had a proud history of inventions and innovations since colonial times, but the future of our intellectual capital is now at risk. America's size, natural resources and historical role as a superpower are no longer enough to ensure its economic future. In today's global economy, the U.S. is losing many of its previous competitive advantages. Upgrading the knowledge and skills of our workforce is critical. U.S. students must have the relevant knowledge of science, technology, engineering and math to become a more competitive workforce.
>
> *-NMSI Brochure.*

According to the *Trends in International Mathematics and Science Study*, which analyzed forty-one nations across the globe, the United States greatly lags behind in mathematics on the international scale (Hagedorn et.al. 1999). In an effort to stay competitive, the United States has created educational standards to measure academic success. These have been enforced on every level from the nation, to the state, to the institution. On the national level, President George W. Bush began the *No Child Left Behind Act of 2001* that took action to have all children be proficient in basic mathematics and reading by 2014. President Barack Obama has replaced this with the *Elementary and Secondary Education Act* which will take action to have students "college- and career-ready" by 2020. It includes new, rigorous standards for knowledge in mathematics. On the state level, Massachusetts has developed the *Massachusetts Comprehensive Assessment System* (commonly referred to as MCAS) to test learning of mathematics and language arts in K-12 schooling.

Strengthening mathematics programs on the K-12 level is closely aligned with carrying out the mission of NMSI, because early struggles in mathematics affect higher education. Many times, students are discouraged from pursuing their desired major because of the necessary mathematics requirements

(Conley 2005; Arem 2003). When students do not aspire for these mathematics-based majors, jobs in mathematics and science are not filled, thus creating the national economic issue described by NMSI.

At Bridgewater State College, educational standards have been created within the general education requirements in the Core Curriculum. All students must take two quantitative reasoning courses, of which one must be a foundations for mathematical reasoning course. In addition, many majors require more advanced mathematics courses than those which fulfill the Core Curriculum.

The Toolbox Revisited: Paths to Degree Completion from High School Through College, a detailed publication of the U.S. Department of Education, studies what aspects of formal education contribute to completing a bachelor's degree by a student's mid-twenties. This essay speaks of the importance of credit momentum during the first year of college in predicting the attainment of a college degree. *The Toolbox Revisited* defines credit momentum as the rate to which a student attains credit towards a college degree. Earning twenty degree credits within the first year at a four-year institution was found to be significantly related to retention and degree completion. Students who are in remedial mathematics classes or failing college-level mathematics (CLM) have low credit momentum. Therefore, they are at a greater risk of not earning a degree (Adelman et.al. 2006; Hagedorn et.al. 1999).

In many cases, students simply have not completed a rigorous enough mathematics program in high school to prepare them for college (Conley 2005). A large number of high school graduates are unable to begin CLM. This leads to colleges struggling to deliver appropriate remedial courses to compensate for the gap in mathematics knowledge (Hagedorn et.al. 1999). Currently, students in Massachusetts public schools are required to successfully complete three years of mathematics (Massachusetts DOE). This leaves many students taking their college's mathematics placement test without having seen mathematics in over a year. As a result, students cannot place immediately into their desired mathematics course and must take a prerequisite course or the non-credit bearing remedial mathematics course. Therefore, *The Toolbox Revisited* recommends that each student has at least 3.75 years of mathematics, with the highest level as Calculus, Precalculus, or Trigonometry, to yield a sturdy mathematics student prepared for higher education (Adelman et. al. 2006).

At Bridgewater State College (BSC), placement tests are completed during the First Year Orientation in the summer before beginning to attend. If students' Elementary Algebra placement test scores do not meet the standard required to take CLM, they are placed into a non-credit remedial mathematics (RM) course called Freshman Skills. This remedial mathematics course must be passed before continuing on to CLM (Source: AAC).

