2017

Students' Mathematics Self-Efficacy, Anxiety, and Course Level at a Community College

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COLLEGE OF EDUCATION

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Scott Spaniol

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2017

Abstract

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MA, Eastern Illinois University, 2009

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Research suggests that student success in mathematics is positively correlated to math self-efficacy and negatively correlated to math anxiety. At a Hispanic serving community college in the Midwest, developmental math students had a lower pass rate than did college-level math students, but the role of math self-efficacy and math anxiety on these students' learning was unknown. This causal comparative, correlational study, guided by social cognitive theory and math anxiety research, hypothesized that students in developmental math would have lower levels of math self-efficacy and higher levels of math anxiety, and that significant correlations would exist between course level, self-efficacy, and anxiety. All math students at this setting (N = 1,019) were contacted to complete the self-report Mathematics Self-Efficacy and Anxiety Questionnaire; 32 developmental math and 103 college-level math students returned the survey. A random sample of 32 college-level students was selected to create equal group sizes for the data analyses. Independent samples t-tests revealed no significant differences in self-efficacy and anxiety between the groups. Significant correlations were found for course level, self-efficacy, and anxiety. Lower course level math students reported on average significantly lower levels of self-efficacy and significantly higher levels of anxiety than did upper course level students. A professional development program was created to educate faculty about math self-efficacy and math anxiety and to implement strategies that may increase math self-efficacy and decrease math anxiety over time. This doctoral study has the potential to create social change by offering educators new insight into the role of math self-efficacy and math anxiety in student learning.

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Dedication

For my Dad.

Acknowledgments

Thank you to all my family, friends, colleagues, and teachers who made this possible, especially: to my fiancée, Sara, for being my sounding board, editor, and motivation; to my mom, Shari, for teaching me the importance of learning new things; and to my grandpa, Roland, for being an inspiration to follow as I worked to complete my Ed.D.

Table of Contents

List of Tables

Section 1: The Problem

Introduction

Community college students who enter college underprepared for college-level mathematics are often enrolled in developmental mathematics; yet, the success rates for students enrolled in developmental math courses are low (Bahr, 2012). At the community college where this study took place, the pass rates for developmental math courses were 10% lower than those for college-level math courses (M. Banda, personal communication, October 28, 2015). Two issues that may play a role in a lack of success in math courses are math self-efficacy and math anxiety (Phan, 2012; Zakaria, Zain, Ahmad, & Erlina, 2012). Therefore, the purpose of this study was to examine the level of math self-efficacy and math anxiety for both developmental math students and college-level math students using the Mathematics Self-Efficacy and Anxiety Questionnaire. This quasi-experimental, causal comparative and correlation study included survey data to look for differences in student math self-efficacy and math anxiety between these two groups of students and to determine if correlations exist between course level, math self-efficacy, and math anxiety.

Definition of the Problem

Lack of student success, measured by pass rates, in developmental math courses compared to student success in college level math courses is a significant problem in community college math education, as is the lack of understanding of how the students in these courses are different from one another. Math self-efficacy levels and math anxiety levels might contribute to these differences (Phan, 2012; Zakaria et al., 2012). According

to Bahr (2012), most students who enter the developmental math sequence will never complete a college-level math course. Students in developmental math courses also have lower pass rates than those at the college level, which indicates a lack of student success in developmental math courses (California Community Colleges Chancellor's Office Data Mart, 2015; M. Banda, personal communication, October 28, 2015). These two groups of students differ in that developmental students have lower self-efficacy and higher anxiety than their peers in college-level math courses. According to Barrows, Dunn, and Lloyd (2013), students with higher levels of math self-efficacy and lower levels of anxiety have higher levels of success in mathematics. There are positive correlations between student success and math self-efficacy, as well as a strong negative correlation between student success and math anxiety (McMullan, Jones, & Lea, 2012). These results align with social cognitive theory, which suggests that individuals are more likely to learn and retain knowledge when their level of self-efficacy is high (Bandura, 1977). There is a reciprocal relationship between self-efficacy and anxiety in math—namely, that high levels of self-efficacy are linked to low levels of anxiety and vice-versa (Ahmed, Minnaert, Kuyper, & van der Werf, 2012). Based on social cognitive theory and the reciprocal relationship between math self-efficacy and anxiety, it is possible that lower success rates among developmental math students are linked to lower levels of self-efficacy and higher levels of anxiety in mathematics.

Rationale

Evidence of the Problem at the Local Level

Colleges have addressed the problem of a lack of student success in developmental mathematics in a variety of different ways, as evidenced by the number of colleges that are choosing to redesign their developmental math courses (Twigg, 2011). At the community college that formed the setting for this study, only 63% of students who completed a developmental math course between Fall 2013 and Summer 2015 did so with a passing grade, which is 10% lower than the pass rate for students who completed a college-level math course during that same period (M. Banda, personal communication, October 28, 2015). The reason for this difference is unclear; however, in this study, I examined two variables that could be related to student success rates—math self-efficacy and math anxiety.

Evidence of the Problem from the Professional Literature

The lower pass rates of developmental math students compared to college-level math students at this institution are similar to many other institutions around the United States. In a study of the California community college system, Bahr (2012) found that of the 431,455 first time students in 2001, 2002, and 2003, more than 44% required a developmental level math course, and of these students, only 36% would eventually pass a college-level math course. Also, in California. developmental math students have lower pass rates than college-level math students. In the Spring 2015 semester, the success rate for students in college-level math courses at all community colleges in California was 5% higher than it was for all math students combined together (California

Community Colleges Chancellor's Office Data Mart, 2015). Although there is currently no research at the local setting to account for the variables related to the differences in student success rates, math self-efficacy and math anxiety relate to student success in mathematics. For example, in a study of students in Turkey, Yuksel and Gean (2016) found that self-efficacy and anxiety were predictors of math course achievement. Barrow et al. (2013) found a strong relationship between anxiety, self-efficacy, and exam grades. In this study, students with lower levels of math anxiety and higher levels of math self-efficacy performed better on a math exam than students with higher levels of math anxiety and lower levels of math self-efficacy.

Definitions

The following definitions of terms are used frequently within this project study:

Developmental/remedial math: Mathematics course work for students who lack the skills necessary to succeed in college-level math courses (Parsad & Lewis, 2003).

Hispanic serving institution: Colleges and universities where 25% of their full time equivalent student population is Latino (Laden, 2004).

Math anxiety: Students' feelings of tension or anxiety when confronted with mathematics that interfere with their ability to use math in an academic or everyday setting (Richardson & Suinn, 1972).

Self-efficacy: Individuals' belief in their ability to successfully perform the task or tasks necessary to reach a given outcome (Bandura, 1977).

Significance

There is a need to understand the difference in student pass rates between developmental and college-level mathematics students at community colleges. In this study, I examined a combination of variables: course level, math self-efficacy, and math anxiety. This combination has not yet been widely researched. Similarly, most community college math instructors or community college math departments do not consider the impact of math self-efficacy and anxiety on their students. By collecting and analyzing the data, this gap in practice has begun to be rectified at the local setting. This study took place in a Hispanic serving institution, which is a setting that has not been widely used for research. The findings of this study have been used to create a plan for professional development that would accomplish the following: educate math faculty on math self-efficacy; math anxiety; the relationship between math self-efficacy, math anxiety; and student success, and create a plan of action to address student math self-efficacy and anxiety. The process used to collect and analyze these, data along with the proposed professional development, can give administrators and educators at similar colleges a deeper understanding of math self-efficacy and math anxiety and ways to address these variables.

Research Questions

The focus of this study was on the lack of student success, measured through pass rates, in developmental math courses compared to college-level math courses, as well as a lack of understanding of how these two groups of students are different from one another. Two factors that might contribute to these differences are math self-efficacy

levels and math anxiety levels. Higher levels of math self-efficacy and lower levels of anxiety are linked to student performance in math (Barrows et al., 2013; McMullan et al. 2012). The purpose of this research was to examine whether a similar link is present in this setting by answering the following questions:

RQ1: Is there a difference between the math self-efficacy levels of students in developmental math compared to students in college-level math?

$H_0$1: There is no difference between the mean levels of math self-efficacy on the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) for students in developmental math courses compared to students in college-level math courses.

H_a1: There is a significant difference between the mean levels of math self-efficacy on the MSEAQ for students in developmental math courses compared to students in college-level math courses.

RQ2: Is there a difference between the math anxiety levels of students in developmental math compared to students in college-level math?

$H_0$2: There is no difference between the mean levels of math anxiety on the MSEAQ for students in developmental math courses compared to students in college-level math courses.

H_a2: There is a significant difference between the mean levels of math anxiety on the MSEAQ for students in developmental math courses compared to students in college-level math courses.

RQ3: Is there a correlation between course level and the level of math self-efficacy?

$H_0$3: There is no correlation between course level and the level of math self-efficacy on the MSEAQ.

H_a3: There is a significant correlation between course level and the level of math self-efficacy on the MSEAQ.

RQ4: Is there a correlation between course level and the level of math anxiety?

$H_0$4: There is no correlation between course level and the level of math anxiety on the MSEAQ.

H_a4: There is a significant correlation between course level and the level of math anxiety on the MSEAQ.

Review of the Literature

A variety of journals and articles were used for this project study, including the *Journal of Developmental Education, Journal of College Student Retention: Research, Theory, and Practice, Educational Research Review, Adult Education Quarterly, International Journal of Education Research,* and the *Community College Journal of Research and Practice*. Articles were collected from several databases, including Education Resources Information Center, Education Research Complete, Science Direct, and Sage Premier. Keywords used for this study included d*evelopmental math, remedial math, math self-efficacy, Hispanic serving institutions, college math, community college math*, and *math anxiety*.

Theoretical Framework

The focus of this study was the lack of student success, measured through pass rates, in developmental math courses compared to college-level math courses, as well as

a lack of understanding of how these two groups of students are different from one another. Two factors that might contribute to these differences are math self-efficacy levels and math anxiety levels. Social cognitive theory and math anxiety both offer insight into why certain students may have more difficulty succeeding in math courses than other students. According to these theories, described in greater detail below, math self-efficacy and math anxiety play a role in students' ability to succeed in mathematics courses.

Social cognitive theory was based on the work of Bandura (1971), who first proposed a theory in which behavior is not only learned through a person's own experiences but can also be learned vicariously through witnessing the experiences of others. Later, Bandura (1977) expanded this theory to emphasize the importance of self-efficacy on behavioral change. Bandura (1977) explained that self-efficacy is a person's beliefs in his or her ability to perform a task or to learn a topic. This belief can be influenced by a person successfully completing a task, a person witnessing someone else successfully completing a task, an outside individual persuading a person that they can complete the task, and by a person's current emotional state. Self-efficacy plays a role in the learning process by influencing the amount of time and effort an individual will put towards a given task and how well that individual uses coping techniques in difficult situations. Social cognitive theory is applicable to this study because it offers self-efficacy as a possible variable to explain the differences in success rates among a certain group of students as compared to a different group of students in the same setting.

Math anxiety does not have the theoretical backing of self-efficacy; but, it does have a large amount of research supporting its impact on learning. Math anxiety is the tension or fear a person feels when he or she is confronted with the need to perform mathematical tasks (Richardson & Suinn, 1972). It is connected to self-efficacy because of the influence that anxiety and stress can have on the self-efficacy of an individual (Zientek & Thompson, 2010). Chui and Henry (1990) broke math anxiety into four dimensions: the anxiety of entering into an environment or activity where math learning could occur, the anxiety that comes from performing math calculations on a nonevaluation, the anxiety that occurs based on the person who is teaching the math course, and the anxiety that occurs from the need to take a math test. Rubinsten and Tanook (2010) listed several causes of math anxiety, including experiences in math classes or with math teachers, low self-efficacy or previous bad experiences with mathematics, and low intelligences or poor math ability. Students with high levels of math anxiety will tend to perform poorly on mathematics tasks (Finlayson, 2014; Lyons & Beilock, 2011; Nunez-Pena, Pellicioni, & Bono, 2013). Math anxiety was chosen as a variable for this study because of its connection to poor performance on math tasks.

