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Finding a Path to Gateway Success: Analyzing the Effectiveness of Corequisite Remediation

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Finding a Path to Gateway Success: Analyzing the Effectiveness of Corequisite Remediation.

A Thesis

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The thesis entitled '**Finding a Path to Gateway Success: Analyzing the Effectiveness of Corequisite Remediation.**' presented by **Glen Michael Ragan, Jr,**, a candidate for the degree of **Master of Science in Mathematical Sciences,** has been approved and is worthy of acceptance.

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ABSTRACT

As more and more students arrive at college deficient in mathematics skills, colleges and universities are looking for a change in practices for these students. Corequisite remediation is one of the methods being used across the nation. The focus of this study was to compare success rates of students in corequisite gateway courses to students in the standard gateway courses, did these two groups of students complete the follow up course at the same level of success, and did they do as well in the gateway course as students that have traditionally been placed in noncredit bearing remedial courses. Students' grades were coded to a pass/ fail binary representation with 1 as credit received and 0 as no credit received for the course. $\chi 2$ tests, Analysis of Variance, Kruskal-Wallis test, and Fisher's Exact test were performed. The results showed that there was no statistically significant difference between credit received across the type of gateway course that was taken. The students in corequisite courses and standard gateway courses performed with no statistical difference in the follow up course. Students in corequisite courses did perform statistically different than those in traditional remediation courses.

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I would like to thank many people that have made this research project possible. First, I'd like to Dr. Douglas Darbro for all his time and help throughout this process, countless phone calls, emails, and answering my cries for help no matter the time or day. Next, I must thank my family for all their support. My wife Katie, son Dillon, and daughter Natalie have been very patient with my disappearing for days on end into the office to research, calculate and type. Their sacrifice of family time and vacations have meant more to me than they could possibly know. And last, but not least, I would like to thank all my instructors at Shawnee State University, both those that I had as an undergrad, and those that I met on this journey to a Master's degree.

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CHAPTER I

INTRODUCTION

As colleges around the nation look at ways to improve student success, fewer students that are placed in remedial courses complete credit bearing classes. Most end up leaving college without any college credit but several thousands of dollars' worth of student loan debt. To change this trend colleges, universities, state departments of higher education, and other organizations are seeking another path to success in these gateway courses. Corequisite remediation appears as the front runner as a solution. This study will test the effectiveness of corequisite remediation as providing the same level of success as non-remedial students and the success rates of these students to others that were placed in remedial courses and then attempted the gateway course.

Background

Although the literature isn't clear on the beginning of corequisite remediation for combining developmental and gateway courses, Tennessee Board of Regents, Massachusetts Department of Higher Education, and other such organizations appear to have been the first to mandate corequisite remediation. Corequisite remediation allows students who would traditionally be placed in a remedial (developmental) course to take the credit bearing course while receiving remediation at the same time. Some colleges have elected to have two separate courses that the students take simultaneously, the 3-hour standard course and the 2-hour remedial course. While others have mandatory weekly meetings outside of the standard course time allow students to review or learn for the first time the prerequisite skills they are lacking for the course that week. This just-in-time remediation is aiding students without bogging them down with huge amounts of debt and lost time.

Students placed in developmental course pathways have seen little success over the years. Around 30% of students who enroll in developmental courses complete a degree or certificate program (Bailey, 2008). Universities and community colleges across the nation are looking at ways to improve student success and prepare students for both their majors and the real-world beyond graduation. Some models place students in standard courses with no remediation in a sink or swim mentality whereas other models are changing the levels of required mathematics for different majors. No matter the model of remediation being administered, they have all came to the same conclusion, the old ways no longer work.

While corequisite remediation is winning over college administrators not everyone is as impressed. Most remedial courses are taught by faculty that is not qualified to teach the standard courses and would therefore be out of a job. Also, the supplemental courses are taught by the same professors as the standard courses which means colleges must pay these professors more or hire more staff which could nearly double the amount needed to fund these programs (Goudas, 2017). Either way it is often a decision about balancing cost and performance. And there are always those that are stuck in their ways and will reject any new idea.

