International Journal of Assessment Tools in Education: Vol. 4, Issue 1, (2017) pp. 37-53

http://www.ijate.ne
e-ISSN: 2148-7456 © IJATE

INTERNATIONAL JOURNAL of ASSESSMENT TOOLS in EDUCATON

"Research Article"

Developmental Mathematics Students: Who are They and What is Their Mathematics Self-Efficacy?

Ryan Baxter[1], Alan Bates[1], Adel Tawfig Al-Bataineh[1,*]

[1]Illinois State University, School of Teaching and Learning, College of Education, Campus Box 5300, Normal, Il 61790-5300

Abstract

The purpose of this quantitative study was to determine differences in developmental mathematics students' self-efficacy within the demographic data from the survey. Data from a sample of 240 Intermediate Algebra students at a single four-year university using the Mathematics Self-Efficacy Results indicate that males possess higher levels of mathematics self-efficacy and confidence with their mathematical abilities than females. Students who completed a lower developmental mathematics course prior to Intermediate Algebra possess lower levels of mathematics self-efficacy. The results of this study suggest developmental mathematics instructors should refine their teaching methodologies by incorporating strategies to increase their student's self-efficacy.

Article Info

Received
08 September 2016

Revised:
06 October 2016

Accepted
26 October 2016

Keywords:
Developmental mathematics, Higher education, Self-Efficacy, Traditional and non-traditional students, Gender, Ethnicity

1. INTRODUCTION

Most teaching professionals spend their entire careers refining their instructional methods in the pursuit of teaching excellence. This refining process continually challenges teachers to adapt teaching methodologies in order to improve student performance and engagement. However, this refining process becomes even more critical when the teaching professional teaches underprepared college students in mathematics (Smittle, 2003). Traditional and non-traditional students enroll in community colleges and universities every year lacking the foundation and skills required for college level mathematics. Students who lack the foundational skills in mathematics place into developmental mathematics courses in order to become prepared to succeed in their mathematics course (s) required for graduation. In the 1990 study by the Conference Board of the Mathematical

*Corresponding Author E-mail: atalba@ilstu.edu

2148-7456 /© 2017 DOI: 10.21449/ijate.264026

Sciences (CBMS) (Albers, Loftsgaarden, Rung, & Watkins, 1992), it was reported that 56% of all students studying mathematics at two-year colleges were studying at the remedial level. Nearly a decade later, the Fall 2000 CBMS survey reported 60% of all students enrolled in two-year colleges annually take remedial math courses (Lutzer, Maxwell, & Rodi, 2002). Instructors for developmental mathematics courses at these higher education institutions serve as a gateway for success throughout a student's collegiate career. These instructors face the challenge of building, or rebuilding, the necessary foundation of mathematical skills and attitudes necessary to succeed in credit generating mathematics courses required for graduation.

Instructors face this challenge of building mathematical skills and attitudes upon an insecure mathematical foundation many students bring into colleges and universities. Unfortunately, the average United States student's ability in math, according to the National Assessment of Educational Progress (NAEP), SAT, and ACT scores, is not keeping pace with society's demands (Scherer, 2002). According to Scherer (2002), the average SAT math score has only increased three points since 1967 and only forty percent of these students earned a score of 22 or higher on the ACT math portion (the equivalent of predicting a C or better in a first-year college-level course). With such a high percentage of college students not prepared for college mathematics, something must be done differently to prepare students and help develop mathematical skills at the college level. More specifically, developmental mathematics students have generally been unsuccessful with traditional instructional methods and materials. Effective developmental mathematics teachers must be able to present mathematics in different ways, requiring teachers to have in-depth knowledge of the concepts and skills they are teaching as well as higher level content knowledge in the field (Smittle, 2003).

Along with providing different teaching strategies, another key component of a developmental mathematics course is to raise the self-efficacy of the developmental mathematics student. Much research has focused on mathematics anxiety and achievement yet little research exists on the factors affecting the self-efficacy of the developmental mathematics student. Understanding the self-efficacy of developmental mathematics students could lead to intervention strategies or teaching strategies aimed to promote a positive sense of mathematical ability which influences mathematics achievement (Pajares, 2002). Developmental mathematics instructors seeking to refine their teaching methodologies should strive to improve mathematical ability while simultaneously improving student's self-efficacy. Increasing these two components in the developmental mathematics classroom begins the building, or rebuilding, process of a solid mathematical foundation for underprepared mathematics students.