Current State of Developmental Mathematics

Developmental or remedial mathematics consists of courses offered at 2- and 4-year colleges for students who enroll at the college and are unable to demonstrate a skill level that suggests that they are prepared to succeed in a college-level math course (Parsad & Lewis, 2003). Because most community colleges are open enrollment institutions where students at any level of academic performance can enroll, they

typically offer a large number of developmental math courses. The most common method for determining a student's math skill level when entering community college is through placement testing. These tests can allow community colleges to maintain their academic standards and allow lower performing students the chance to build their skills in developmental math courses (Gabbard & Mupinga, 2013). Goeller (2013) found that about three quarters of students were satisfied with the course that they were placed in based on the placement test. Although a pathway is in place for students to gain access to college-level mathematics and most students are satisfied with where they enter this path, there are issues with the current state of developmental mathematics. Many students are still failing to complete the developmental math sequence, which prevents them from succeeding in college-level math (Bahr, 2012).

A large percentage of students who enroll at a community college need to take at least one developmental math course. In 2011, 60% of first-time undergraduates at public 2-year colleges in Missouri participated in a developmental math course (Radford & Chambers, 2012). In 2008, 41% of first-time community college students in Texas scored below the college readiness standards for math (Abraham, Slate, Saxon, & Barnes, 2014). Nationally, more than half of all college students will enroll in some form of developmental course during their time in college, most of which are developmental math or English (Bailey, Jeong, & Cho, 2010). For students who take a developmental math course, success is difficult. Less than half of all California community college remedial math students go on to pass a college-level math course (Bahr, 2012). Students who need developmental math courses but do not enroll immediately upon entering a college are

less likely to pass those developmental math courses (Fike & Fike, 2012). This lack of success extends beyond the math classroom for many of these students. For students who leave the remedial math sequence without reaching college-level math, less than a quarter of these students eventually complete a certificate, credential, or transfer to a 4-year university (Bahr, 2013). Students in the remedial course sequence are also less likely to attain their certificate or degree than students who did not need remedial course work (Radford & Chambers, 2012).

A large amount of the current research in developmental math education focuses on examining variables that could play a role in success in developmental mathematics. Older students, White students, and women are more likely to succeed than other groups (Bremer, 2013; Wolfe, 2012; Wolfe & Williams, 2014). More research is needed to understand what about these groups makes them more likely to succeed. The teaching status of the instructor and how frequently the student attends class are also important variables for student success. Students who are taught by full-time instructors, who have more time and resources to use in teaching their courses than part-time instructors, and who regularly attend class are more likely to succeed than students taught by part-time instructors or who do not regularly attend class (Zientek et al., 2013). Colleges should make sure that all faculty teaching developmental courses are well prepared and supported. In addition, requiring student attendance could help colleges increase student success in their developmental sequences. Students can also benefit from early intervention when they are not succeeding, and this intervention can increase the chances of success for the student in the future (Dasinger, 2013). Colleges should, therefore,

make sure that all developmental math instructors understand how to spot students who are struggling and that the instructors are prepared to intervene for the benefit of these students.

Colleges should find ways to integrate developmental students into the college environment because this increases their chances of staying in the developmental math sequence and continuing with their college education (Davidson & Petrosko, 2015). Relationships also exist between the variables of developmental math course success and students' grades in their preceding developmental math course. The higher a student's course grade is in a previous course, the more likely the student is to succeed in the next course (Davidson, 2015).

Math Self-Efficacy and Anxiety

Just as many variables can impact student success, a variety of variables have a strong correlation to mathematics self-efficacy and anxiety. Jameson and Fusco (2014) reported that adult learners had lower levels of self-efficacy and higher levels of math anxiety compared to traditional college students. Gender also plays a role in math self-efficacy. According to Peters (2013), females report lower levels of math self-efficacy than males even when the levels of ability are similar. Self-efficacy is also lower in minority students; however, as the self-efficacy of minority student increases, the achievement gap between White and minority students begins to shrink (Kitsantas et al., 2011). Similar to how increasing math self-efficacy can mitigate the achievement gap between minority and White students, caring teachers have been shown to boost math scores and math self-efficacy among Hispanic elementary school students (Lewis et al.,

2012). Ozgen and Bindak (2011) examined the math self-efficacy of 712 high school students and reported their findings on a number of variables: males reported higher levels of self-efficacy than females, student self-efficacy levels decreased as they progressed from ninth grade to 12th grade, students whose parents had higher levels of education and higher socioeconomic status reported higher levels of math self-efficacy, and students who believed that math class important had higher levels of math self-efficacy.

In the social cognitive theory, self-efficacy plays the central role in how well an individual can learn; researchers have focused on the role that self-efficacy plays in the learning of mathematics (Bates, Latham, & Kim, 2011; Kitsantas, Cheema, & Ware, 2011; Ozge, & Bindak, 2011; Parker, March, Ciarrochi, Marshall, & Abduljabbar, 2014; Shank & Cotton, 2014; Zientek et al., 2013; Zientek & Thompson, 2010). Researchers have supported Bandura's contention that self-efficacy and performance modify each other to help individuals build an appraisal of their competence toward a mathematical task (Williams & Williams, 2010). Likewise, students with higher levels of self-efficacy are more likely to enter and eventually graduate from college (Larson et al., 2014; Parker et al., 2014). Compared to their peers, students with higher levels of self-efficacy also have higher levels of general achievement in mathematics, more easily overcome negative outcomes, display more positive attitudes towards mathematics, and possess a more comprehensive understanding of mathematics (Phan, 2012; Tariq & Durrani, 2012). As self-efficacy increases or decreases, it has a corresponding effect on learning and academic achievement (Phan, 2012). The educator has the capacity to increase students'

self-efficacy through different teaching strategies, such as using problem posing (Akay & Boz, 2010). Students with higher math self-efficacy are more likely to attend class, do homework assignments, read the textbook, and ask for help in math courses than students with lower levels of math self-efficacy (Hendy, Schorschinsky, & Wade, 2014).

Mathematics anxiety also plays a role in students' academic success, and the effect is not limited to a single age group. The higher a student's level of mathematics anxiety, the less likely he or she is to be successful in mathematics, regardless of whether he or she is an elementary student, high school student, or college student (Nunez-Pena et al., 2013; Wu, Barth, Amin, Malcarne, & Menon, 2012; Zakaria et al., 2012). Anxiety similarly affected characteristics of how college students performed in a mathematics course, with higher levels of anxiety leading to lower class attendance and lower final course grades (Hendy et al., 2014).

Both mathematics self-efficacy and anxiety have an affect on math achievement (Ahmed et al., 2012; Akin & Kurbanoglu, 2011; McMullan et al. 2012). Ahmed et al. (2012) found that among 522 seventh grade students in the Netherlands, there was a reciprocal relationship between math self-concept and anxiety, but the magnitude of the relationship was almost double from self-concept to anxiety than it was from anxiety to self-concept. Although self-concept and anxiety are linked, students who have low self-concept are likely to be anxious; but, students who have higher anxiety levels do not necessarily have a low self-concept of their math ability. Akin and Kurbanoglu (2011) examined the math self-efficacy, math anxiety, and math attitudes of 372 university students in Turkey. Akin and Kurbanoglu found that math anxiety was negatively related

to positive attitudes and self-efficacy and that math self-efficacy was positively associated with positive attitudes. McMullan et al. (2012) studied 229 undergraduate British nursing students and found a statistically significant relationship between anxiety, self-efficacy, and ability. Anxiety was associated with self-efficacy and ability in a negative direction, whereas self-efficacy and ability had a positive association. Math self-efficacy and anxiety correlate to student success and that math self-efficacy and anxiety correlate to each other.

Implications

The process for data collection and the analysis of the data that were collected are discussed in the coming pages. Prior to the completion of the data analysis, a number of possible directions for the project were considered. If the evidence supported the hypotheses that developmental math students have different levels of math self-efficacy and anxiety than college-level math students, then math self-efficacy and anxiety are connected to lower student success rates in developmental math courses compared to college-level math courses. Educators could use these results to implement curriculum in developmental math courses that have increased math self-efficacy and decreased anxiety in other environments. Additionally, educators could add supports for developmental math students or math students in general to increase math self-efficacy and decrease math anxiety. Such data could lead to the creation of a bridge program for students who test into developmental mathematics. On the contrary, if there was no significant evidence to support these hypotheses, it would suggest that more analysis is required or that self-efficacy and anxiety are not different between developmental and college-level

math students. If this were to occur, researchers would need to take a more detailed look at math self-efficacy and anxiety or examine other possible differences between these groups of students.

If the evidence supported the hypotheses that a significant correlation exists between course level and math self-efficacy or course level and math anxiety, the direction of the correlation, either positive or negative, would give educators a better understanding of any possible relationships between math self-efficacy, math anxiety, and community college course level. For example, if the correlation between course level and math self-efficacy is positive, but the correlation between course level and math anxiety is negative, the students at higher levels of community college math have higher levels of math self-efficacy and lower levels of math anxiety than students at lower levels of community college math. Students who have progressed through more levels of math would have higher levels of math self-efficacy and lower levels of math anxiety than students who have not progressed as far. Correlations of this type could suggest that more supports be included for lower level math students to increase their math self-efficacy and decrease their math anxiety. If there is no evidence to support these hypotheses, then students at any level of community college mathematics can have any level of math self-efficacy or anxiety, meaning that more math classes do not necessarily correlate with higher math self-efficacy or lower math anxiety.

Summary

The number of students who fail to succeed in developmental math courses, especially when compared to the success rates of college-level math students, is a

problem in community college education, and little to no data were available to suggest why this is occurring in the local setting. Students with lower success rates in math also tend to have lower levels of math self-efficacy and higher levels of math anxiety. Developmental math students in the local setting have pass rates that are 10% lower than their peers in college-level math, which suggests some difference between the developmental and college-level math students at the local setting. In this study, I examined this difference and its relation to math self-efficacy and anxiety. In the next section, I outline the design, setting, instrumentation, and data analysis for the study.

Section 2: The Methodology

Introduction

At community colleges, developmental math students are succeeding at lower rates than their peers in college-level math courses, and there is a lack of understanding as to why these rates are different. This may be due to lower levels of self-efficacy and higher levels of anxiety among students in developmental math courses compared to college-level math students. This study was quasi-experimental and used a causal-comparative and correlational design. A sample of students in all levels of math courses at the local setting completed a math self-efficacy and anxiety questionnaire. Statistical analyses were then used to compare the results for students in developmental and college-level math courses and to each level of developmental and college-level math course.

Research Design and Approach

In this quasi-experimental study, I used a causal-comparative and correlational design. The causal-comparative design was selected because students were taking math courses that cannot be randomized, and the first and second research questions led to a comparison of levels of math self-efficacy and anxiety. The correlational design was selected because, in the third and fourth research questions, I asked about the relationship between the variables, and correlation is a statistical tool for stating the relationship between two variables. An experimental design was considered because it could allow for causal conclusions based on possible data; however, it was rejected because in the local setting, it was impossible to completely randomize the experimental and control groups. All math students at the local setting were given the opportunity to complete the

MSEAQ (See Appendix B; May, 2009). Comparing the results of the MSEAQ for students in different math courses gives insight into the differences in math self-efficacy and anxiety levels between students in developmental math courses with lower success rates than students in college level math courses.

Setting and Sample

The setting for this study was a Hispanic serving community college located in the suburbs of a major Midwestern city. This setting was selected because it was my place of employment. Therefore, it was a setting where I had the most interest in the results of this data collection and where I had an opportunity to use the results of this study to implement changes. As of 2012, 74% of the students at this community college were Hispanic, 12% were White, 5% were African American, and 2% were Asian. The average age of the students was 27-years-old, and 60% of the students were females and 40% were male (The Center for Governmental Studies, 2014). The sample of the study had similar demographic and gender breakdowns to the college as a whole: 78% of the students were Hispanic, 13% were White, 2% were African American, and 1% were Asian, 67% were female, and 30% were male.