Purpose of the Study

Is corequisite remediation a viable option for colleges and students to effectively progress through gateway mathematics courses? Previous studies have shown positive results, but many questions still hinder its universal acceptance. The purpose of this study is to examine the effectiveness of corequisite remediation versus traditional methods of remediation. Also, it will look beyond the gateway course and compare the performance of corequisite students and standard students in their follow up course, trigonometry.

Significance of the Study

Many studies have been done for corequisite remediation and if it works. However, many of them have taken any improvement as a win and not considered the model used or if the improvement was because of the model or the extra time spent on task. This study will focus on a cohort model. That is, all students in the course are also in the corequisite course. There is no commingling of standard and corequisite students.

Research Questions

The research questions for this study are

- Do students who are placed in a corequisite statistics course achieve the same level of success as students who were placed in the standard statistics course?
- Do students who are placed in a corequisite college algebra course achieve the same level of success as students who were placed in the standard college algebra course?
- Do students who successfully complete a corequisite college algebra course have similar success rates in trigonometry (the follow up course) as students who successfully completed the standard college algebra course?
- Do students who were placed in a corequisite mathematics course (statistics or college algebra) complete their gateway course at a higher rate than students with the same placement level who were required to successfully complete a standalone developmental mathematics course before enrolling in the gateway mathematics course?

Research Design

This is a quantitative, hypothesis testing study. Survey data from the Bridges to Success grant will be used as the population for this study. This is a statewide initiative to redesign remediation at the collegiate level. An SRS of 500 students will be chosen

from this data set. ANOVA and χ^2tests are a few of the methods that will be used to analyze the data and test the hypotheses from the research questions. The data will be scrubbed of any identifying characteristics before being released.

Limitations and Scope

This study is using a population of students that are in a cohort model, with two courses. This is not the only model that universities are using to offer corequisite remediation to students. This factor does limit the results of this study to only be only relevant to schools that offer the same model. However, it does give credibility to the model and its results being reproducible. This study is specifically looking at success/ fail rates, ignoring outside factors such as gender, socioeconomic levels, race, location, etc. This limit is to put the model at the focus and the score for the course as the variable. Corequisite remediation is used in mathematics, writing, and reading. Proof of the model in any one field would lend itself toward the others as well.

Definitions

Throughout this study developmental and remedial will be used to define a course that is below a credit bearing collegiate course. Standard and gateway courses will represent the college credit bearing courses that are part of a degree program. These pairs of words will be used interchangeably.

Summary

Long sequences of remedial courses as a prerequisite to taking credit bearing courses are stifling students and causing large amounts of student loan debt without progress through a program of study. These courses which were designed to help

students have become a hindrance. A new path must be found to get students through gateway courses and on to their programs of study and then to degrees.

CHAPTER II

LITERATURE REVIEW

With the ever-growing need for remediation reform in American colleges and universities, corequisite remediation, or sometimes called coremediation, is an enticing choice for Departments of Higher Learning to study. Starting with studies from the Tennessee Board of Regents Subcommittees and going from state to state and region to region of the country everyone is trying to gain an understanding of how to better prepare students for an education in mathematics at the collegiate level. Some colleges start with just college algebra, other include statistics in their corequisite remediation courses, but all are looking at increasing entry into pathway mathematics courses for students that are on the doorsteps but fall just slightly short of the requirements.

For years developmental courses have been the prescription for students that were not quite ready for credit bearing courses. These courses often discouraged students to the point of dropping out or never taking a credit bearing course. The Community College Research Center (CCRC) at the Teachers College, Columbia University studied the many different experiments that were being done in the field of developmental education. They found several institutions were trying new things and trying to find a way for students to progress through pathway courses and complete their programs in a timely manner. They found in traditional remediation courses that around 31% of students referred to remedial courses ever completed the series, and less than a quarter of students in community colleges that were in remedial courses completed a degree or certificate program within eight years of enrolling in college (Bailey, 2008). The study by Bailey also showed that when students were placed three levels below credit-bearing courses, their completion of a credit-bearing math course was only 10%.

The state of Tennessee is often considered the leader in remediation reform because they chose to dive in headfirst to study the effectiveness of corequisite remediation. After starting to research how students were progressing through developmental courses in 2013, they fully instituted a state-wide corequisite remediation trial program through their institutes of higher learning in the 2014-15 academic year. Followed by a major roll out for the Fall 2015 semester for both mathematics and language arts. Students enrolled in the corequisite remediation courses passed their credit bearing courses with almost a 400% increase over the previous pre-requisite model (Denley, 2016). The program also shown improvement in closing the achievement gap for minorities and low-income students.