The purpose of RM is to build sufficient mathematics knowledge to be successful in CLM. By placing underprepared students in remedial mathematics, student failure is reduced in introductory mathematics courses (Conley 2005). According to a study by Peter Bahr, students at community colleges who take a remedial mathematics course demonstrated comparable outcomes to those who did not, indicating that the remediation was "highly effective in resolving skill deficiencies" (Bahr 2008). However, there also have been findings which show the opposite, claiming that remediation is ineffective, with the remedial courses themselves even having high failure rates (Hagedorn et.al. 1999).

For the purpose of this study, the courses in which a student can be placed through passing the Elementary Algebra placement test are considered Basic CLM. They are *Precalculus*, *Selected Topics in Mathematics (Topics)*, *Principles of Mathematics I* and *Principles of Mathematics II (Principles)*, and *Elementary Statistics (Statistics)*. The courses in this study which require passing the College Level Mathematics placement test will be referred to as Calculus. They are: *Elements of Calculus I (Calculus I)*, *Applied Calculus for Business (Applied Calculus)*, and *Calculus I*. The various Calculus courses are typically taken by students whose majors require it.

Bridgewater State College offers two types of *Precalculus* sections. The first type is the traditional section which is in the format of typical college courses. The second type is called *Targeted*, which is a supported section that includes mandatory weekly meetings with a mathematics coach to go over homework and answer questions. *Targeted Precalculus* is taken by students who need to continue onto Calculus and who are either coming from RM or who scored just below the placement test cutoff to place into a traditional *Precalculus* section. The purpose of this support is to help bring these students' mathematics knowledge up to the knowledge of the students regular *Precalculus* counterparts. *Targeted* sections were first offered at Bridgewater State College in Fall 2007.

Given previous research and the nature of courses at Bridgewater State College, this study will explore the following research questions:

1. What is the impact of Remedial Mathematics pathways versus direct placement pathways to first Basic College Level Mathematics on students' success in that course?

2. What is the impact of Remedial Mathematics pathways versus direct placement pathways to first Basic Cllege Level Mathematics on students' retention at Bridgewater State College?
3. What is the impact of students' success in first College Level Mathematics on retention at Bridgewater State College?
4. What is the impact of pathways to Calculus on success in Calculus? More specifically,
    a. What is the impact of Precalculus-to-Calculus versus direct placement pathways on success in Calculus?
    b. What is the impact of Targeted Precalculus versus regular Precalculus pathways on success in Calculus?

Methodology

The population for this study are the cohorts of first-time, full-time students entering BSC in Fall 2006, Fall 2007, and Fall 2008 who took one of the eight specified mathematics courses by Spring 2009. Consequently, any students entering in the Spring semesters are not considered in this study. In addition, transfer students are not considered in this research. The Office of Institutional Research created a data file for this study in spreadsheet format on SPSS (Statistics Programming for the Social Sciences).

The first task was to narrow the sample by keeping those who had one of the eight courses by Spring 2009 and had a CLM grade. The final sample sizes for this research were 1102 for 2006, 1357 for 2007, and 1150 for 2008. The next task was to create variables that could be compared to answer the research questions. Some of the variables included *First CLM Course, Retention,* and *Success in First CLM Course*. For the variable of *Success*, a grade of C- or above was considered "successful" and a grade of D+ or below was considered "unsuccessful."

Thirdly, chi-squared tests were run to explore all of the research questions. Chi-square is a test which determines whether a distribution of frequencies could happen that way by chance. It determines if one variable is dependent or independent of another. When this test is run, a resulting p-value determines the likelihood of the results happening by chance. If the p-value is less than 0.05 (5%), those results are considered unlikely to happen by chance. Therefore, one may conclude that the variables cross-tabulated are indeed dependent on each other. Question 1 cross-tabulated *RM* and *Success in First CLM*. Question 2 cross-tabulated *RM* and *Retention*. Question 3 cross-tabulated *Success* and *Retention*. Question 4a cross-tabulated *Precalculus* and *Success in Calculus*. Question 4b cross-tabulated *Section of Precalculus* and *Success in Calculus*. Questions 4a and 4b narrowed the sample to only those students who had taken Calculus and had the grade on record.