The population consisted of all students at this community college who were enrolled in a math course during the Spring 2016 semester, 22 developmental math sections and 24 college-level math sections. Developmental courses included basic math (MAT 090), elementary algebra (MAT 083/084 and 093), and intermediate algebra (MAT 085/086 and 095). The college-level courses included general education math (MAT 102), college algebra (MAT 105), college trigonometry (MAT 110), finite math

(MAT 124), statistics (MAT 141), discrete mathematics (MAT181), Calculus I (MAT 201), Calculus II (MAT 202), Calculus III (MAT 203), differential equations (MAT 215), and business calculus (MAT 224). A detailed number of sections and number of students enrolled in each course for the Spring 2016 semester can be found in Table 1 below.

Table 1

Math Course Enrollment Spring 2016

	Sections	Students
Developmental		
MAT 090 Basic Math	6	123
MAT 083/084 or MAT 093 Elementary Algebra	7	173
MAT 085/086 or MAT 095 Intermediate Algebra	8	147
Developmental Total	21	443
College-Level		
MAT 102 General Education Mathematics	6	164
MAT 105 College Algebra	6	157
MAT 110 College Trigonometry	2	45
MAT 124 Finite Math	1	7
MAT 141 Statistics	2	52
MAT 181 Discrete Mathematics	1	12
MAT 201 Calculus 1	2	50
MAT 202 Calculus 2	1	34
MAT 203 Calculus 3	1	24
MAT 215 Differential Equations	1	26
MAT 224 Calculus for Business and Social Sciences	1	5
College-Level Total	24	576
Total	45	1019

In order to receive the maximum number of responses, all students enrolled in a math class at the community college during the Spring 2016 semester received an e-mail link to the MSEAQ (see Appendix C). The survey was open to participants for 2 weeks. At the end of those 2 weeks, a total of 135 students completed the survey: 32 developmental and 103 college-level math students; this was a 13% overall response rate. This rate was similar to other surveys of this type at the local setting. The response rates of 26% to 34% had been achieved by following up by phone or e-mail over several months but with a one-time e-mail request similar to what was used in this study, the response rates are much lower (M. Banda, personal communication, December 14th, 2016). The developmental student response rate was 7%, and the college-level response rate was 18%. The detailed breakdown of courses can be seen in Table 2. In order to have a similar number of students in the developmental group and college-level group, a simple random sample of 32 responses were selected from the 103 college-level math students, and these 32 students where used for all analyses. The detailed breakdown of the courses for the final sample can be found in Table 3. The developmental students were 72% female and 28% male, and 72%were Hispanic, 9% were African American, and 16% were White. The final 32 college-level math students used for data analysis were 72% female, 27% male, and 2% of students did not respond; they were also 78% Hispanic, 16% White, and 3% Asian. Based on these results, the two groups had similar demographic characteristics.

Power analysis performed for samples of the same size suggest that with a medium effect size of 0.5, alpha of 0.05, and power of 0.8 each sample should include 64

students twice as large as the samples used for this analysis. According to post hoc power analysis, the power for the samples used was 0.50. Based on these power analyses, any conclusions based on the data analysis using these samples should be tempered, and as part of any project, this data collection and analysis should be repeated using larger sample sizes to return more useful data.

Table 2

Students Responses by Math Course

	Frequency	Percent
Developmental		
MAT 083/084 or MAT 093 Elementary Algebra	10	7.4
MAT 085/086 or MAT 095 Intermediate Algebra	19	14.1
MAT 090 Basic Math	3	2.2
Developmental Total	32	23.7
College-Level		
MAT 102 General Education Mathematics	20	14.8
MAT 105 College Algebra	23	17.0
MAT 110 College Trigonometry	12	8.9
MAT 124 Finite Math	1	.7
MAT 141 Statistics	18	13.3
MAT 181 Discrete Mathematics	3	2.2
MAT 201 Calculus 1	11	8.1
MAT 202 Calculus 2	2	1.5
MAT 203 Calculus 3	5	3.7
MAT 215 Differential Equations	5	3.7
MAT 224 Calculus for Business and Social Sciences	3	2.2
College-Level Total	103	76.3
Total	135	100.0

Table 3

Students in Sample by Math Course

	Frequency	Percent
Developmental	10	15.6
MAT 083/084 or MAT 093 Elementary Algebra		
MAT 085/086 or MAT 095 Intermediate Algebra	19	29.7
MAT 090 Basic Math	3	4.7
Developmental Total	**32**	50.0
College-Level		
MAT 102 General Education Mathematics	**7**	10.9
MAT 105 College Algebra	**9**	14.1
MAT 110 College Trigonometry	**3**	4.7
MAT 141 Statistics	6	9.4
MAT 181 Discrete Mathematics	1	1.6
MAT 201 Calculus 1	1	1.6
MAT 203 Calculus 3	2	3.1
MAT 215 Differential Equations	3	4.7
College-Level Total	32	50.0
Total	64	100.0

Instrumentation and Materials

The instrument used for this study was the MSEAQ (May, 2009). Permission to use this instrument can be found in Appendix D. Questions about work hours, family education history, language, and previous math courses were added to the instrument to give a better picture of the math students at the local setting. This instrument was administered to the participants of the study following the Spring 2016 semester. The MSEAQ is a 28-item, 5-option, Likert-type scale survey consisting of 13 items related to self-efficacy and 15 items related to anxiety. During the creation and the examination of the MSEAQ, the self-efficacy and anxiety items of the questionnaire were treated as independent and compared to established math self-efficacy and math anxiety scales, respectively, in order to ensure validity and reliability (May, 2009). The self-efficacy items of the MSEAQ had a statistically significant positive correlation to the established Mathematics Self-Efficacy Scale by Betz and Hackett. Similarly, the anxiety items of the MSEAQ had a statistically significant positive correlation to the established short version of the Mathematics Anxiety Rating Scale by Suinn and Winston (May, 2009). In this case, self-efficacy refers to the individual's belief that the individual can perform mathematical tasks at an appropriate level, while math anxiety refers to the level of tension or anxiety an individual feels when presented with a mathematical task. Participants chose a number between one and five, inclusive for each item. A higher number indicated a higher level of self-efficacy or a higher level of anxiety, depending on the item.

The construct validity of the MSEAQ was established previously using correlations to compare the MSEAQ to the two previously mentioned established questionnaires. There were statistically significant positive correlations at the $p < .05$ level with the Mathematics Self-Efficacy Scale and at the $p < .01$ level with the short version of the Mathematics Anxiety Rating Scale (May, 2009). The MSEAQ had a high internal reliability, established using Cronbach's alpha scores. The self-efficacy items had an alpha score of .93, the anxiety items also had an alpha score of .93, and the full MSEAQ had an alpha score of .96 (May, 2009). May (2009) also found that the MSEAQ was valid and reliable for both paper and pencil and online versions of the MSEAQ. Because validity and reliability were already established for this instrument previously, no further measurements were needed for this study.

Data Collection and Analysis

The local setting provided e-mail addresses for all students enrolled in a Spring 2016 math course. All math students received an e-mail link to the MSEAQ (see Appendix C). The MSEAQ data are at the interval level of measurement. This, along with the independent nature of the developmental and college-level math courses, suggests the use of an independent samples *t*-test. Developmental and college-level math courses are independent of each other at this community college because the prerequisites for all college math courses include a score high enough on the placement test to avoid developmental math courses or the completion of the developmental math courses. This survey was conducted to compare math self-efficacy and math anxiety mean differences

for the developmental and college-level math courses to address the first two research questions.

RQ1: Is there a difference between the math self-efficacy levels of students in developmental math compared to students in college-level math?

$H_0$1: There is no difference between the mean levels of math self-efficacy on the MSEAQ for students in developmental math courses compared to students in college-level math courses.

H_a1: There is a significant difference between the mean levels of math self-efficacy on the MSEAQ for students in developmental math courses compared to students in college-level math courses.

RQ2: Is there a difference between the math anxiety levels of students in developmental math compared to students in college-level math?

$H_0$2: There is no difference between the mean levels of math anxiety on the MSEAQ for students in developmental math courses compared to students in college-level math courses.

H_a2: There is a significant difference between the mean levels of math anxiety on the MSEAQ for students in developmental math courses compared to students in college-level math courses.

The two groups that were compared using independent samples *t*-tests were developmental math students and college-level math students during the Spring 2016 semester. Both of these groups consisted of 32 students, and the developmental group consisted of all developmental respondents to the survey, while the college-level group

consisted of a random sample of the college-level respondents. Developmental students are students who enrolled in a course with a course level less than four, whereas college-level math students are students enrolled in a math course with a course level greater than or equal to four. Course levels are outlined in Table 3. Courses with the same or similar prerequisites are at the same level.

Table 4

Course Level

Course	Level
MAT 090 Basic Math	1
MAT 083/084 or MAT 093 Elementary Algebra	2
MAT 085/086 or MAT 095 Intermediate Algebra	3
MAT 102 General Education Mathematics	4
MAT 105 College Algebra	4
MAT 110 College Trigonometry	5
MAT 124 Finite Math	5
MAT 141 Statistics	5
MAT 181 Discrete Mathematics	5
MAT 201 Calculus 1	6
MAT 202 Calculus 2	7
MAT 203 Calculus 3	8
MAT 215 Differential Equations	8
MAT 224 Calculus for Business and Social Sciences	6

Students who were enrolled in a developmental math course (levels 1-3) from the sample had lower mean levels of math self-efficacy and higher mean levels of math anxiety compared to the college-level math students (levels 4+) from the sample. However, these differences were not statistically significant. Therefore there is not

enough evidence to suggest that these differences exist for all students at the local setting. Detailed results can be found in Tables 5, 6, 7, and 8.

Table 5

Self-Efficacy Means

Course Level	N	Mean	Std. Deviation
>= 4	32	3.611	.844
< 4	32	3.325	.910

Table 6

Self-Efficacy Independent Samples t-test

t-test for Equality of Means				
t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
1.304	62	.197	.2861	.2194

Table 7

Math Anxiety Means

Course Level	N	Mean	Std. Deviation
>= 4	32	2.825	.953
< 4	32	3.160	1.015

Table 8

Math Anxiety Independent Samples t-test

t-test for Equality of Means				
t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
-1.363	62	.178	-.3354	.2461

To address the third and fourth research questions, Pearson product-moment correlations were calculated to look for relationships between the variables of math self-efficacy, anxiety, and course level.

RQ3: Is there a correlation between course level and the level of math self-efficacy?

$H_0$3: There is no correlation between course level and the level of math self-efficacy on the MSEAQ.

H_a3: There is a significant correlation between course level and the level of math self-efficacy on the MSEAQ.

RQ4: Is there a correlation between course level and the level of math anxiety?

$H_0$4: There is no correlation between course level and the level of math anxiety on the MSEAQ.

H_a4: There is a significant correlation between course level and the level of math anxiety on the MSEAQ.

In each calculation, the math self-efficacy or anxiety mean on the MSEAQ for a student was the first variable and the course level of the student was the second variable. This analysis was also conducted using all 32 developmental students who participated in

the study and the same random sample of 32 college-level students. Statistical analysis showed statistically significant correlations between course level and self-efficacy at the $p < 0.05$ level of significance. Statistically significant correlations were also found between course level and anxiety at the $p < 0.01$ level of significance. Both of these results are summarized in Table 9. The correlation coefficient for self-efficacy and course level is positive, suggesting that students enrolled in higher level math courses have higher levels of math self-efficacy. Alternatively, the correlation coefficient for math anxiety and course level is negative, suggesting that students in higher level math courses have lower levels of math anxiety. It should also be noted that this data analysis found a significant negative correlation between math self-efficacy and math anxiety, which supports the findings of previous research (Ahmed et al., 2012; Akin & Kurbanoglu, 2011; McMullan et al. 2012).