Inside Higher Ed conducted a study at City University of New York for the effectiveness of corequisite remediation. The study involved 907 students that required remedial elementary algebra and did not need college algebra for their major program. The students were randomly placed in three different courses: one remedial, one remedial with a weekly workshop, and one college-level with a weekly workshop. The workshops were two-hour long classes that were led by undergraduates that are proficient in the subject. Beyond the assigned courses, the study followed the students' college careers for three years. In those three years, 17% of the remedial course achieved an Associate's Degree, while 25% of the college level group were able to receive an Associate's Degree (Logue,2018).

Complete College America (CCA) released an Executive Summary called *Corequisite Remediation: Spanning the Completion Divide*. Their numbers show that over a million students start their college career in some form of remediation for mathematics each year. Traditional remediation students seldom enroll or complete gateway courses and less than 17% will graduate (CCA, 2016). They also show that in Tennessee alone the number of students the successfully

complete gateway mathematics courses increase from 12% to 61% under their corequisite remediation program.

Corequisite remediation comes in many forms. One-semester redesigned gateway, extra time, mandatory labs, and the California Accelerated Project are just a few of the models that are popping up in universities, community colleges, and technical schools across the country. In some states, corequisite support programs are required while in others the state provides incentive programs for schools that provide the supports (Vandal, 2014).

With any new program the bottom line is always the bottom line, and corequisite remediation does not raise costs as much as one might think. A study through CCRC showed that the traditional prerequisite model and the corequisite model used in Tennessee differed only by $100 for a remedial 3 credit course and by $30 for a college-level 3 credit course (Belfield, 2016). Also, the number of students that will successfully complete a college-level programs due to their completion of the corequisite courses reduces the total cost per student and increases efficiency of the resources provided to the institutions.

Improved scores, higher completion levels, and greater efficiency with lower costs are just a few of the benefits of the corequisite remediation programs that are being initialized and created across the country. We've seen the results for two-year community colleges and technical schools, and the first of the four-year university students will be completing their programs this year in the state of Tennessee. So, more and more information will be pouring in to be studied and analyzed, and this truly is an exciting time to be involved in this transformation of higher education.

CHAPTER III

METHODOLOGY

The main goal of this study is to look at the effectiveness of corequisite remediation for students entering both College Algebra and Statistics. Other goals of this study were to test if students in corequisite remediation courses were as successful at the next level of coursework as their peers not in corequisite remediation, and to test whether students placed in corequisite remediation preformed as well as students that were historically placed in developmental classes before being allowed to take the standard course.

Research Questions

This study's hypotheses were,

- Students who are placed in a corequisite statistics course achieve the same level of success as students who were placed in the standard statistics course.
- Students who are placed in a corequisite college algebra course achieve the same level of success as students who were placed in the standard college algebra course.
- Students who successfully complete a corequisite college algebra course have similar success rates in trigonometry (the follow up course) as students who successfully completed the standard college algebra course.
- Students who were placed in a corequisite mathematics course (statistics or college algebra) complete their gateway course at a higher rate than students with the same placement level who were required to successfully complete a standalone developmental mathematics course before enrolling in the gateway mathematics course.

Participants and Setting

The participants of this study were Shawnee State University students. The population started in Fall 2015 in MATH1200 College Algebra and has continued since every semester with self-selected students. The MATH1150 Statistics offerings started later in Spring 2017 with similar enrollment. The comparison groups are from those who tested high enough to be placed in the credit-bearing course alone, and those that were required to take developmental courses such as Intermediate Algebra. There is also a Quantitative Reasoning course offered at SSU that began in Fall 2017 and Spring 2018. These programs were made possible by grant work started by Dr. John Whitaker and continued by Dr. Douglas Darbro.

The students were offered courses based mainly on their ACT scores and their field of study. Students in a Statistics Pathway scoring under 18 were offered the Corequisite Statistics course, while a score of 18 or higher placed into Principles of Statistics. Students in a STEM or Business pathway scoring between 18 and 21 were to be offered the Corequisite College Algebra, while a score of 22 or 23 would place into standard College Algebra. All the courses were offered face-to-face and online.