RESULTS

Question 1: Remedial Mathematics vs. Direct Placement on Success in Basic CLM

Not all courses had significant differences in success based on remedial status. The *Principles* result showed significance, along with the *Precalculus* result. For the purpose of this research, the students who are directly placed into CLM without taking RM first will be referred to as "directly-placed students," while those who needed to take RM before their CLM course will be referred to as "RM students." In the 2006 sample, the percentages of directly-placed students who are successful versus RM students who are successful are 96.8% and 80.6% for *Principles*, and 79.2% and 44.9% for *Precalculus*, respectively. These percentages were difference enough that the p-values were less than 0.05, therefore making the results significant. The *Topics* result is not significant, with percentages of 83.9% and 81.8% respectively. While the *Statistics* result is not significant, the percentages of 69% and 46% are both very low and showed observable differences. In general, it appears that directly-placed students in *Principles* and *Precalculus* are more likely to be successful than RM students.

The 2007 sample yielded different results from the 2006 sample. The *Precalculus* result remains consistently significant with percentages for directly placed students and RM students at 78% and 61%. Also, the result of *Topics* is significant, with percentages of 90% and 78% respectively. The result of *Principles* is not significant here, but still yielded similar percentages of 95% and 88%. The *Statistics* result is again not significant, but resulted in interesting percentages. Here, the directly-placed students are successful only 64.6% of the time, while the RM students are successful 87.5% of the time. This finding is noteworthy because it is the first time RM students are more successful than directly-placed students.

The 2008 the results appear more similar to the 2007 sample than to the 2006 sample. Again, the result for *Precalculus* is significant, with dramatically different percentages for the success rate of directly-placed students and RM students of 86.3% and 50%. The result of *Topics* is again significant, with percentages of 88.6% and 78.3% respectively. The result of *Principles* is not significant, with nearly exact percentages for directly-placed students and RM students of 94.0% and 94.2%. Nor is the *Statistics* result statistically significant, though the percentages are observably different at 88.2% and 66.7%. This is in part due to the low counts in the groups.

Question 2: Remedial Mathematics vs. Direct Placement on Retention

Evaluating the 2006 sample on retention of students into their second year, there is no significant difference between the RM and directly-placed students. However, all courses did demonstrate RM students having a higher percentage of retention than the directly-placed students.

Looking at the 2006 sample and retention of students into their third year, again there are no significant results. However, the *Principles* group flipped its trend from the previous year. Now, the directly-placed students had the better retention rate (83.2%) than the RM students' rate (71.0%). In the rest of the courses, RM students continued to have greater retention.

Analyzing the 2006 sample's retention of students into their fourth year, again the chi-square test shows no significant results. The difference in percentages appears to be decreasing, with the results of *Precalculus* and *Topics* coincidentally having the same percentage for both the directly placed students (61.2%) and the RM students (72.3%). The *Principles* result did remain consistent with the directly-placed students having higher retention than the RM students.

The 2007 sample's retention of students into their second year presented some statistically significant results. For the results of *Topics*, the students who did take RM are more likely to be retained (93.1%) than the directly-placed students (79.5%). Also, the *Statistics* result is the only one where the directly-placed students had a better retention rate. The results of *Principles* and *Precalculus* showed the opposite with RM students having the better retention rate. When combining all the courses, the results are statistically significant, with RM students more likely to be retained.

For the 2007 sample's retention into their third year, statistically significant results are found again only for *Topics* and the entire sample. The results for *Topics* showed 83.8% retention for the RM students and 72.2% retention for the directly-placed students. Just like 2007 and retention into their second year, this test showed *Principles* and *Precalculus* RM students with better retention. Conversely, the results of *Statistics* showed directly-placed students with better retention.