Table 9

Pearson Moment Correlation Coefficients

		Course Level	Self-Efficacy Mean	Anxiety Mean
Course Level	Pearson Correlation	1	.287*	-.354**
	Sig. (2-tailed)		.021	.004
	N	64	64	64
Self-Efficacy Mean	Pearson Correlation	.287*	1	-.737**
	Sig. (2-tailed)	.021		.000
	N	64	64	64
Anxiety Mean	Pearson Correlation	-.354**	-.737**	1
	Sig. (2-tailed)	.004	.000	
	N	64	64	64

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Assumptions, Limitations, Scope and Delimitations

For the purpose of this study, I assumed that participants answered the MSEAQ items truthfully and to the best of their ability. To attempt to ensure truthful answers, I assured participants that their individual responses would not be shared with anyone, and no identifying characteristics were collected. A limitation of this study is that by sampling the entire population, the data for the students who chose to respond could be significantly different than it would be for those students who chose not to participate. Another limitation of this study is the difference in response rates for the two groups of students, the response rate of developmental math students, seven percent, was much

smaller than the response rate of college-level math students, 18%. To address this limitation the number of college-level students was reduced by using a simple random sample of college-level math students equal to the number of developmental students. Power analyses also suggest that the samples used in this study are smaller than would be needed to establish strong claims about differences between these groups. Therefore, it is suggested that as part of the project evaluation this data collection and analysis be repeated with a larger sample of students. This difference in response rates is in itself a result which suggests another difference between developmental and college-level math students. For some reason developmental math students were less likely to participate in the study, this is an area of inquiry that could be examined in future research. Therefore, part of any future project at the local setting should continue to look at the variables math self-efficacy, math anxiety, and math course level to add to the work of this study. A delimitation of this study is that it took place at a suburban Hispanic serving community college in the Midwest and because of this specific sample the results of the study may not be applicable to all community college students.

Protection of Participants' Rights

The proposal for this study was submitted to the Walden University Institutional Review Board (IRB) for approval, using the Walden University IRB form. Following approval from the IRB at Walden University, this proposal was submitted to the local setting's IRB for approval, using the setting's IRB form. Data collected for this study included no identifying information, therefore reducing the risk to the participants of this study. Also, even though it is possible that I might have recognized a student's email that

was included in the list of students asked to participate in the study, I was not able to tell which students chose to participate in the study. Students received an informed consent form prior to beginning the MSEAQ online. All data were collected and will be kept on a USB drive that will be kept in my office in a locked cabinet for 5 years, at which time the data on the USB drive will be deleted.

Conclusion

This study has examined the problem of disparities between student success in developmental mathematics at community colleges when compared to student success in college-level mathematics at community colleges, as well as a lack of understanding of the differences between the students in these courses. Prior research suggests a relationships between math self-efficacy, anxiety, and student success. While the data collected and analyzed in this study does not suggest that there is significant difference between developmental and college-level math students in terms of math self-efficacy and math anxiety, the data does show that course level has a positive correlation with math self-efficacy and a negative correlation with math anxiety. As noted previously these results together suggest that students in lower level math courses have on average lower self-efficacy and higher anxiety than students in higher level math course but this difference is not apparent when the students are grouped by developmental students and college-level students. Based on these results, I will outline a plan for a professional development event that will focus on educating math faculty on math self-efficacy; math anxiety; how self-efficacy and anxiety affect their students; and ways to increase math self-efficacy and decrease math anxiety. As a part of this project data will continue to be

collected to examine the research questions outlined previously using a larger sample size. Ultimately, the overall goal of implementing this professional development training is to increase pass rates in developmental math courses at the local setting.

Section 3: The Project

Introduction

Based on the data collected in Section 2 of this study, students in lower level math courses at the local setting had lower math self-efficacy and higher math anxiety than students taking higher level math courses irrespective of whether those courses were developmental math or college-level math. Students with higher math self-efficacy and lower math anxiety have higher math achievement (Phan, 2012; Tariq & Durrani, 2012; Wu et al., 2012; Zakaria et al., 2012). Therefore, to increase math self-efficacy and decrease math anxiety, I propose the following professional development. This professional development will focus on educating faculty about math self-efficacy; math anxiety; the relationships between math self-efficacy, math anxiety, and student success; and ways to increase math self-efficacy and decrease math anxiety. In this section of the paper, I will describe the event, discuss current literature that is pertinent to the creation of the professional development, discuss how the professional development will be evaluated, and examine the implications of this event.

Description and Goals

There was a lack of student success, measured by pass rates, among developmental math students compared to college-level math students at the local setting, as well as a lack of understanding of the differences between these two groups of students. Therefore, this study was undertaken to examine two variables that could differ among math students: self-efficacy and anxiety. Although, I did not find a difference between developmental and college-level math students, I did find that lower course level

math students did have lower self-efficacy and higher anxiety than higher course level math students. Therefore, in this project, I focused on addressing math self-efficacy and math anxiety among the students at the local setting. This will be accomplished by creating a professional development focused on educating community college math faculty about the topics of math self-efficacy and math anxiety and how math self-efficacy and math anxiety can impact the success of community college students. In this professional development, I will also focus on the creation, implementation, and assessment of a plan to address math student self-efficacy and anxiety, along with further collection of the data from this study.

All math faculty, including both full-time and adjunct faculty, will be encouraged to take part in a three-part professional development event (see Appendix A). Part 1 can take place either at the faculty members' pace over the summer semester or during a face-to-face seminar day. This first part consists of disseminating information from the relevant literature to the math faculty on the topics of math self-efficacy and math anxiety. In Option 1, the faculty would read relevant articles during the summer semester. In Option 2, math faculty would attend a seminar day where I would present the information from the various articles during several sessions. Parts 2 and 3 of this professional development will take place during regularly scheduled faculty professional development days at the local setting. The second part will include sessions to discuss the information from Part 1, create a plan to increase math self-efficacy and decrease math anxiety, and create an evaluation plan. The final part will focus on assessing the success or failure of the plan from Part 2 and making appropriate changes.

The first goal of this project is to increase math faculty's awareness of math self-efficacy; math anxiety; and the possible relationship between math anxiety, math self-efficacy, and student success. This will be accomplished by focusing on the current research on math self-efficacy and math anxiety, including the results of this study, and their relationship to student success. The second goal of this project is to introduce the math faculty to research-based strategies to increase math self-efficacy and to decrease math anxiety. Both of these goals will be addressed through the presentation of resources in Part 1 of the professional development event. The third goal is to create an implementation plan for the local setting to increase math self-efficacy and to decrease math anxiety. This will be accomplished during Part 2 of the professional development event and is more likely to be successful because the math faculty will be included in the creation of the plan. The final goal is to assess and make changes to the plan. This will occur during Part 3 of the professional development event.

Rationale

Based on the data analysis, at the local setting, students in lower level math courses have lower math self-efficacy and higher math anxiety than students in higher level math courses. By choosing to create a professional development event with all of the math faculty, this project has the potential to impact all math students at the local setting, as well as any future students whom the full-time and adjunct faculty might teach. Increasing student math self-efficacy and decreasing student math anxiety may help address student success over time. This project will have the opportunity to affect this change by first educating the math faculty on the issues of math self-efficacy and math

anxiety both in the literature and through the results of this study at the local setting. Secondly, the faculty will be introduced to research on methods for increasing math self-efficacy and decreasing math anxiety. Finally, the math faculty will create and implement a plan to increase math self-efficacy and to decrease math anxiety. Based on the relationship found in prior research between math self-efficacy, anxiety, and student success by increasing math self-efficacy and decreasing anxiety, the local setting could see an associated increase in student success over time.

The format for this professional development was chosen in order to increase faculty participation in the event. Full-time faculty are required to attend the two regularly scheduled faculty professional development days. This is why the suggested format of this professional development event would have Part 1 of the event completed by the faculty over the summer semester on their own time and Parts 2 and 3 completed during the regularly scheduled faculty professional development days. It is also easier to increase adjunct faculty participation in the event if the event requires fewer in-person days. Adjunct faculty at the local setting can be required to attend professional development events, but the college must pay them for their time. So to decrease the financial burden of this event, I suggest fewer days of professional development. For these reasons, the informational portion of the professional development event should take place asynchronously. This is outlined in Day 1 (Option 1) of the project (see Appendix A). However, as outlined in Day 1 (Option 2) of the project, it is possible to present this information in an in-person setting (see Appendix A). Offering professional development asynchronously can be as effective as offering it in-person. Fishman et al.

(2013) randomly assigned 49 environmental science teachers from schools that were implementing a new curriculum to either face-to-face or online professional development (24 face-to-face, 25 online). A facilitator led the face-to-face professional development, and the online professional development was asynchronous. Fishman et al. found no significant differences in teacher learning in terms of changes in beliefs and knowledge, classroom practice, or student learning outcomes between the face-to-face and online professional development. Dash, de Kramer, O'Dwyer, Masters, and Russell (2012) found that elementary school math faculty who participated in an online asynchronous professional development had significant gains in pedagogical knowledge compared with math faculty who did not participate in the professional development. An asynchronous professional development can have similar results as presenting the information face-to-face. Lastly, the in-person discussions of implementation and assessment are important because of the small size of the math faculty. At the local setting, the math faculty are more likely to implement a plan if they take part in the creation of the plan.

Review of the Literature

In this project study, I used a variety of journals and articles, including but not limited to, *International Journal of Innovation in Science and Mathematics Education, School Psychology Quarterly, Australian Journal of Teacher Education, Educational Research International,* and *Educational Psychology.* Articles were collected from several databases, including Education Resources Information Center, Education Research Complete, Science Direct, and Sage Premier. Keywords used for this study included *increasing math self-efficacy*, *decreasing math anxiety*, *college math*,

professional development, *math self-efficacy*, and *math anxiety*. I noticed that there is a large amount of new research (1-or 2-years-old) on the topics of increasing math self-efficacy and decreasing math anxiety. Some of these articles have been included in this literature review to help illustrate the current trends in this area.

Professional Development

When attempting to incorporate new curriculum in any program in education, it is important that faculty be well educated in the changes and invested in the new curriculum. Professional development is a vehicle for educating faculty on the topic, in this case math self-efficacy and math anxiety, and for including them in the creation of a plan for implementation. The adoption and implementation of the Common Core State Standards in English/language arts and mathematics are a good example of this. Over the past few years, as the standards have been adopted and implemented, high quality professional development has been an integral part of the plans to make these new standards have a real and positive impact on student success (Marrongelle, Sztajn, & Smith, 2013). Professional development is also a key part of the dissemination of instructional expertise, which is imperative for the creation of new curriculum. Furthermore, professional development can give faculty the chance to work together and use their combined expertise to solve problems and create initiatives that have the opportunity to impact students' academic success (Sun, Penuel, Frank, Gallagher, & Youngs, 2013).

Even though professional development is traditionally offered face-to-face, online professional development can be just as successful (Dash et al., 2012; Fishman et al.,

2013). There is also precedence for online professional development related to math self-efficacy and math anxiety (Prusaczyk & Baker, 2011; Stevens, Harris, Aguirre-Munoz, & Cobbs, 2009). Although Fishman et al. (2013) found no significant difference in outcomes between professional development offered face-to-face versus online, Dash et al. (2012) found that fifth grade math teachers who participated in online professional development had significant gains in pedagogical content knowledge and pedagogical practices compared to a control group of teachers who did not participate in the online professional development. Prusaczyk and Baker (2011) examined the success and sustainability of a partnership between Southern Illinois University– Carbondale and 12 rural school districts. This partnership was successful in increasing math content knowledge and reducing math anxiety among instructors who were not trained in mathematics. Stevens et al. (2009) used a case study approach to work with middle school teachers to design effective professional development that would increase the teachers' knowledge of math self-efficacy and thereby understand how to increase their students' math self-efficacy. These studies taken together offer support for the basic structure of this project.