1.1 Statement of the Problem

According to the National Center for Education Statistics (NCES), in 1999-2000, 32% of all freshmen in four-year colleges and universities along with 41% of community college freshmen required developmental education, which includes developmental mathematics (NCES, 2001, as cited in Smittle, 2003). Other studies indicate about 40% of traditional undergraduates take at least one such course (Woodham, 1998, as cited in Attewell, Lavin, Domina, & Levey, 2006). Developmental mathematics educators have been attempting to improve struggling learner's ability to learn and succeed in mathematics for decades. Students' ability to succeed in college level mathematics courses are required for graduation and seems to be a "determinate of not only choice of a college major but also serves as a determinant in the acquisition of a college degree" (Hall & Ponton, 2005, p. 26). If students cannot successfully complete their developmental mathematics course (s), and then proceed to successfully complete their required mathematics courses, they cannot graduate. Students in developmental mathematics courses show promise of succeeding at the college level by displaying strengths in some academic areas but they show weakness and struggle with mathematics (Attewell et al., 2006).

Many struggling learners believe they cannot succeed in school (Pajares, 2003). When developmental mathematics students enter the mathematics classroom, they bring negative past experiences and most believe that they will not do well in this mathematics course. This belief is also referred to as a student's mathematics self-efficacy. Self-efficacy refers to "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). Over three decades of research findings "amply support the contention that students' self-efficacy beliefs powerfully affect their academic performance in various ways" (Mills, Pajares, Herron, 2007, p. 417). Also, low self-efficacy beliefs "impede academic achievement and, in the long run, create self-fulfilling prophecies of failure and learned helplessness that can devastate psychological well-being" (Margolis & McCabe, 2006, p. 219). With almost one-third of new students entering colleges and universities taking developmental courses, what factors impact the self-efficacy of developmental mathematics students? What instructional strategies are instructors utilizing to ensure students increase their self-efficacy while simultaneously becoming competent to complete the required courses?

The purpose of this quantitative study is to determine differences in developmental mathematics students' self-efficacy, within the demographic data from the survey, based upon the Mathematics Self-Efficacy Scale results.

2. REVIEW OF RELATED LITERATURE

Developmental mathematics instructors face this challenge of building mathematical skills and attitudes upon an insecure mathematical foundation many developmental mathematics students bring into colleges and universities. Students in developmental mathematics courses show promise of succeeding at the college level by displaying strengths in some academic areas but they show weakness and struggle with mathematics (Attewell et al., 2006). However, if students cannot successfully complete their developmental mathematics course (s), and then proceed to successfully complete their required mathematics courses, they cannot graduate. Since students' ability to succeed in college level mathematics courses is required for graduation, this requirement seems to be a "determinate of not only choice of a college major but also serves as a determinant in the acquisition of a college degree" (Hall & Ponton, 2005, p. 26). Developmental mathematics students have generally been unsuccessful with traditional instructional methods and materials. Effective developmental mathematics instructors must be able to present mathematics in different ways, requiring teachers to have in-depth knowledge of the concepts and skills they are teaching as well as higher level content knowledge in the field (Smittle, 2003). With such a high percentage of college students not prepared for college mathematics, something must be done differently to develop students' mathematical skills and appropriate attitudes to be successful at the college level.

One such difference in the developmental mathematics classroom is the holistic approach taken to prepare students to succeed. Many struggling learners believe they cannot succeed in school (Pajares, 2003). More specifically, when developmental mathematics students enter the mathematics classroom, they bring negative past experiences, usually some apprehension, and most believe that they will not do well in this mathematics course. This belief is also referred to as a student's self-efficacy toward mathematics. Self-efficacy refers to "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). Over three decades of research findings “amply support the contention that students’ self-efficacy beliefs…powerfully affect their academic performance in various ways” (Mills et al., 2007, p. 417). Also, low self-efficacy beliefs “impede academic achievement and, in the long run, create self-fulfilling prophecies of failure and learned helplessness that can devastate psychological well-being” (Margolis & McCabe, 2006, p. 219). With almost one-third of new students entering colleges and universities taking developmental courses, what approach does the developmental educator take to increase not only mathematical skills but the self-efficacy of the student? Increasing these two components in the developmental mathematics classroom lays the groundwork for building, or rebuilding, a solid mathematical foundation for underprepared mathematics students.