For the 2008 sample's retention into their second year, there are no statistically significant results. However, every course yielded percentages where the RM students had better retention than the directly-placed students. This differs from the 2006 and 2007 samples, which had some courses showing the opposite.

Question 3: Successful vs. Unsuccessful in CLM on Retention

Looking at the relationship between success in CLM and retention, there is significance in several courses. For the purpose of this research, those students who are successful in their first CLM will be referred to as "successful students," and those who are not successful will be referred to as "unsuccessful students." The 2006 sample's retention of students into their second semester showed significant results for *Precalculus*, *Topics*, *Calculus I*, and all the courses combined. Successful students had significantly greater retention over unsuccessful students. *Precalculus*' successful students are 96.0% retained, while its unsuccessful students are only 81.3% retained. For *Topics*, successful students are 98.6% retained, while unsuccessful students are 81.4% retained. For *Calculus I*, successful students are 96.7% retained, while unsuccessful students are 69.2% retained. For those courses that are not significant, the successful students still demonstrated greater retention than the unsuccessful students.

For the 2006 sample's retention of students into their second year, there is statistical significance in the results of *Precalculus*, *Topics*, *Statistics,* and *Calculus I*. In *Precalculus*, successful students are retained 79.0% of the time, while unsuccessful students are retained 67.5% of the time. In *Topics,* successful students are retained 87.2% of the time, while unsuccessful students are retained 70.0% of the time. In *Statistics*, successful students are retained 100% of the time, while unsuccessful students are retained 70.0% of the time. In *Calculus I,* successful students are retained 96.7% of the time, while unsuccessful students are retained 69.2% of the time. In addition, all courses combined had successful students significantly more likely to be retained.

For the 2006 sample's retention into their third year, *Topics*, *Statistics*, and *Calculus I* are the only significant courses. In *Topics*, 80.6% of the successful students are retained, while only 58.6% of the unsuccessful students are retained. In *Statistics*, 97.1% of the successful students are retained, while only 70.0% of the unsuccessful students are retained. In *Calculus I*, 83.6% of the successful students are retained, while only 38.5% of the unsuccessful students are retained. However, it is interesting that *Precalculus* had nearly identical retention rates for successful and unsuccessful students, when just one year before, the rates are different enough to be considered significant. *Applied Calculus* is the only course which did not demonstrate successful students with the higher retention rate over unsuccessful students.

Finally, for the 2006 sample's retention into their fourth year, there is less significance. *Topics*, *Calculus I*, and all the courses

combined are the only ones with a statistically significant difference in retention. *Topics* had the retention of successful students at 75.9% and unsuccessful students at 54.3%, while *Calculus I* is 80.3% and 38.5%, respectively. All the courses again remained with successful students having better retention rates than unsuccessful students.

For the 2007 sample and retention of students into their second semester, *Precalculus*, *Topics*, *Calculus I*, and all courses combined are statistically significant with successful students retaining better than unsuccessful students. For *Precalculus*, the percentages are 96.5% and 88.5%, respectively, for *Topics* they are 97.4% and 82.1%, and for *Calculus I* they are 100% and 81.8%. For each course, successful students had higher percentages of retention than unsuccessful students.

For the 2007 sample and retention of students into their second year, *Precalculus*, *Topics*, and *Statistics*, along with all courses combined, showed significance. *Precalculus* is significant with successful students being retained 85.7% of the time and unsuccessful students being retained 70.8% of the time. For *Topics*, the retention rates for successful and unsuccessful students are 86.5% and 73.1%, respectively.

Finally for the 2007 sample's retention into their third year the same courses came out to be significant. *Precalculus*'s successful students are retained 75.3% of the time, while unsuccessful students are retained 62.5% of the time. *Topics*'s successful students are retained 79.1% of the time, while unsuccessful students are retained 61.5% of the time. *Statistics*'s successful students are retained 91.1% of the time, while unsuccessful students are retained 57.9% of the time. Again, *Principles*, while not significant, still had successful students with a slightly higher percentage of retention.