Increasing Math Self-Efficacy and Decreasing Math Anxiety

Math self-efficacy and math anxiety correlate to student success in math. Therefore, many researchers and educators have examined the environments in which educators teach math, the methods educators use to teach math, the ways educators assess students, psychological methods, and other strategies that have the possibility of impacting student math self-efficacy and math anxiety. The environment in which

educators teach math can have a significant impact on student math self-efficacy and anxiety. For example, Taylor and Fraser (2013) found a negative correlation between classroom environment and mathematics anxiety associated with the learning of mathematics. An environment conducive to learning mathematics can reduce math anxiety. A part of a conducive learning environment could be the use of sedative music, which has found mixed results (Feng, Suri, & Bell, 2014; Gan, Lim, & Haw, 2016). At the elementary level, whole classroom and curriculum structures have been outlined to create such environments. The responsive classroom is one example of social and emotional learning that some elementary schools are implementing. Responsive classroom techniques include guided discovery, modeling, academic choice, and collaborative problem-solving. Griggs, Rimm-Kaufman, Merrit, and Patton (2013) examined the effect that the responsive classroom had on math and science self-efficacy and anxiety and found that students at schools who used more responsive classroom techniques saw a reduction in the negative correlation between anxiety and self-efficacy. Students with high levels of math anxiety are also likely to have low levels of math self-efficacy. This relationship is not as evident when using the responsive classroom as it is in a standard classroom. The techniques of the responsive classroom could reduce the negative correlation between math self-efficacy and anxiety. As seen in Section 2 of this study, there was a strong negative correlation between math self-efficacy and math anxiety at the local setting. The use of instructional immediacy techniques, such as smiling, eye contact, and open body posture, among others, can also create a positive

environment. Kelly et al. (2015) found that students who had instructors who exhibited immediacy had reduced math anxiety.

Other techniques also impact math self-efficacy and anxiety. Tok, Bahtiyar, and Karalok (2015) examined the effect of teaching math creatively and found that sixth grade students who were taught math creatively had increased math achievement and decreased math anxiety. Teaching math creatively included teaching math through stories and interactive activities, such as origami. Modelling also increased the math self-efficacy of ninth grade students in Germany, especially when the modeling techniques also involved student-centered learning techniques (Schukajlow et al., 2012). Another similar technique to those used in the previous studies that has been shown to be effective in increasing math self-efficacy among college students is problem posing, which is the process of having students restate problems they encounter in class and create new problems on the topic they are studying (Akay & Boz, 2010). Math self-efficacy can be increased for both elementary and college math students by incorporating game-based learning into math courses (Afari, Aldridge, Fraser, & Khine, 2013; Meluso, Zheng, Spires, & Lester, 2012).

Teaching math, especially statistics, using language that is more familiar to the students is one simpler technique that can also decrease math anxiety (Lalayants, 2012; Silk & Parrott, 2014). Researchers have also noted relationships between math achievement, math anxiety, time spent on homework, and socioeconomic status (Cheema & Sheridan, 2015). Higher math achievement is linked to more time spent on homework, lower math anxiety, and higher socioeconomic status. Thus, a concerted effort should be

placed on decreasing math anxiety, which could result in students doing more homework and increased math achievement. The techniques educators use to teach mathematics can impact the students' math self-efficacy and math anxiety.

The educational tools an educator chooses for his or her classroom impact on students' math self-efficacy and anxiety. The use of technology seems to have a positive impact on math self-efficacy and math anxiety. Alday and Panaligan (2013) found that among Filipino college students, the use of e-learning when teaching analytic geometry reduced math anxiety and improved student performance. The use of laptops by lower socioeconomic urban youth for e-mail and playing games is related to higher math self-efficacy (Shank & Cotton, 2014).

Educators can also affect math student self-efficacy through the use of different types of assessment. In one case, ninth grade students were broken into two groups: one group of students received process-oriented feedback on a math test and the other received grade-oriented feedback (Harks et al., 2014). The group with the process-oriented feedback found their feedback to be more useful and exhibited higher math achievement than the grade-oriented feedback group; however, it had no effect on the students' self-evaluation of their math abilities. In a similar study on the effect of formative assessment on student success and math anxiety in higher education, Nunez-Pena, Bono, and Suarez-Pellicioni (2015) found that students who felt the feedback from the formative assessments was useful performed better on the final exam than students who did not find the feedback useful, but no relationship existed between math anxiety and final exam scores. The feedback reduced the negative impact of math anxiety on

final exam scores. Peer and self-assessment can increase student math self-efficacy. Adediwura (2012) found that among 60 senior secondary math students, the use of peer and self-assessment during math lessons increased the students' math self-efficacy. Furthermore, students who experience success in math can also experience reduced anxiety. Jansen et al. (2013) placed 207 elementary students into four groups where they completed math practice problems. The four groups included a control group of students working math problems with paper and pencil and three experimental groups who used the computer (Jansen et al., 2013). The three experimental groups were separated by the adaptive difficulty of the problems they were asked to do (Jansen et al., 2013). The group with the largest decrease in math anxiety was the medium difficulty experimental group (Jansen et al., 2013). One way to decrease math anxiety is to help students find success on problems they find somewhat difficult.

The literature also suggests techniques that are not normally included in a math course that could impact math self-efficacy and anxiety. This includes: interventions outside of a normal math course, in-class presentations, psychological techniques, and more. One important aspect from outside the classroom is social support. Vokovic, Robers, and Wright (2013) noted the importance of parental involvement outside the classroom in decreasing math anxiety and Rice et al. (2012) add teachers and friends to parents in the list of people outside of the school that can increase students self-efficacy. Many papers suggest that techniques that force students to examine their math anxiety further can help to mitigate the effects of this anxiety (Bartsche, Case, & Meerman, 2012; Kim & Hodges, 2011; Whyte & Anthony, 2012). Bartsch, Case, and Meerman (2012)

compared two in-class interventions which attempted to affect student math self-efficacy in statistics. The first was to have a former student come to class and outline his or her math anxieties and the strategies they used to succeed in the course. The second was to have the students write about the characteristics they felt made for a successful student. Their results show that the students that heard from the former student showed a significant increase in their self-efficacy compared to the writing group. A similar study examined the effects of an emotional control treatment for students in an online math course (Kim & Hodges, 2011). The emotional control treatment was a web-based video and the researchers found that students that watched the video had more positive academic emotions and higher motivation than those students who did not.

There have also been several studies that suggest that math anxiety can be reduced and math performance increased through the use of behavioral and emotional techniques (Brunye et al., 2013; Jamieson, Peters, Greenwood & Altose, 2016; Lyons & Beilock, 2012; Singh, 2016). These techniques include breathing exercises, educating students on the benefits of stress arousal, development of alternative emotional responses to threatening stimulus, and brain yoga. All of the research in this section suggests that there are many promising options for addressing math student self-efficacy and anxiety, and that a professional development training that educates faculty on these topics and allows them the opportunity to create interventions that would work well in the local setting is a valuable use of professional development time.

Project Description

The results of the research presented in sections one and two, the prior research cited in Section 3, and my own experience with the local setting provided the basis for the project plan and implementation, which is centered on creating a project that can be effective in having an impact on the problem stated in section one and can be implemented at the local setting (see Appendix A). The proposed professional development is broken into three parts. Part 1 will give faculty the information they need to participate in Parts 2 and 3. Part 1 will include information on math self-efficacy; math anxiety; their impact on student success; and ways to increase math self-efficacy and decrease math anxiety. Part 2 will focus on the creation of a plan to increase math self-efficacy and decrease math anxiety and how to evaluate the success of the plan. Finally, Part 3 will be an opportunity to evaluate the success of the plan and make changes for the future

Potential Resources and Existing Supports

One of the advantages of the proposed professional development is that it will not require a large amount of resources or support on the part of the local setting. By including all face-to-face pieces of the professional development in regularly scheduled professional development days, the local setting can use the school resources allocated for these events to support this professional development. These resources include meeting space and time, food for breakfast and lunch, and the attendance of the full-time math faculty. The most important resources the local setting will need to provide is the use of these days for the proposed professional development, funding to pay the adjunct

faculty to participate in the event, and any resources needed for implementation of the plan that will be created in part two of the professional development. Resources needed in the implementation of a plan could include release time for full-time faculty to create and evaluate the plan and possible purchase of new technology or other classroom resources.

Potential Barriers

Barriers to this project will come in the form of lack of support or participation from key groups. Lack of backing from the administration or faculty development committee at the local setting would be a barrier to the successful implementation of this professional development. Lack of support from these two groups would make it unlikely that the event could be scheduled as part of the regularly scheduled professional development days. If this occurred than it would reduce the resources available for this event and make it unlikely that the faculty would participate in the event. If this event needed to be held on a day when full time faculty are not required to attend it is unlikely that they would attend. The faculty participation is also a potential barrier even if they are all in attendance at the professional development. For this event to have an impact on the pass rates at the local setting it is important that the faculty participate in all of aspects of this professional development. This includes creating the plan, implementing the plan, and evaluating the plan. If the faculty do not participate in these parts of the professional development it is unlikely that this event will have any impact on math student success. The final possible barrier is funding. For this professional development to have a meaningful impact, the school must provide funding to pay adjunct faculty to attend the

event and provide for any resources needed to implement the plan created during part two of the professional development.

Proposal for Implementation and Timetable

The preferred option for implementation is that at the end of the spring semester, all full-time and adjunct math faculty will receive a series of articles focused on math self-efficacy, math anxiety, their impact on student success, and ways to increase math self-efficacy and decrease math anxiety. The faculty will be asked to read and consider these articles during the summer semester: Adediwura, 2012; Ahmed, Minnaert, Kuyper, and van der Werf, 2012; Akay and Boz, 2010; Akin and Kurbanoglu, 2011; Barrows, Dunn, and Lloyd, 2013; Bartsch, Case, and Meerman, 2012; Betz and Schifano, 2000; Finlayson, 2014; Iossi, 2013; Maloney and Beilock, 2012; Núñez-Peña, Bono, and Suárez-Pellicioni, 2015; Núñez-Peña, Suárez-Pellicioni, and Bono, 2013; Perry, 2004; van Dinther, Dochy, and Segers, 2011 . A second proposed option for this portion of the professional development seminar is to have an in-person seminar on the Wednesday prior to the regularly scheduled faculty in-service day, at the end of the summer semester just prior to the beginning of the fall semester. This seminar day would focus on presenting the information contained in the resources from the first option to the faculty. Following completion of one of the two options for Day 1, Day 2 of the professional development will occur during several of the regularly scheduled faculty in-service day sessions to discuss the information present through either of the two proposed options stated above. The day will begin with a discussion of what math self-efficacy and math anxiety are and how the faculty see these traits in their students. Next, the group will

discuss ways to increase math self-efficacy and decrease math anxiety. Finally, the day will conclude with two discussions: (1) how to impact the math self-efficacy and math anxiety of students at the local setting, and (2) how to assess the effectiveness of the impact on the students' math self-efficacy and anxiety. The plans created on this in-service day will be implemented during the fall semester. The final portion of the professional development will take place during the regularly scheduled staff in-service day during the spring semester. During this event the math faculty will spend time discussing the assessment and impact of the implemented plan, and make changes to the current plan to be implemented during the spring semester.

Roles and Responsibilities of Student and Others

Beyond the creation of the professional development training I will be responsible for running the event and leading the sessions. Depending on the results of the training other math faculty may take responsibility for the implementation of any plans to impact student self-efficacy and anxiety as well as the assessment of that implementation. For example all math faculty will be expected to implement the agreed upon plans. The math faculty will also be expected to complete the survey discussed in the following section and encourage their students to complete the online MSEAQ. The local setting administration will be responsible for approval of this professional development project and for providing the finances necessary for its success. Prior to Day 3 of the professional development seminar and at the end of the spring semester it will be my responsibility to organize all of the assessment findings of the project and distribute those findings to the

math faculty and administration at the local setting so that it can be used for future planning.