Understanding the factors that impact the self-efficacy of developmental mathematics students is the focus of this study. Understanding the self-efficacy of developmental mathematics students could lead to intervention strategies or teaching strategies aimed to promote a positive sense of mathematical ability which influences mathematics achievement (Pajares, 2002). This literature review discusses the background of developmental education and placement into developmental mathematics courses. The literature then examines self-efficacy related to academic achievement; the sources of self-efficacy; self-efficacy regarding gender and race; and a brief history of assessing mathematics self-efficacy. This literature review primarily focuses on articles describing college students and not articles discussing middle or high school students. Topics not thoroughly discussed include self-efficacy relating to self-regulation and self-efficacy relating to self-concept. Following the literature is a summary of the research findings.

2.1 Research Questions

1. Which factors have an effect on developmental mathematics students’ self-efficacy?
2. What is the relationship of developmental mathematics students’ MSES scores in regards to gender?
3. What is the relationship of developmental mathematics students’ MSES scores with race and gender?
4. What implications are evident by analyzing the developmental mathematics students’ self-efficacy within the developmental mathematics classroom?

2.2 Definition of Terms

Affective domain: This refers to an emotional component. It consists of attitudes, or one’s tendency to respond in a certain way, along with memories of past failures and successes. Affective variables include math anxiety, self-confidence in learning and doing mathematics, liking or disliking mathematics, interest in mathematics, attributions for success and failure in mathematics, as well as beliefs about oneself as a learner of mathematics, and beliefs about math’s usefulness (Bassarear, 1991).

Attitude toward mathematics: This may be defined as “the level of like or dislike felt by an individual toward mathematics” (Quinn, 1997, p. 108).

COMPASS mathematics placement exam: COMPASS is defined by Illinois State University as a Placement Exam determines which math courses students are eligible to take at Illinois State University. Placement exam results are provided to assist in determining initial placement in a math course and are discussed with Academic Advisors. All examinees receive questions in Algebra. Depending on their Algebra score, they are then be routed into either Pre-Algebra questions OR College Algebra and Trigonometry questions. COMPASS is an untimed exam. The average time needed to complete the exam is less than one hour.

Cognitive Domain: "The logical component that processes thought, that stores and retrieves information, that deals with aptitude for learning math, and that matches learning readiness to teaching strategies" (Martinez & Martinez, 1996, as cited in Shields, 2006).

Developmental Mathematics Student: A student displaying moderate skill deficiencies in mathematics that requires cognitive and affective growth before enrolling in credit courses. Throughout this process of growth, the student is expected to function adequately. Students are placed in developmental mathematics courses following a mathematics placement exam (Shields, 2006).

Math Anxiety: "Feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematics problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p. 551).

Mathematics Self-Efficacy Scale: This self-report instrument is useful for measuring college students' mathematics self-efficacy and consists of two subscales. The Likert-style questionnaire consists of 34 self-reported items where the student rates his or her level of confidence relating to mathematical tasks. The purpose of the Mathematics Tasks subscale is to measure student confidence in the ability to perform everyday mathematical tasks. The purpose of the Mathematics Courses subscale is to assess student confidence in their ability to earn a B or better in college courses that require mathematical skills (Hall & Ponton, 2005).

Self-Efficacy: This concept refers to "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3).

Self-regulation: This concept refers to a "metacognitive process that requires students to explore their own thought processes so as to evaluate the results of their actions and plan alternative pathways to success" (Usher & Pajares, 2009, p. 443). Furthermore, successful self-regulating students organize their work, set proximal and distal goals, seek help when needed, and manage their time well.

Traditional students: This concept refers to students are who are often below the age of 24. They enroll in college immediately after graduation from high school and pursue undergraduate education on a full-time basis. Most traditional students are financially dependent on others and are employed only on a part-time basis. They often do not have family with children and education is their primary responsibility.

Nontraditional students: This concept refers to students are who considered to be adult learners who often have family and work responsibilities. They are often over the age of 24 and return to college to seek out additional education that is necessary for job transitioning in the workforce.

2.3 Limitations of the Study

This study has been limited to adult college students from developmental mathematics courses enrolled in MAT 104: Intermediate Algebra during the Spring 2010 semester. Adult students will be classified as traditional or non-traditional students during the data collection. The data collected may not be representative of the entire population regarding the self-efficacy of developmental mathematics students. Even though Informed Consent forms are given before research begins, and the course instructor will not be present when students fill out the survey, some students could feel the answers they provide may affect their grade in some way. The sample size is limited due to the following qualifications: participants who volunteered, were 18 years of age or older, and placed in developmental mathematics courses for the Spring 2010 semester. There is an assumption the participants accurately and honestly responded to the survey and demographic questions. For this reason, it is assumed the data is accurate to the best of the students' abilities.