Data Collection

Data was collected from SSU for student grades and ACT scores. The data does not include names or other identifying characteristics. The methods for processing the data is explained in the next section.

Methods

For research hypothesis one, a χ^2 test was ran between the corequisite Statistics students final grades and those of students in standard Statistics. Then we conducted an Odds Ratio test to determine the strength of the association of our results.

For research hypothesis two, another χ^2 test was ran between corequisite College Algebra students' final grades and those of students in standard College Algebra. Then we conducted an Odds Ratio test to determine the strength of the association of our results.

A χ^2 test was ran to examine the relationship between MATH1200, MATH1200A, and transfer credit in the grades for Trigonometry. An ANOVA was used to examine hypothesis three; no difference in mean across final grades in Trigonometry for the corequisite College Algebra course, the standard College Algebra course and the transfer credit group. The independent variable was the type of course (corequisite, standard, and transfer credit) and the dependent variable was the grade in the Trigonometry course. A Tukey HSD post hoc test was used to compare pairwise relationships.

For hypothesis four, a χ^2 test was used to compare grades of students placed in a corequisite math course (College Algebra or Statistics) and those traditionally placed in developmental courses due to similar testing scores.

Data Collection Procedures

Data was collected from student records and facilitated through Dr. Douglas Darbro.

Data Analysis

Data analysis was done using a statistical software, R. Any personal information that could be used to identify an individual was not included in the data to ensure anonymity of the students.

CHAPTER IV

RESULTS

The purpose of this chapter is to present the results of the multiple statistical analyses that were completed on the data collected from SSU. The computations were done in a statistical software called R (R Core Team, 2018), with a specific package called gmodels (Warnes et al, 2018) that includes a cross tabulation function. The research questions for this study are

- Do students who are placed in a corequisite statistics course achieve the same level of success as students who were placed in the standard statistics course?
- Do students who are placed in a corequisite college algebra course achieve the same level of success as students who were placed in the standard college algebra course?
- Do students who successfully complete a corequisite college algebra course have similar success rates in trigonometry (the follow up course) as students who successfully completed the standard college algebra course?
- Do students who were placed in a corequisite mathematics course (statistics or college algebra) complete their gateway course at a higher rate than students with the same placement level who were required to successfully complete a standalone developmental mathematics course before enrolling in the gateway mathematics course?

Participants and Settings

The participants of this study were 500 SSU students in MATH0101, MATH0102, MATH1200, MATH1200A, STAT1150, STAT1150A, and MATH1250 courses. These courses include standard remediation courses (MATH0101 and MATH0102), gateway level courses (MATH1200 and STAT1150), corequisite gateway courses (MATH1200A and STAT1150A), and next level course (MATH1250). Students were placed in courses as per standard procedures

of the university. The placement score for STAT1150 Principles of Statistics was an ACT score of 18, and MATH1200 College Algebra was an ACT score of 22. The corequisite courses STAT1150A had an ACT range of 15-17 and MATH1200A had an ACT range of 18-21.

Data Analysis

Research Hypothesis #1

In the study of difference in performance of students in STAT1150 Principles of Statistics and STAT1150A Principles of Statistics Corequisite course, the students were grouped by course and their results were coded as 0 for no credit and 1 for receiving credit for the course. A 2x2 contingency table was completed for Credit vs Course, see Table 1. A cross tabulation function was used in R to calculate percentages, expected values, the Pearson χ^2 statistic, and an odds-ratio using Fisher's Exact Test for Count Data. Due to an expected cell count below 10 Pearson's Chi-squared test with Yates' continuity correction was used (Deviant, 2017). The difference in percentages for success rates was not significant, $\chi 2\ (1) = 1.8070$, p=.1789. However, the odds-ratio was 2.5670, p = .1643, indicating that a student in STAT1150A was 2.5670 more likely to receive credit than a student in STAT1150, though the result was not significant.