Project Evaluation

The goals of this project are to educate math faculty on the issues of math self-efficacy and math anxiety, and to then use the combined knowledge of the math faculty to create a plan that can be implemented at the local institution to attempt to increase student math self-efficacy and decrease math anxiety. Therefore, there are two parts to the project the professional development and the plan that is created as part of the professional development. The evaluation of the professional development will be goal based. The goal this evaluation will measure is to have math faculty create and implement interventions that could help increase their students' math self-efficacy and decrease their students' math anxiety. Evaluation will occur at the end of the fall semester prior to Day 3 of the professional development seminar and again at the end of the spring semester. At both of these times the math faculty will complete an online survey that will ask them to describe how they implemented the strategies discussed on Day 2 of the professional development and what they thought worked and what did not work. The results from the survey at the end of the fall semester will be discussed during Day 3 of the professional development.

The evaluation of the plan created as part of the professional development will be outcome-based. Assessment of this outcome-based evaluation will occur in the following way. Math self-efficacy and math anxiety will be assessed in the same manner to how they were assessed in this study. Math faculty will encourage their students to complete

the MSEAQ at the end of each semester anonymously online. The mean scores for math self-efficacy and math anxiety for each student will be compared semester to semester to look for increases in math self-efficacy and decreases in math anxiety. This will also serve to gain more data to further evaluate the results found in this doctoral study.

As discussed earlier, prior research has found a positive correlation between math self-efficacy and math achievement and a negative correlation between math anxiety and math achievement (Phan, 2012; Tariq & Durrani, 2012; Wu et al., 2012; Zakaria et al., 2012). Therefore, it is expected that increasing math self-efficacy and decreasing math anxiety could increase pass rates. This is also a limitation of this doctoral study that could be addressed moving forward. Therefore, pass rates will be assessed with the help of the local setting's office of institutional research, to see if a similar correlation can be found at the local setting. The office of institutional research will supply the pass rates for developmental math classes each semester so that pass rates can be compared semester to semester. Initially, I will complete these analyses, but the future process for these evaluations will be discussed on both Day 2 and Day 3 of the professional development. Therefore, it is possible that more members of the math faculty will assist with these evaluations. Following the completion of the spring semester, the results of these evaluations will be discussed at a math department meeting to determine future steps.

Implications Including Social Change

Local Community

The initial implications for this project will occur in the local community. As discussed in Section 1 of this paper, the pass rates for developmental math students at the local setting are 10% lower than for college-level math students. Also, developmental math is a major barrier for many students to complete a degree or certificate. At the local setting, all associate's degrees require the student to at least successfully progress out of the developmental math sequence, and many of the certificates also require the completion of a college level math course. This project should give math faculty a better understanding of math self-efficacy and math anxiety, two variables that may impact math student success over time. Further as part of this project math faculty will create a plan that should have the potential to increase math self-efficacy and decrease math anxiety. The evaluation plan also calls for continued collection of data on the variables of math self-efficacy, math anxiety, and student success. These data should continue to add to the understanding of the relationship between math self-efficacy, math anxiety, and student success at the local setting. As described in social cognitive theory and by math self-efficacy and math anxiety research higher levels of self-efficacy and lower levels of anxiety should impact students in all areas of their lives that involve math, making those individuals more likely to succeed at any task that involves math.

Far-Reaching

The problem stated in Section 1, lack of student success in developmental math, is a problem that is not unique to the local setting. If we are successful at the local setting

in increasing math self-efficacy, decreasing math anxiety, and increasing student success the professional development created at the local setting could serve as a framework for other community colleges to create their own professional development. Also the continued data collection can be used to further the scholarly discussion on the relationships between math self-efficacy, math anxiety, and student success. To increase the impact of this doctoral study and possibly the project, I could attempt to publish the findings from the research and any results from the project. I could also present this information at regional or national conferences.

Conclusion

The data collected in this research and prior research suggest that math self-efficacy and math anxiety are associated with student success. Therefore, I have proposed a professional development seminar that would focus on educating the math faculty on math self-efficacy; math anxiety; their impact on student success; the creation of interventions to increase math student self-efficacy and decrease math anxiety; and the assessment and adjustments of these interventions. This plan would be implemented at the local setting and may have a real impact on math student success over time. The collection of the data that informed this project and the creation of this professional development have impacted my understanding of scholarship, project development, and leadership. A discussion of these topics follows in the final section of this doctoral study.

Section 4: Reflections and Conclusions

Introduction

The process of completing a doctoral study is certainly an eye-opening one. It has given me a better understanding of the research and publishing process. It has also given me a better understanding of the students I work with every day at the local setting. In this final section of this paper, I will discuss what I believe are the strengths and limitations of the project along with ways to address these limitations or examine the problem from a different direction. Following this, I will discuss what I have learned through this process and how I feel about my own abilities as a scholar, practitioner, and a project developer. Finally, I will discuss the implications of this study for social change and directions for future research.

Project Strengths and Limitations

This project has promise. The first strength of this project is that it is realistic. Out of all the possible projects that could be created to address this problem, I believe this project has a realistic chance of being implemented and has the possibility of creating real change for the local setting. My experience as a faculty member at the local setting for almost a decade tells me it is difficult to get the faculty to attend events unless they are required to do so, and they are unlikely to participate in new initiatives if they have not been included in the creation of the initiative. The project outlined in this paper would avoid both of these problems. Another strength of this project is that it has the possibility to increase math student self-efficacy and decrease math student anxiety across the college. By including all math faculty in the professional development, there

is a higher possibility that the implemented plans would impact almost all math students across the college. The input of the local setting faculty also takes advantage of their shared experiences to implement a plan that would work well at the local setting for all students.

The project has two limitations when it comes to addressing the problem of a lack of student success in developmental math courses. First, it puts a lot of faith in the faculty and administration of the local setting to implement changes that could affect student math self-efficacy and math anxiety. In order to successfully implement this project and have an impact on the success of math students at the local setting, the college must support and encourage the project. Supplying funds that would allow faculty to use their time in the implementation of this project and give faculty the resources they require might be the most effective way for the college to support and encourage this project. Second, I focus on just two variables that could be affecting math student success, and there could be many other variables that play a part in lack of student success in developmental mathematics.

Recommendations for Alternative Approaches

One alternative approach to the problem of student success would be to examine the same variables as in this study but with alternative research strategies. Qualitative research, for example, might give the local setting a more in-depth look at why developmental math students have lower pass rates than their peers in college-level math and what role math self-efficacy and math anxiety might play in this difference. There might also be further student attributes that are associated with student success that could

be examined in a similar manner to this study. These could include variables like time spent on homework, family educational background, or family socioeconomic status. I approached the problem of student success from the student variable side (i.e., what about the students is associated with a lack of student success in math courses at the local setting). An alternative approach would be to examine how educators teach math is associated with a lack of student success. This line of inquiry could also lead to the investigation of different teaching styles and their effects on student success, such as the emporium model or the flipped classroom. In each of these limitations, opportunities for further study exist.

Scholarship, Project Development, and Leadership and Change

Throughout the research process, I learned a lot about the amount of time and effort it takes to conduct scholarly research. I came into this process thinking of it more as an individual experience, but what I have found is that some of the most important insights have occurred through collaboration. Through the help of my committee chair, committee members, university reviewers, colleagues, friends, and family, I have found sounding boards and critiques that have helped me make this paper better. At several times during the process, I have been frustrated with the steps involved in the completion of this project, but as I came closer to completing this project, I believed that the steps I had to complete have made this a better project. The steps in place to complete this study have forced me to think critically and creatively about how I chose to examine the problem I was interested in, and in the end, they pushed me to examine variables that I might not have considered before I began this project. I also believe that these different

insights have yielded more interesting results than if I had conducted the study based on my initial plans. Finally, I have learned that, in scholarship, there are many things scholars know to be true through experience or anecdotal evidence, but often the evidence is lacking in the literature. In the case of my study, I think most people in the field, myself included, would make the assumption that students who are not as successful in math courses have lower self-efficacy and higher anxiety; yet, there is a lack of data in the literature to support this notion, especially at the community college level. I learned that adding data to these discussions can be valuable.

As I have progressed through this doctoral program and the writing of this doctoral study, I have also progressed in my profession. The combination of these experiences has taught me a lot about project development and evaluation. The most important thing I have learned about project development is the importance of planning. In order to create a meaningful project, it is important to take the time to think through the goal of the project and the best way to achieve that goal. I also learned that it is possible to over plan or overthink a project during the development stage. For example, a project that I am involved with at the local setting that involves changing our 16 week developmental math courses into two 8-week courses has been in development and the piloting of the project since before I started working at the local setting 8 years ago. Although this amount of planning has created a successful project, it has also meant that a large number of students have come and gone from the local setting without experiencing any advantages from this new program. I have also learned that during the planning process, understanding the setting for the project and creating a project that is realistic is

important. This is something I have tried to take into account in the creation of this project. For a project to have an impact on its setting, successful implementation is key. In order to implement a project successfully, it must be realistic. When it comes to the evaluation of a project, I believe that any assessment is not done just for the sake of having assessment but with the goal of improving the project. In the current educational climate, educators often collect data so that they can say they are doing assessment without having any understanding of how the data will help them make improvements. Through the process of creating this project, I wanted to make sure that any data collected as part of the project evaluation could be used for assessment of the project and for improving it.

Being an educational leader is not always the same as being a leader in other settings. The most important quality of being an educational leader is being concerned with student success. In order to be an effective leader in an educational setting and affect change, it is important that others can see that the leader's number one concern is for the success of the students. It is also important that leaders inform their decisions with data and experience if they would like to be a leader in education. It is also important that leaders can demonstrate the reasons behind their decisions. I have learned that changes can come from small actions, but the results can take time. In a field where the goals of any changes educators might make are to impact student success both in the classroom and beyond, it can take a long time for the results of the actions to become apparent. Even the smallest decisions that educators make in their classrooms can impact the students' lives. I also feel that as part of being an educational leader, it is important

that I am not afraid of failure. Educators cannot be afraid to try new things when they are trying to help more students be successful, and teachers cannot be afraid of letting their students see their failures. One of the symptoms of high math anxiety and low math self-efficacy is a fear of failure. It is important that students know that failure is only nothing to be afraid of, and it is a part of the learning process. As a leader in education, it is important that I demonstrate the ability to overcome this fear by trying new things and not sticking to tried and true educational practices because they are easy and comfortable.

As I come to the end of this journey of scholarship, I believe I have progressed a long way. The process of completing this doctoral program has given me a great appreciation of what it means to be a scholar. At this point I believe that one of my greatest strengths as a scholar is as a consumer of research. I feel that when I read the research of others, I can read their process, data, and conclusions and can use their results to form my own conclusions and find ways to apply their findings to my own teaching and research. Furthermore, I believe that my strengths as a scholar also lie in the creation of research. I enjoy finding a problem that interests me and a way to collect and analyze data to answer the research questions that relate to that problem. One area that I feel is a weakness of mine is my writing. While I feel like I can create research and analyze data well, I need to become a better scholarly writer so that it is easier for my readers to understand what I have done, why I chose to do it, and what I found as a result.

As I complete this paper I have begun my eighth year as a community college math professor. Before I even began this doctoral program, I already felt and still do feel that I am a good teacher. Then and now, I care about my students and work every day to

help them succeed in my classes and meet their goals. Yet through the process of this doctoral program, as I have started reading more research on teaching strategies in higher education, I have become more open to incorporating these new ideas into my classes and assessing their effectiveness. For example, I have started using the flipped classroom technique in some of my smaller classes and I have found some success with this method. I have also found that through this doctoral program my interest in research has certainly increased, even though I still feel like the classroom is where I belong. As a result of this process though, I do plan to include more research along the lines of the Scholarship of Teaching and Learning in my classrooms.

At the beginning of this doctoral program I would not have thought of myself as a project developer, even though I was a member of the team that created, implemented, and assessed a new developmental math sequence at the local setting. Through the course work of this doctoral program and the process of writing Section 3 of this doctoral study I have come to recognize the project development I have already done and what my strengths and weaknesses are. At the moment, I believe my strengths as a project developer lie in the evaluation of a project plan and the evaluation of a completed or ongoing project. I am not as strong in creating a project from scratch, but I enjoy taking a project idea that needs further development and helping it reach its full potential. I believe I work very well in a team setting where I can collaborate with others.