3. METHODOLOGY

3.1 Participants

The sample population consisted of 240 male and female college students who were eighteen or older and enrolled in MAT 104: Intermediate Algebra for the Spring 2010 semester at a Midwestern four-year public university. From the 240 participants, 79 (33%) of the students were male, and 158 (66%) of the students were female (see Table 1). Although a more balanced sample would have been ideal, more women are typical in developmental mathematics classes. Analyzing the university's Fall 2009 student enrollment data showed 11886 (57%) undergraduate students were female compared to 8970 (43%) male students (University Facts, 2009). Although women represented a vast majority of the sample, this would probably be true in most courses at this university and is typically the case in developmental mathematics courses. The sample consisted of many racial backgrounds including 4 (2%) American Indian/Native Alaskan students; 41 (17%) Black/Non-Hispanic students; 6 (3%) Asian/Pacific Islander students; 23 (10%) Hispanic students; 158 (66%) White/Non-Hispanic students; and 8 (3%) students classified themselves as other. The sample had 24 (10%) non-traditional students with 207 (86%) students classified as traditional students. Ninety-six (40%) of the sample completed the Basic Algebra course prior to enrolling in Intermediate Algebra. Almost all students enroll in developmental mathematics courses based upon completion of the COMPASS mathematics placement exam. The rationale for selecting developmental mathematics students in only Intermediate Algebra was due to the researcher's belief students who place into this level of mathematics will demonstrate a low level of self-efficacy toward mathematics.

Table 1. Descriptive Data of the Sample

Category	Description	N	%
Gender	Male	79	32.9
	Female	158	65.8
	Not Indicated	3	1.3
	Total	240	
Race	American Indian/Native Alaskan	4	1.7
	Black/Non-Hispanic	41	17.1
	Asian/Pacific Islander	6	2.5
	Hispanic	23	9.6
	White/Non-Hispanic	158	65.8
	Other	8	3.3
	Total	240	
Minority vs. Majority	Minority	82	34.2
	White/Non-Hispanic	158	65.8
	Total	240	
Credit Hours Earned	0-29	150	62.5
	30-59	48	20.0
	60-89	27	11.3
	90+	9	3.8
	Unsure	1	0.4
	Not Indicated	5	2.1
	Total	240	
Completed Basic Algebra	Yes	96	40.0
	No	142	59.2
	Not Indicated	2	0.8
	Total	240	
Repeated Intermediate Algebra	Yes	37	15.4
	No	203	84.6
	Total	240	
Student Status	Traditional	207	86.3
	Non-Traditional	24	10.0
	Not Indicated	9	3.8
	Total	240	

Due to the quantitative nature of this study, the convenience sampling includes participants from all eleven sections of Intermediate Algebra courses offered in the Spring 2010 semester.

3.2. Instrumentation

Participants were asked to complete the Mathematics Self-Efficacy Scale (MSES). The intended outcome of the MSES was to accurately measure student confidence in the ability to perform every day mathematical tasks. The MSES was originally developed in 1983 by Betz and Hackett and contained 75 items. However, after a revision in 1993, the survey became more concise and now contains 34 items. The MSES contains a Mathematics Tasks subscale and a Mathematics Courses subscale. The purpose of the Mathematics Tasks subscale measures student confidence in the ability to perform everyday mathematics tasks. The purpose of the Mathematics Courses subscale is to determine student confidence in their ability to earn a B or better in college courses that require mathematical skills (Betz & Hackett, 1993). Betz & Hackett (1983) reported internal consistency using the coefficient alpha to be .96 for the total scale and .92, .96, and .92 for the Tasks, Problems, and Courses subscales, respectively. Lent et al. (1991) reported a coefficient alpha of .92 and a two-week test-retest reliability of .94. Based upon the findings in this current study, our Cronbach's alpha is .95. Therefore, the findings in this research are consistent with previous reports and should be considered reliable and valid data.

The Likert-style questionnaire consists of 34 self-reported items where the student rates his or her level of confidence. Participants rate their level of confidence using categories such as "no confidence at all," "very little confidence," "some confidence," "much confidence," or "complete confidence." Scoring for each question ranges from 0 = no confidence at all, to 9 = complete confidence. To compute the MSES score, the mean of all 34 items is calculated. The range of MSES scores could fall between 0.000 and 9.000. If a student failed to respond to an item, the sum is calculated based upon the items that were completed. However, if more than 3 items were not completed, the survey is not considered valid. Such surveys were not included in the sample for this research study. Table 2 provides the approximate percentile equivalents to aid in interpreting the MSES scores. These percentile equivalents are separated by gender since significant gender differences were found when creating the mathematics self-efficacy scale. For example, if a female receives a MSES score of 6.223, she falls within the 60-70th percentile. This result indicates the female participant exhibits a stronger sense of mathematics confidence than approximately 65% of the female population. However, if a male receives a MSES score of 6.223, he falls within the 40-50th percentile. This result indicates the male participant exhibits a stronger sense of mathematics confidence than approximately 45% of the male population.