Table 1: *Cross Tabulation Results for STAT1150 and STAT1150A*

	0 (no credit)	**1 (credit)**	**Total**
STAT1150	81	294	375
Expected	77.586	297.414	
Percent	21.6%	78.4%	
STAT1150A	3	28	31
Expected	6.414	24.586	
Percent	9.677%	90.323%	
Total	84	322	406

Research Hypothesis #2

Success rates for students in MATH1200 College Algebra and MATH1200A Corequisite College Algebra groups were also examined and coded as previously with research question #1. Using the cross-tabulation function in R resulted in Table 2. Since all expected cell counts were above 10 the Yate's continuity correction was not used with the Pearson's chi-square test, χ^2 (1) = 3.5893, p = .0582. The difference in success rates were not statistically significant. the odds-ratio was 2.0564, p = .0754, indicating that a student in MATH1200A was 2.0564 more likely to receive credit than a student in MATH1200, though the result was not significant.

Table 2: *Cross Tabulation Results for MATH1200 and MATH1200A*

	0 (no credit)	**1 (credit)**	**Total**
MATH1200	38	82	120
Expected	32.667	87.333	
Percent	31.667%	68.333%	
MATH1200A	11	49	60
Expected	16.333	43.667	
Percent	18.333%	81.667%	
Total	49	131	180

Research Hypothesis #3

The purpose of this research question was to examine success rates in MATH1250 Trigonometry for students who enrolled in either MATH1200, MATH1200A, or were a transfer student. A cross tabulation function, see Table 3, was used in R to calculate the Pearson χ^2 statistic, $\chi^2(2) = 4.6535$, p = .0976, so no statistical difference is found between course and credit received for Trigonometry.

Table 3: *Cross Tabulation Results for MATH1200, MATH1200A, and Transfer Credit*

	0 (no credit)	1 (credit)	Total
MATH1200	24	60	84
Expected	22.575	61.425	
Percent	28.571%	68.333%	
Std Resid	0.300	-0.182	
MATH1200A	15	29	44
Expected	11.825	32.175	
Percent	34.091%	65.909%	
Std Resid	0.923	-0.560	
Transfer Credit	4	28	32
Expected	8.600	23.400	
Percent	12.500%	87.500%	
Std Resid	-1.569	0.951	
Total	43	117	160

Following up with a logistic regression model with one predictor, setting transfer as the reference group, resulted in coefficients of MATH1200 being -1.0296, $p = .0792$ and MATH1200A being -1.2867, $p < .05$. A test of the full model against a constant only model was statistically reliable, $\chi^2(3) = 31.9$, $p < .001$, indicating that the predictor did distinguish between receiving credit and not receiving credit in Trigonometry. The variance in credit received accounted for is small with McFadden's rho = 0.0277, df = 3. Prediction success (with a threshold of 0.5) was 117 out of 160 cases (73.1%) accurately classified with sensitivity and specificity values of 1 and 0. Table 4 shows regression coefficients, Wald statistics, and odds ratios for each category of the predictor variable.

Table 4: *Logistic Regression Analysis of Credit Received as a Function of Course Taken*

Variable	*B*	Wald (z ratio)	Odds Ratio	p-value	95% CI Lower	95%CI Upper
1200	-1.030	0.535	0.357	.079	0.098	1.033
1200A	-1.287	0.587	0.276	< .05	0.072	0.869
(Constant)	1.946	0.622	7.000	< .001	2.742	23.642

Figure 1 shows the ROC curve for our predictor, with the area under the curve being 0.5934. Figure 2 shows a plot of the model sensitivity and specificity for various cutoffs. It was found that 0.714 is the value that minimizes the difference in sensitivity and specificity. The values of sensitivity and specificity at 0.714 are 0.752 and 0.349.

Figure 1: *ROC Curve of model*

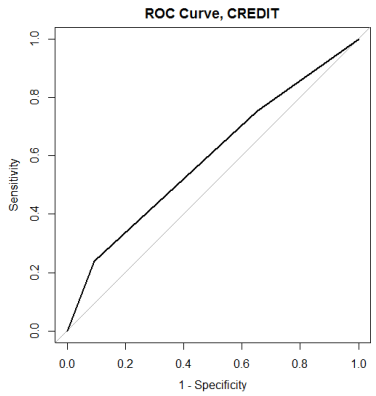
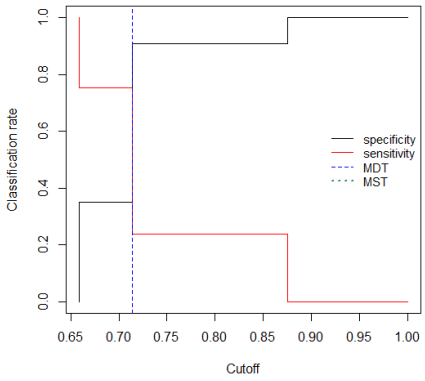