Reflection on Importance of Work

This study is a small but important piece of a larger puzzle, math student success at community colleges. By examining two variables, math self-efficacy and math

anxiety, which could play a role in math student success, this study has added to the research on this topic. This study also involves a setting that is not often used for research, a Hispanic serving institution, allowing researchers and educators a more thorough understanding of the issues of math self-efficacy and math anxiety. This work found significant correlations between math self-efficacy, math anxiety, and course level, applying evidence to the assumptions that students in lower level math courses have lower self-efficacy and higher anxiety. The study also found a significant correlation between math self-efficacy and math anxiety corroborating results from previous research (Ahmed et al., 2012; Akin & Kurbanoglu, 2011; McMullan et al. 2012). These are important parts of research that allow educators to make better informed decisions. This study also created a professional development event that can serve as a template for educating faculty on an issue of importance and using the collective brain power of the faculty to create and implement plans to address that issue at the local setting. This professional development would be a good first step towards increasing student math self-efficacy and decreasing student math anxiety at the local setting but it could also be used beyond the local setting and to address other variables.

Implications, Applications, and Directions for Future Research

Social change as with most change happens slowly. This study has the opportunity, over time, to create positive social change for individuals, the local setting, its community, and possibly beyond. First, this study offers data that support an increased emphasis on math self-efficacy and math anxiety at the local setting. This increased emphasis on these two variables will allow the local setting to put in place

initiatives aimed at increasing the math self-efficacy and decreasing the math anxiety of its students. If this can be accomplished our individual students may be impacted in a way that will benefit them and society. They will be benefit by being more confident and less anxious around math both inside and outside the classroom. Prior research suggests that by being more confident and less anxious with math they are more likely to be successful when required to use math (Phan, 2012; Tariq & Durrani, 2012; Wu et al., 2012; Zakaria et al., 2012). This possible increase in success could benefit both the individual student, by removing a roadblock from completion of the educational goals, and the community, by creating a more educated workforce. The project can impact social change at the local setting by bringing faculty together to work towards the common goal of increasing student math self-efficacy and decreasing math anxiety. If successful this project can serve as a template for successful collaboration towards a common goal, allowing faculty and staff to approach other problems in a similar manner. Beyond the local setting, educators around the country can use the results of this study and the proposed project to examine the issues of math self-efficacy and anxiety at their own institutions, to impact social change in their communities.

This research has added data to assumptions made by math educators about the differences between developmental math students and college-level math students. The data collected in this study has both affirmed and contradicted these assumptions. While the data suggest that lower course level students do have lower math self-efficacy and anxiety than higher course level math students, there was a not a significant difference in these variables between developmental and college-level math students. Therefore,

future research in the area of developmental math student success should also consider the variables of math self-efficacy and math anxiety. Also any interventions designed to increase developmental math student success should consider the impact the interventions have on the students' math self-efficacy and math anxiety. It is also important to note for future research that the effects of these two variables may not be limited to mathematics; future research should examine the impact of self-efficacy and anxiety in other disciplines. There may also be other variables that impact student success in math, and researchers should continue to examine these for their impacts on student success. Personally, I can examine the impacts of interventions designed to increase math self-efficacy and decrease math anxiety implemented either through the professional development described above or in my own classes. I can also examine other variables that might impact student success using similar techniques as I used in the data collection for this study.

Conclusion

Developmental math students at the local setting are passing math classes at a rate lower than their college-level peers. This study has collected and analyzed data that suggests that the lower course level math students have lower levels of math self-efficacy and higher levels of math anxiety. To attempt to increase math students' self-efficacy and lower their math anxiety, I proposed a professional development seminar. The first part of this three part professional development would inform faculty about math self-efficacy; math anxiety; the role math self-efficacy and math anxiety play in student success; and methods to increase math self-efficacy and decrease math anxiety. Part 2

will focus on the creation of a plan to increase math self-efficacy and decrease math anxiety and Part 3 will focus on evaluating and making changes to this plan. The results of this study support the creation of this professional development and suggest that future research should examine the variables of math self-efficacy and math anxiety further, as well as, examining other variables that could be related to student success. As might be expected, I have found the process of completing a doctoral study very rewarding. My knowledge of the subject matter, student success, math self-efficacy, and math anxiety has grown immensely and will have an impact on my teaching. I have also gained a better understanding of and improved my skills in the process of scholarship and project development. By completing this doctoral study, I believe I have improved my skills as a scholar, practitioner, and project developer significantly.

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Appendix A: Professional Development Project

Purpose

This is a professional development training that will focus on increasing math faculty's understanding of the issues of math self-efficacy and math anxiety (specifically at the local setting), how math self-efficacy and math anxiety impact student success, and strategies for increasing student math self-efficacy and decreasing student math anxiety.

Goals

The goals of this professional development training are to:

1. Increase the local settings math faculties' knowledge of math self-efficacy and math anxiety, and their impact on student success,
2. Engage the faculty in a discussion about ways to increase student math self-efficacy and decrease student math anxiety.
3. Create a plan to implement measures to increase student math self-efficacy and decrease student math anxiety.
4. Assess the measures implemented to increase student math self-efficacy and decrease student math anxiety.
5. Based on the assessment plan and implement changes to those measures.

Target Audience

The target audience for this professional development training is all math faculty at the community college which serves as the setting for this study. This includes both full-time and adjunct faculty.

Timeline

This professional development training will happen during a full school year beginning in the summer semester. Day 1 of this training can be accomplished in one of two ways. Option one entails the distribution of resources pertaining to math self-efficacy and math anxiety, their effects on student success, and methods that can be used to increase student math self-efficacy and decrease math anxiety. Math faculty will interact with these resources asynchronously during the summer semester. Option two is to have the faculty meet face-to-face on the Wednesday prior to the regularly scheduled fall faculty in-service day. During that day the information found in the resources will be presented to the faculty. Day 2 of the professional development training will take place during the college's regularly scheduled faculty in-service day, which is the Thursday of the same week as the Wednesday of day 1. Day 2 will include a discussion of the resources presented over in day 1 and how to implement these ideas at the local setting. Day 3 of this professional development training will take place during the spring semester on the date of the college's regularly scheduled spring faculty in-service day.

Day 1 (Option 1) - Professional Development Resources

The following articles, as well as, sections 1 and 2 of this project study, will be distributed to all math faculty at the end of the spring semester to be read over the summer in preparation for the fall in-service day. The articles focus on how math self-efficacy and math anxiety are related, how they affect student learning, and ways to increase math self-efficacy and decrease math anxiety. The articles are grouped by topic, and the citation for each article is listed along with the articles abstract.

Relationship between math self-efficacy and math anxiety

Ahmed, W., Minnaert, A., Kuyper, H., & van der Werf, G. (2012). Reciprocal relationships between math self-concept and math anxiety. *Learning and individual differences*, *22*(3), 385-389. doi:10.1016/j.lindif.2011.12.004

The present study examined the reciprocal relationships between self-concept and anxiety in mathematics. A sample of 495 grade 7 students (51% girls) completed self-report measures assessing self-concept and anxiety three times in a school year. Structural equation modeling was used to test a cross-lagged panel model of reciprocal effects between math self-concept and math anxiety. The analysis showed a reciprocal relationship between self-concept and anxiety in math (i.e., higher self-concept leads to lower anxiety, which in turn, leads to higher self-concept). However, the magnitude of the path from anxiety to self-concept is almost half of that from self-concept to anxiety. Overall, the results provide empirical support for the theoretical notion that math self-concept and math anxiety are reciprocally related.

Akin, A., & Kurbanoglu, I. N. (2011). The relationships between math anxiety, math attitudes, and self-efficacy: A structural equation model. *Studia Psychologica*, *53*(3), 263. doi:10.2190/ec.39.1.d

The purpose of this study is to examine the relationships between math anxiety, math attitudes, and self-efficacy. Participants were 372 university students who were enrolled in Sakarya University, in Turkey. In this study, the Revised Mathematics Anxiety Rating Scale, the Mathematics Attitudes Scale, and the Self-efficacy Scale were used. Using correlation analysis, math anxiety was found negatively related to positive attitudes and self-efficacy and positively to negative attitudes. On the other hand, positive attitudes were found positively associated with self-efficacy and negatively with negative attitudes. According to the path analysis results, positive attitudes were predicted positively and negative attitudes predicted negatively by self-efficacy. Also, self-efficacy and positive attitudes predicted math anxiety in a negative way and negative attitudes predicted math anxiety in a positive way. Results were discussed in the light of literature.

van Dinther, M., Dochy, F., & Segers, M. (2011). Factors affecting students' self-efficacy in higher education. *Educational research review*, *6*(2), 95-108.

The purpose of this study is to examine the relationships between math anxiety, math attitudes, and self-efficacy. Participants were 372 university students who were enrolled in Sakarya University, in Turkey. In this study, the Revised Mathematics Anxiety Rating Scale, the Mathematics Attitudes Scale, and the Self-efficacy Scale were used. Using correlation analysis, math anxiety was found negatively related to positive attitudes and self-efficacy and positively to negative attitudes. On the other hand, positive attitudes were found positively associated with self-efficacy and negatively with negative

attitudes. According to the path analysis results, positive attitudes were predicted positively and negative attitudes predicted negatively by self-efficacy. Also, self-efficacy and positive attitudes predicted math anxiety in a negative way and negative attitudes predicted math anxiety in a positive way. Results were discussed in the light of literature.

Math self-efficacy, math anxiety, and student success

Barrows, J., Dunn, S., & Lloyd, C. A. (2013). Anxiety, self-efficacy, and college exam grades. *Universal Journal of Educational Research, 1*(3), 204-208. Retrieved from http://www.hrpub.org/journals/jour_info.php?id=95

A student's level of self-efficacy and test anxiety directly impacts their academic success (Abdi, Bageri, Shoghi, Goodarzi, & Hosseinzadeh, 2012; Hassanzadeh, Ebrahimi, & Mahdinejad, 2012). When students doubt themselves and their own ability to test well, the students' sole focus becomes worrying about poor grades and cannot focus on academics (Bandura, 1993). But, little is understood about how test-anxiety and self-efficacy affect short-term success in the classroom. Specifically, how test anxiety and level of self-efficacy directly preceding an exam will affect the exam score. Pre-and post-questionnaires assessing anxiety and self-efficacy immediately before and after a single college exam was completed by 110 college students and exam grades were obtained from the instructor. Results showed a strong relationship between both test anxiety and exam grades, and self-efficacy and exam grades. Further, multiple linear regression analyses showed that exam grade could be predicted by test anxiety and self-efficacy level, and that self-efficacy moderated the effects of anxiety.

Maloney, E. A., & Beilock, S. L. (2012). Math anxiety: who has it, why it develops, and how to guard against it. *Trends in cognitive sciences, 16*(8), 404-406.

Basic math skills are important for success in school and everyday life. Yet many people experience apprehension and fear when dealing with numerical information, termed math anxiety. Recently, researchers have started to probe the antecedents of math anxiety, revealing some surprising insights into its onset, risk factors, and remediation.

Núñez-Peña, M. I., Suárez-Pellicioni, M., & Bono, R. (2013). Effects of math anxiety on student success in higher education. *International Journal of Educational Research, 58,* 36-43. doi:10.1016/j.ijer.2012.12.004

This study examines whether math anxiety and negative attitudes toward mathematics have an effect on university students' academic achievement in a methodological course forming part of their degree. A total of 193 students were presented with a math anxiety test and some questions about their enjoyment, self-confidence and motivation regarding mathematics, and their responses were assessed in relation to the grades they had obtained during continuous assessment on a course entitled "Research Design". Results

showed that low performance on the course was related to math anxiety and negative attitudes toward mathematics. We suggest that these factors may affect students' performance and should therefore be taken into account in attempts to improve students' learning processes in methodological courses of this kind.