For the 2008 sample and retention of students into their second semester, all the courses except for *Elements of Calculus* and *Applied Calculus* showed statistical significance with successful students more likely to be retained than unsuccessful students. *Principles* students had retention rates of 98.7% and 80.0%, respectively. *Precalculus* students had retention rates of 97.1% and 73.8% respectively. *Topics* students had retention rates of 97.2% and 89.8%, and *Statistics* students had retention rates of 97.2% and 71.4% respectively. *Calculus I* students had retention rates of 97.9% and 73.3% respectively.

For the 2008 sample and retention of students into their second year, only *Precalculus* and *Statistics* are statistically significant. For *Precalculus*, successful students are 87.0% retained, and unsuccessful students are 64.6% retained. For *Statistics*, successful students are 85.1% retained, and unsuccessful students are 50.0% retained. For *Calculus I*, successful students are 93.6% retained, and unsuccessful students are 66.7% retained.

Question 4a: Precalculus vs. Direct Placement to Calculus on Success in Calculus

Overall for the 2006 sample, students who are directly placed into Calculus are more likely to be successful in Calculus over students who took *Precalculus* first. For the purpose of this research, those students who place directly into Calculus will be referred to as "directly-placed Calculus students" and those students who went through *Precalculus* first will be referred to as "Precalculus-to-Calculus students." For *Elements of Calculus*, directly-placed Calculus students are 88.1% successful, while Precalculus-to-Calculus students are only 59.3% successful. For *Calculus I*, directly-placed Calculus students are 82.4% successful while Precalculus-to-Calculus students are 65.8% successful. *Applied Calculus* did not have any directly-placed students, so no comparison test could be run.

For the 2007 sample, the results of all three calculus courses demonstrated statistical significance. For *Elements of Calculus*, directly-placed Calculus students are 88.9% successful, while Precalculus-to-Calculus students are only 61.5% successful. For *Applied Calculus*, directly-placed Calculus students are 93.8% successful, while Precalculus-to-Calculus students are only 76.1% successful. For *Calculus I*, directly-placed Calculus students are 81.4% successful, while Precalculus-to-Calculus students are only 60.5% successful.

For the 2008 sample, interestingly none of the courses showed statistical significance, differing very much from the 2006 and 2007 samples. Also, *Elements of Calculus* and *Applied Calculus* did have directly-placed Calculus students with higher success rates than Precalculus-to-Calculus students. *Calculus I* had nearly identical percentages, but the Precalculus-to-Calculus students had a slightly higher success rate than the directly-placed students, which is different from all the other trends for this test.

Question 4b: Targeted Precalculus vs. Regular Precalculus on Success in Calculus

Since Targeted sections were not offered until Fall 2007, the 2006 cohort is not able to be included in this question. For this research question, only those students who took Precalculus and then took Calculus are included. Students who took the regular Precalculus section before Calculus will be called "Regular Precalculus students" while those who took the Targeted Precalculus section will be called "Targeted Precalculus students."

In the 2007 sample, there is a significant difference in Calculus success between regular Precalculus and Targeted Precalculus

students in *Elements of Calculus* and *Calculus I*. For *Elements of Calculus*, Regular Precalculus students are more successful (74.1%), over Targeted Precalculus students (33.3%). Similarly, for *Calculus I*, Regular Precalculus students are more successful (76.0%) over Targeted Precalculus students (30.8%). *Applied Calculus*' results are not significant but interestingly have Targeted Precalculus students with greater success. For *Applied Calculus*, Targeted Precalculus students are 85.4% successful while Regular Precalculus students are less successful at 68.1%.