Figure 2: *Plot of Model Sensitivity and Specificity for Various Cutoffs*



ANOVA techniques were used to examine mean GPAs across the prerequisite courses: MATH1200, MATH1200A, and transfer credit. The subjects included students in MATH1200 ($n = 84$, $\bar{x} = 1.8770$, $s = 1.5190$), MATH1200A ($n = 44$, $\bar{x} = 1.5303$, $s = 1.3243$), and students that had received a transfer credit (coded as TR) ($n = 32$, $\bar{x} = 2.6979$, $s = 1.4576$). The results, see Table 5, indicate a difference in means, $F(2,157)=6.156$, $p < .01$. In order to test the

assumptions of the ANOVA, a Shapiro-Wilk normality test was done to test for normality ($W = 0.8730$, $p < .001$) and a Levene test for homogeneity of variances was used to check for equal variances ($F(2,157) = 1.4816$, $p = .2304$). Research shows (see Laerd Statistics, 2018) that in the presence of the violation of the normality assumption, ANOVA is robust with only a small effect on Type I error rates when normality failed. A Tukey HSD post hoc test was conducted (Table 6) to examine to relation pairwise between the courses. The only pairings showing significant difference was between MATH1200 and transfer credit (0.8209, (0.1053, 1.5365), $p < .05$), and MATH1200A and transfer credit (1.1676, (0.3673, 1.9679), $p < .01$). However, there was no significant difference between MATH1200 and MATH1200A in their grades in Trigonometry (-0.3467, (-0.9877, 0.2944), $p = .4088$).

Table 5: *ANOVA Table for GRADE Across COURSE*

	df	**SS**	**MS**	**F**	**P value**
COURSE	2	26.1	13.1	6.2	< .01
Residuals	157	332.8	2.1		

Table 6: *TukeyHSD Results*

	Diff	**Lower**	**Upper**	**p**
1200A-1200	-0.3467	-0.9877	0.2944	.4088
TR-1200	0.8209	0.1053	1.5365	< .05
TR-1200A	1.1676	0.3672	1.9679	< .01

Research Hypothesis #4

The purpose of this question was to compare success rates of students placed in corequisite courses (MATH1200A or STAT1150A) compared to the students that had the same placement level of ACT but were required to complete a stand-alone remediation course before enrolling in the gateway course (MATH1200 or STAT1150). By comparing ACT scores that are

now placed into corequisite courses with students that were placed in remedial courses two groups were formed, those who enrolled in a remedial course and those who didn't. Credit in the gateway courses were still coded as in previous tests, with 0 being no credit and 1 being credit received for the course. No expected cell counts were less than 10, therefore a standard Pearson's chi square test (Table 7) was used ($\chi^2(1) = 4.0822$, $p < .05$), indicating there is statistically significant difference between the two groups. Fisher's Test returned an odds ratio of 2.0953, 95%CI(0.9649, 4.7354), $p = .0527$ meaning it is 2 times as likely that a student in corequisite course will receive credit in the gateway course than the remediation students. However, the odds ratio is statistically insignificant.

Table 7: *Cross Tabulation Results for Corequisite vs Traditional Remediation*

	0 (no credit)	**1 (credit)**	**Total**
Traditional	35	57	92
Expected	29.273	62.727	
Percent	38.043%	61.957%	
Std Resid	-1.289	0.881	
Coreq	14	48	62
Expected	19.727	42.273	
Percent	22.581%	77.419%	
Std Resid	1.059	-0.723	
Total	49	105	154

The purpose of this chapter was to present the results from the statistical analyses for each of the research questions. It was shown to be no statistical difference between success rates of those students in corequisite remediation courses and those in the standard course, for both Statistics and College Algebra. Also, there was no statistical difference in success rates in Trigonometry for students coming from the corequisite College Algebra and the standard College Algebra. And lastly, students in corequisite remediation did better than students required to take prerequisite courses before the standard course.