Increasing math self-efficacy

Adediwura, A. A. (2012). Effect of peer and self-assessment on male and female students' self-efficacy and self-autonomy in the learning of mathematics. *Gender & Behaviour*, *10*(1), 4492.

This study investigated the effect of peer and self-assessment on the self-efficacy and students' learner autonomy in the learning of mathematics as well as determining the attitude of male and female students towards the use of peer and self-assessment. The population was made of senior secondary three students (SS3) of a state public school in Osun State. A total of 60 SS3 students made up the study sample with sex serving as the stratum. Two questionnaires were used for data collection. The first questionnaire was aimed at collecting information about the students' study habit and math self-efficacy, While the second questionnaire in addition to collecting information about students' study habit, and math self-efficacy, it was also aimed at collecting information about students' attitudes towards peer and self-assessment. Data collected were analyzed using descriptive, Z-test, chi-square and t-test statistics. The result of the study showed that, the use of peer and self-assessment in math lessons enhance students' self-efficacy and promote learner autonomy in learning mathematics. It was discovered that while there is no significant relationship between sex and enhancement of self-efficacy as a result of students' engagement with the use of peer and self-assessment, the enhanced students' leaner autonomy that was noticed in the sampled students is significantly influenced by their sex. Furthermore, the study revealed that the students have positive attitude towards the use of peer and self-assessment and that their attitude towards the use of these assessment strategies is independent of sex. The study concluded therefore that the use of peer and self-assessment should not be made to stress or create negative attitude in the students. Thus, peer and self-assessment activities should be separated from formal assessment in our schools.

Akay, H., & Boz, N. (2010). The Effect of Problem Posing Oriented Analyses-II Course on the Attitudes toward Mathematics and Mathematics Self-Efficacy of Elementary Prospective Mathematics Teachers. *Australian Journal of Teacher Education*, *35*(1), 59-75.

Research on mathematics teaching and learning has recently focused on affective variables, which were found to play an essential role that influences behaviour and learning. Despite its importance, problem posing has not yet received the attention it warrants from the mathematics education community. Perceived self-efficacy beliefs

have been found to be a strong predictor of mathematical performance, while problem posing is considered to be a fundamental ability in mathematical learning. On the other hand majority of research in this area present a positive relation between attitude toward mathematics and success. Therefore, it is shown that attitude toward mathematics is a determinative of success or failure. In this respect this study examines the effect of problem posing instruction on the attitudes toward mathematics and mathematics self-efficacy of elementary prospective mathematics teachers. The study used a pre-test-intervention-post-test experimental design. Quantitative research techniques were employed to gather, analyze and interpret the data. The sample comprised 82 elementary prospective mathematics teachers. In the result of data analysis, it was determined that the effect of problem posing instruction on the attitudes toward mathematics and mathematics self-efficacy of elementary prospective mathematics teachers was in a positive way and at significant level.

Bartsch, R. A., Case, K. A., & Meerman, H. (2012). Increasing academic self-efficacy in statistics with a live vicarious experience presentation. *Teaching of Psychology*, *39*(2), 133-136.

This study investigated the effect of a vicarious experience on the academic self-efficacy of graduate students enrolled in a statistics and research methods course. Participants (N = 39) completed a self-efficacy scale during the first two meetings of the course. Two weeks later, a portion of these students participated in a randomly assigned intervention to increase statistics self-efficacy. In the experimental condition, a former statistics student came to the class and explained her own math anxieties and outlined the behaviors that led to her personal success in the same course. Comparison students wrote about the characteristics of a successful student in the course without the experience of a peer model presentation. Analysis of pre- and postintervention academic self-efficacy indicated students in the peer model group showed a significant increase compared to the writing group. We discuss the potential of using live vicarious experience presentations to increase self-efficacy in psychology statistics courses.

Betz, N. E., & Schifano, R. S. (2000). Evaluation of an intervention to increase realistic self-efficacy and interests in college women. *Journal of Vocational Behavior*, *56*(1), 35-52.

High self-efficacy expectations in Realistic activities have been related to the pursuit of careers in engineering, science, and technology, where women have been historically underrepresented. Fifty-four college women were studied to determine if interventions based on self-efficacy theory would increase their confidence and interests in “Realistic” (from Holland's theory) activities (e.g., using tools, assembling, building, operating machinery). Interest and confidence levels were measured pre- and posttreatments. Participants were prescreened to identify those with at least moderate interest in Realistic activities, but who were also low in Realistic confidence. At posttreatment, the 24

participants in the treatment group showed a statistically significant increase in Realistic confidence relative to the control group of 30 that received a neutral intervention. Ways to increase women's Realistic confidence, and the relationships of confidence to interests and career pursuits, are discussed.

Decreasing math anxiety

Finlayson, M. (2014). Addressing math anxiety in the classroom. *Improving Schools, 17*(1), 99-115.

In today's educational systems, students of all levels of education experience math anxiety. Furthermore, math anxiety is frequently linked to poor achievement in mathematics. The purpose of this study is to examine the causes of math anxiety and to explore strategies which pre-service teachers have identified to overcome math anxiety. The methodology included conducting surveys with 70 pre-service teachers in Canada and completing a critical analysis of the data to provide an overview of the causes of math anxiety. These data indicate that pre-service teachers have encountered math anxiety in many situations. These causes include: lack of self-confidence, fear of failure; teaching styles; ineffective learning practices, and non-engagement of students. Furthermore, these data indicate that facing math anxiety have empowered the participants to devise strategies which have enabled them to overcome math anxiety. The author suggests that an improved understanding of math anxiety hold implications for all students and educators of mathematics.

Iossi, L. (2013). Strategies for reducing math anxiety in post-secondary students.

This literature review explores how educators might address adult math anxiety. Curricular, instructional, and non-instructional strategies are reviewed. The suggested approaches emphasize treating the cognitive and physical manifestations of math anxiety.

Núñez-Peña, M. I., Bono, R., & Suárez-Pellicioni, M. (2015). Feedback on students' performance: A possible way of reducing the negative effect of math anxiety in higher education. *International Journal of Educational Research, 70,* 80-87.

The aim of this study was to investigate the effectiveness of a formative assessment system in improving students' learning. This system involved giving feedback to students regarding the errors they made in a series of assignments performed during a course. Participants were 166 students enrolled in a core course of the degree in psychology offered by the University of Barcelona. Attendance at feedback classes was found to be positively correlated with students' grades, whereas the correlation between math anxiety scores and final exam grades was not significant. Exam grades were only predicted by the 'perceived usefulness of feedback' factor, suggesting that feedback may have helped to reduce the negative impact of math anxiety on students' academic achievement.

Perry, A. B. (2004). Decreasing math anxiety in college students. *College Student Journal*, *38*(2), 321.

This paper examines the phenomenon of mathematics anxiety in contemporary college and university students. Forms of math anxiety range from moderate test anxiety to extreme anxiety including physiological symptoms such as nausea. For each of several types of math anxiety, one or more case studies is analyzed. Selected strategies for coping with math anxiety are included. Some students' own ideas are presented along with analysis from leading experts in the subject of math anxiety.

Day 1 (Option 2) - Schedule of Presentation of Resources

9:00 – 10:00 am
What are math self-efficacy and math anxiety.
10:00 – 10:15 am
Break
10:15 – noon
Math self-efficacy, math anxiety, and student success.
12:00 – 1:00 pm
Lunch provided
1:00 – 2:30 pm
Increasing math self-efficacy.
2:30 – 2:45 pm
Break
2:45 – 4:15 pm
Decreasing math anxiety.

Day 2 - Schedule of Fall Faculty In-Service Day

Normal faculty wide in-service day events

7:30 – 8:15 am
Breakfast provided by the college
8:30 – 9:00 am
Welcome from College President
9:00 – 10:00 am
Review and discussion of professional development resources from day 1.
What are math self-efficacy and math anxiety?
How do you see these traits in your students?
10:00 – 10:15 am
Break

10:15 – 11:30 am
Review and discussion of professional development resources from day 1.
Which resources interested you?
How do you already address these issues in your classes?
11:30 – noon
Faculty Union Meeting
12:00 – 1:00 pm
Lunch provided by the college
1:00 – 2:30 pm
Discussion of implementation.
2:30 – 2:45 pm
Break
2:45 – 4:00 pm
Discussion of assessment of implementation.
Introduce ideas from the proposed project.
Allow faculty input on proposed assessment.

Day 3 - Schedule of Spring Faculty In-Service Day

Normal faculty wide in-service day events

7:30 – 8:15 am
Breakfast provided by the college
8:30 – 9:00 am
Welcome from College President
9:00 – 10:00 am
Presentation of assessment findings.
10:00 – 10:15 am
Break
10:15 – 11:30 am
Discussion of assessment findings and faculty experiences.
11:30 – noon
Faculty Union Meeting
12:00 – 1:00 pm
Lunch provided by the college
1:00 – 2:30 pm
Discussion of changes to methods for the coming semester.
2:30 – 2:45 pm
Break
2:45 – 4:00 pm
Discussion of assessment of implemented changes.

Appendix B: MSEAQ

Math Course: _____

In order to better understand what you think and feel about your college mathematics courses, please respond to each of the following statements on a scale of 1 (Never) to 5 (Usually).

1. I feel confident enough to ask questions in my mathematics class.
2. I get tense when I prepare for a mathematics test.
3. I get nervous when I have to use mathematics outside of school
4. I believe I can do well on a mathematics test.
5. I worry that I will not be able to use mathematics in my future career when needed.
6. I worry that I will not be able to get a good grade in my mathematics course.
7. I believe I can complete all of the assignments in a mathematics course.
8. I worry that I will not be able to do well on mathematics tests.
9. I believe I am the kind of person who is good at mathematics.
10. I believe I will be able to use mathematics in my future career when needed.
11. I feel stressed when listening to mathematics instructors in class.
12. I believe I can understand the content in a mathematics course.
13. I believe I can get an "A" when I am in a mathematics course.
14. I get nervous when asking questions in class.
15. Working on mathematics homework is stressful for me.
16. I believe I can learn well in a mathematics course.

17. I worry that I do not know enough mathematics to do well in future mathematics courses.
18. I worry that I will not be able to complete every assignment in a mathematics course.
19. I feel confident when taking a mathematics test.
20. I believe I am the type of person who can do mathematics.
21. I feel that I will be able to do well in future mathematics courses.
22. I worry I will not be able to understand the mathematics.
23. I believe I can do the mathematics in a mathematics course.
24. I worry that I will not be able to get an "A" in my mathematics course.
25. I worry that I will not be able to learn well in my mathematics course.
26. I get nervous when taking a mathematics test.
27. I am afraid to give an incorrect answer during my mathematics class.
28. I feel confident when using mathematics outside of school.

Appendix C: Email to Students

Dear [redacted] College Student,

You are receiving this email because you are currently enrolled in a math course at [redacted] College. I am a math instructor at [redacted] College and I am currently working on completed a Doctorate of Education from Walden University. As part of the process to earn my Doctoral degree I must complete a doctoral study. As part of this study I am surveying students on their personal belief that they can use math and any anxiety that may occur when the use of math is required. It would be extremely helpful if you would take a few minutes to complete the survey that can be found by clicking on the link below.

Insert link here.

Thank You,

Scott Spaniol

Appendix D: Permission to use MSEAQ

Gmail by Google

Scott Spaniol <[redacted]>

Re: Mathematics Self-Efficacy and Anxiety Questionnaire

Diana Swanagan <[redacted]> Wed, Apr 29, 2015 at 10:32 AM

To: "[redacted]" <[redacted]>

Hi Scott

Thanks for your interest in my dissertation. If you're interested in using the questionnaire in your study, feel free. Also, you can modify the items as needed, as long as you note those modifications. I haven't done any research since my dissertation (I primarily teach at my current institution), but if you have any questions, I'd be happy to try to answer them.

Diana Swanagan, Ph.D.
Chair, Department of Mathematics
Associate Professor of Mathematics
[redacted]

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