For the 2008 sample, there are interesting differences from the 2007 sample in Targeted and Success cross-tabulation. Here, no calculus courses had any significant difference between those students who took Regular Precalculus and Targeted Precalculus. For *Elements of Calculus* and *Applied Calculus*, the Regular Precalculus students had a higher percentage of success in Calculus over Targeted Precalculus students. However, for *Calculus I*, the opposite is true; Targeted Precalculus students had a higher percentage of success in Calculus over Regular Precalculus students.

DISCUSSION

Question 1: Remedial Mathematics vs. Direct Placement and Success in Basic CLM

Results from all three cohorts demonstrate that directly-placed students are significantly more likely to be successful in *Precalculus* than RM students. This result could be due to a gap between the knowledge necessary to pass RM and the knowledge necessary to succeed in *Precalculus*. *Precalculus* is a very in-depth subject which relies heavily on past mathematics knowledge, while subjects like *Statistics* and *Topics* do not rely on past knowledge as much. However, the results for *Topics* are found to have this same significant result for the 2007 and 2008 cohorts, and the results for *Principles* are found to have this significant result only for the 2006 cohort. Other possible reasons could be that the RM students have poor study skills, low confidence in their ability to do mathematics, and/or mathematics anxiety that lead to their lack of success in mathematics previously. These traits are unlikely to change without further intervention during college, therefore continuing their lack of success into college mathematics.

A recommendation for eliminating the significance difference in success between RM students and directly-placed students would be to provide greater support for all students in remedial mathematics. Currently, there are Targeted sections of remedial mathematics for students who need to continue on to Precalculus and eventually Calculus. However, since these students are most at risk, one recommendation is to develop a mentoring program to help get past many of the psychological barriers that prevent a student from working to his/her full potential. This program would include coaching to gain confidence in mathematics and lessons on effective study habits.

Note that the results of *Statistics* show no significance for any of the cohort years. The small sample sizes in the course required the chi-square value to be adjusted to compensate for this, therefore limiting the strength of the data. For future research, larger samples of students in *Statistics* should be obtained to run the tests, perhaps by combining cohort years.

Question 2: Remedial Mathematics vs. Direct Placement on Retention

RM students consistently had a higher percentage of retention than directly-placed students. However, this difference is rarely found to be significant. The 2006 cohort is not significant in any course or any retention year. In the 2007 cohort, only results from *Topics* demonstrated RM students as significantly more likely to be retained than their directly-placed counterparts. This is the case for retention into their second year and third year. For the 2008 sample, results are similar with RM students also being more likely to be retained. For the 2008 sample's retention into the first year, this is shown in the results of *Topics* and *Precalculus*. One explanation for this interesting result is that those students who pass RM to get to a CLM course have already overcome a large hurdle at BSC, so they have greater persistence than students who did not have that first hurdle to overcome. Students without much persistence may desire to quit college or transfer to a less rigorous community college when obstacles do come up since they have not invested as much time or money into the system.

Non-retained students could also be transferring to more rigorous colleges or universities that specialize in an area. Therefore, those students who are better in mathematics and did not need to take RM could just be beginning their college education at BSC for the first year or two for the cheaper costs, then transferring over to a more expensive institution which has their desired major. For example, a student who desires to become a pharmacist could stay at BSC for the first two years to get the prerequisite general science courses completed, and then transfer to a pharmacy school to obtain his/her degree. This would also make the results appear that the directly-placed students are less likely to be retained at BSC.

An idea for further research would be to track where the non-retained students went after leaving BSC. Also, a sample of surveys matched to their mathematics course grades would be very informative. The survey could question students as to their reason for leaving BSC, whether they were continuing on with

college at a different location, and whether their remediation in mathematics contributed to their departure from BSC. Another interesting future follow up research question would be to take only those students who took RM, look at whether they pass or fail RM, and compare that to whether they are retained at the college.