CHAPTER V

CONCLUSION

With more and more students arriving at college needing remediation in mathematics, colleges and universities are searching for a way to effectively teach students and prepare them for future coursework. This study looked at one of the many ways that colleges are battling a long, noncredit bearing remediation procedure that has traditionally been used, a corequisite remediation model. The students are enrolled in a credit bearing course as well as a supplementary course that provides scaffolding and on the spot remediation for the credit bearing course. The classes were taught at Shawnee State University by several of the faculty. The gateway courses MATH1200 College Algebra and STAT1150 Principles of Statistics are two of the first courses to have corequisite offerings at Shawnee State with MATH1200A and STAT1150A respectfully. The other courses used in this study were MATH1250 Trigonometry and MATH0101 Basic Algebra with Geometry and Applications. MATH 1250 is the follow up course for MATH1200 and MATH0101 as the start of the standard remediation coursework at Shawnee State.

Data was collected from student records at Shawnee State University. Datasets received from the university had all names removed and only the most basic information was kept for the study, an ID number, course taken, ACT Math score (for placement purposes only), and the grade achieved for each course in the study. After data collection, the data was cleansed and put into subsets per the needs of each hypothesis.

Conclusion of Hypothesis #1

There was no statistically significant association (χ^2 (1) = 1.8070, p = .1789) in the credit received across the courses (STAT1150 and STAT1150A) that the students were enrolled. The odds-ratio for receiving credit in STAT1150A was 2.5670, p = 1.643. This means that the result of receiving credit could not be determined from whether the student had taken the standard course

or the corequisite course. They achieved statistically at the same level as their peers with higher placement scores.

Conclusion of Hypothesis #2

For students in MATH1200 and MATH1200A (College Algebra and the corequisite course) there was no statistically significant association (χ^2 (1) = 3.5893, p = .0582) between the groups receiving credit. The odds-ratio for receiving credit in MATH1200A was 2.0564, p = .0754. This means that the result of receiving credit could not be determined from if the student had taken the standard College Algebra course or the corequisite College Algebra course. They achieved statistically at the same level as their peers with higher placement scores.

Conclusion of Hypothesis #3

In the examination of how students from the College Algebra groups performed in MATH1250 Trigonometry, a χ^2 test was conducted looking at only receiving credit in the course, and no significant difference was found between the groups (χ^2 (2) = 4.6535, p = .0976). Then an ANOVA was ran to test for equal means (F(2,157) = 6.156, p<.01) and there was statistically significant difference between the groups when looking at the grades received in the course. A TukeyHSD post hoc test was conducted to see the pairwise relationships and no significant difference was shown between MATH1200 and MATH1200A. So, students coming from MATH1200 and MATH1200A had statistically the same level of success in Trigonometry, the follow up course to College Algebra.

Conclusion of Hypothesis #4

To see if students in the corequisite course performed at a higher rate of success than those in traditional remediation, students that were placed in remedial courses with ACT scores that could be in a corequisite course (MATH1200A or STAT1150A) were coded as S, and those

in the corequisite course were coded as A. There was a significant difference ($\chi^2(1) = 4.0822$, $p < .05$) in the groups. An examination of the odds ratio (2.0953, $p = .0527$), shows that it is twice as likely for a student in corequisite remediation to receive credit for the gateway courses. A larger subject group may show that the odds ratio is significant, and these corequisite students do perform at twice the completion rate as traditional remediation students.

Limitations and Recommendations

The study does show that students enrolled in a corequisite course (STAT1150A or MATH1200A) do achieve the same level of success as their peers in the standard gateway courses (STAT1150 or MATH1200). Also, they do comparably well in the follow up course to MATH1200 College Algebra, which is MATH1250 Trigonometry. Students in the corequisite courses have a statistically significant advantage over those in traditional remediation courses, however the true ratio could not be found with the sample size of this study. With more and more institutions offering corequisite courses, the data for a much larger study to this effect would be very useful in nailing down this figure to show that the "old ways" are just not cutting it anymore. A further study of students placed in developmental courses and then completing a credit-bearing course compared to students at the same placement level in corequisite courses would be helpful. The very limited number of participants that fit this definition could be expanded to a nationwide study with the proper resources and time allotments. This could be the way to properly show the true advantage of corequisite remediation over traditional methods.