Question 3: Successful vs. Unsuccessful in CLM on Retention

There is significance across all the cohort samples in nearly all the courses. In general, successful students are more likely to be retained. One possible explanation is that since these students are successful in mathematics, they are successful in other subjects also because they have qualities of time management, patience, and focused study habits. Therefore, they are supporting their long-term goals of graduating from college and having a career. If they are not doing well in mathematics, they are not moving towards their goals of graduating college and getting a job in their field. *Topics* is the only course which is significant across nearly all of the retention period years (2006 2nd semester, 2006 2nd year, 2006 3rd year, 2006 4th year, 2007 2nd semester, 2007 2nd year, 2007 3rd year, 2008 2nd semester).

Precalculus and *Calculus I* are significant in seven out of the nine retention periods. These students in general are in majors which require a large use of mathematics. When they did not do well in mathematics, a large step necessary to achieve their goal, they may have given up altogether and left BSC. In addition, those who are unsuccessful in Precalculus perhaps are more likely to give up since that is not their final difficult mathematics course, but a prerequisite on their way to Calculus. Perhaps these students figure that if they couldn't even make it past Precalculus successfully, they might as well give up their goal before they waste even more time and money.

Statistics shows significance in five out of the nine retention years (looking at 2006, 2007, and 2008 as a whole). Some of these students may be in the same situation as *Topics* students, where this mathematics is being taken because of the college's requirement and not due to their major. These students could be therefore profiled similarly and become easily dejected with college when they weren't successful in mathematics. However, *Statistics* consistently had small sample sizes, which made significance harder to come by. Again, a recommendation for a future study would be to attempt to broaden the sample size of *Statistics*.

Interestingly, *Principles* only shows a significant result for one out of the nine retention periods. This suggests that even if students majoring in education have a road block like lack of success in mathematics, they are going to be retained in college in general. Another reason is since BSC is well known as a college for teaching that students have a greater desire to remain there.

Question 4a: Precalculus vs. Direct Placement on Success in Calculus

The results indicate that directly-placed Calculus students are more likely to succeed in Calculus than Precalculus-to-Calculus students. One possible reason for this is that students who need to take *Precalculus* in college have poorer mathematics skills than students who are exempt and able to go directly to Calculus. In fact, some of those students who needed to take Precalculus could have begun in RM previously, making them further behind in mathematics abilities than their directly-placed counterparts. Possible reasons for their poorer mathematics abilities could be poor study skills, low confidence in mathematics, and mathematics anxiety carried over from high school. Another reason could be that BSC's *Precalculus* course does not adequately prepare students for Calculus, since topics such as Trigonometry are not covered. Oddly, the 2008 sample came out with absolutely no significance for any of the Calculus courses nor all the courses combined. One possible explanation could be that the average SAT Mathematics scores of entering students are significantly higher, but this is not the case. Another explanation for this inconsistency could be changes in the *Precalculus* course objectives or faculty that better prepares Precalculus students for Calculus.

Question 4b: Targeted vs. Regular Precalculus on Success in Calculus

Only for *Elements of Calculus* and *Calculus I* in the 2007 sample is there significance for this test, with Regular Precalculus students being more likely to succeed in Calculus over Targeted Precalculus students. An explanation for this could be that the Regular Precalculus students are better prepared in mathematics to begin with to be able to place into the regular section of *Precalculus*. Therefore, they did better once they got to Calculus because of a stronger mathematics base. 2007 was also the first year Targeted sections were included at the college. By 2008, these sections could have been adjusted such that students were more successful, therefore not showing significant difference in success from the Regular Precalculus students.

Conclusion

This study has shown that Remedial Mathematics students are less likely to succeed in *Precalculus* than directly-placed students. This is shown for *Topics* and *Principles*, depending on the year. Also, successful students are more likely to be retained at BSC than unsuccessful students, especially in *Topics*, *Precalculus*, and *Calculus I*. Next, directly-placed Calculus students are more likely to succeed in Calculus over Precalculus-to-Calculus

students. Finally, for the Calculus courses of *Elements of Calculus* and *Calculus I*, Regular Precalculus students are more likely to succeed over Targeted Precalculus students.

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