Further investigation into this study would be helpful to determine if these findings are limited to our region of students. The student population at SSU is largely Appalachian, with 60% of students coming from Scioto, Lawrence, Pike, Adams and Jackson Counties (Shawnee SU Innovation Grant Proposal, 2016). It would be helpful to test if this trend holds for more

urban populations, or even other Appalachian/ rural populations as well. As corequisite remediation models become more accepted at colleges and universities, more course plans are sure to be developed as well. The methods used in this study would lend themselves greatly to any investigations conducted on them.

Another topic that could be addressed in a future study, would be to follow these students post grad and compare income vs. student debt. The amount of debt accrued by students taking multiple noncredit bearing course would be significantly larger than the debt of a student completing their degree with fewer corequisite credit bearing courses. The cost of living with this student debt could be a driving factor for other state governments to further address the requirements of universities and colleges to find new alternatives for remediation, as Tennessee and others have already done.

A longer time period of investigation would also increase the number of participants in the sample. The study focused mainly on 2 years' worth of grades and information. Many more students have progressed through the program just at SSU, let alone in similar programs across the country at other universities. The look at ACT placement in these traditional remediation courses over the past several decades even, could be compared to the students that are currently being placed in corequisite courses at the same placement level of ACT score. The increase in sample size could greatly increase the power of this study and confirm some of the odds ratios that were just outside of statistical significance.

Students starting at lower placement marks yet progressing at the same pace as higher placed peers, provides both motivation to students to keep striving towards completing a degree and keeps them in credit bearing courses so they do not feel as if they are wasting their money.

Students, and people in general, tend to keep after a long-term goal if they feel they are continually making progress towards that goal.

REFERENCES

Bailey, Thomas & Jeong, Dong & Cho, Sung-Woo. (2008). Referral, Enrollment, and Completion in Developmental Education Sequences in Community Colleges. CCRC Working Paper No. 15. Community College Research Center, Columbia University.

Belfield, C., Jenkins, D., & Lahr, H. (2016, April). Corequisite-remediation-cost-effective-tennessee.pdf [PDF]. New York, NY: Community College Research Center. Retrieved December 14, 2018, from https://ccrc.tc.columbia.edu/media/k2/attachments/corequisite-remediation-cost-effective-tennessee.pdf

Complete College America. (2016). Spanning the divide. Indianapolis, IN: Complete College America. Retrieved December 12, 2018, from http://completecollege.org/spanningthedivide/

Denley, T., (2015) Co-requisite Remediation Pilot Study, Tennessee Board of Regents

Deviant, S. (2017, October 12). Yates Correction: What is it used for in Statistics? Retrieved from https://www.statisticshowto.datasciencecentral.com/what-is-the-yates-correction/

Goudas, A. (2017, March). The Corequisite Reform Movement: An Education Bait and Switch. Retrieved December 7, 2018, from http://communitycollegedata.com/articles/the-corequisite-reform-movement/

Laerd Statistics. (2018). One-way ANOVA. Retrieved July 2, 2019, from https://statistics.laerd.com/statistical-guides/one-way-anova-statistical-guide-3.php

Logue, A. W. (2018, July 17). The Extensive Evidence of Co-Requisite Remediation's Effectiveness. Retrieved December 14, 2018, from https://www.insidehighered.com/views/2018/07/17/data-already-tell-us-how-effective-co-requisite-education-opinion

R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

Vandal, B. (2014). Promoting-Gateway-Course-Success-Final.pdf [PDF]. Indianapolis, IN: Complete College America. Retrieved November 20, 2018, from https://completecollege.org/wp-content/uploads/2017/11/Promoting-Gateway-Course-Success-Final.pdf

Warnes, G. R., Bolker. B., Lumley, T., Johnson, R. C.. (2018) Contributions from Johnson, R. C. are Copyright SAIC-Frederick,Inc. Funded by the Intramural Research Program, of the NIH, National Cancer Institute and Center for Cancer Research under NCI Contract

NO1-CO-12400. gmodels: Various R Programming Tools for Model Fitting. R package version 2.18.1. https://CRAN.R-project.org/package=gmodels

BIBLIOGRAPHY[1]

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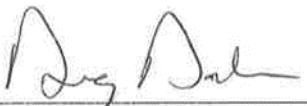

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