This instrument was selected due to its reliability and validity to measure college-level students' mathematics self-efficacy. Furthermore, Betz and Hackett (1993) note that the content validity for the MSES has been demonstrated through research that validates each area measured by the instrument. The MSES has a positive correlation between other mathematics scales such as math anxiety (r = .56), confidence in doing mathematics (r = .66), perceived usefulness of mathematics (r = .47), and the effectance motivation in math (r = .46), thus enhancing the validity of this instrument. Permission was granted to print and distribute the MSES on January 21, 2010 for up to 300 participants (see Appendix B).

Table 2. Approximate Percentile Equivalents for Mathematics Self-Efficacy Scores

	Total Score	
Percentile	**Females**	**Males**
95	7.9	8.5
90	7.5	8.1
80	6.9	7.5
70	6.5	7.1
60	6.1	6.7
50	5.8	6.4
40	5.5	6.1
30	5.1	5.7
20	4.7	5.3
10	4.1	4.7
5	3.7	4.3

4. RESULTS

An independent samples *t*-test was conducted to determine if a significant difference between the mathematics self-efficacy of male ($N = 79$) and female ($N = 158$) students as measured by the MSES exists. The mean MSES score for all male students in Intermediate Algebra was 5.977 ($SD = 1.174$); and the mean MSES score for all female students was 5.243 ($SD = 1.272$). The results of the *t*-test ($t = 4.293$, $p = .000$) suggested that the means are not equal. Therefore, a significant difference exists between the level of mathematics self-efficacy for male and female students in Intermediate Algebra. Male students demonstrate a higher level of mathematics self-efficacy than female students.

A one-way analysis of variance (ANOVA) was performed to determine the main effects of race on the dependent variable for MSES score. Tukey and Scheffe post hoc tests were performed to further analyze the interactions between the individual racial groups (see Table 3). The results indicate no significant differences between and within racial groups $F(5, 234) = 1.290$, $p = .269$. The Tukey post hoc results indicate no significant difference exists between racial groups ($p = .120$). Similarly, the Scheffe post hoc results demonstrate no significant difference exists between racial groups ($p = .274$). Since race could interact with gender to create significant differences based upon race and gender, a multivariate analysis of variance (MANOVA) was performed. Similar to the ANOVA results, the MANOVA results indicate no interaction between race and gender. Race does not have statistical significance and does not appear to be a significant factor in the mathematics self-efficacy of Intermediate Algebra students.

Since many of the racial groups consist of very few participants, the relationship between all minority students and White/Non-Hispanic students was examined. An independent samples *t*-test was conducted to determine if there was a significant difference between the minority group ($N = 82$) and the White/Non-Hispanic group ($N = 158$). The results indicate the mean MSES score of the minority students was 5.332 ($SD = 1.366$); and the White/Non-Hispanic students had a mean MSES score of 5.584 ($SD = 1.244$). The results of the *t*-test ($t = 1.436$, $p = .152$) indicate there is no significant difference in the MSES scores comparing minority students to White/Non-Hispanic students. Combining the MANOVA results, prior ANOVA results, and the results from this *t*-test suggest that race, as its own stand alone variable, does not have a significant effect on MSES scores. Therefore, the results suggest race does not have statistical significance regarding the mathematics self-efficacy of Intermediate Algebra students.

Table 3. Tukey and Scheffe post hoc tests of MSES Score

	Race	N	MSES Score
Tukey HSD[a]	Other	8	4.6738
	Hispanic	23	5.2980
	Black/Non-Hispanic	41	5.3380
	White/Non-Hispanic	157	5.5759
	Asian/Pacific Islander	6	5.7585
	American Indian/Native Alaskan	2	6.2794
	Sig.		.150
Scheffe[a]	Other	8	4.6738
	Hispanic	23	5.2980
	Black/Non-Hispanic	41	5.3380
	White/Non-Hispanic	157	5.5759
	Asian/Pacific Islander	6	5.7585
	American Indian/Native Alaskan	2	6.2794
	Sig.		.319

An independent samples *t*-test was conducted to determine if there was a significant difference between the mathematics self-efficacy of non-traditional (N = 24) and traditional students (N = 207) as measured by the MSES. Although the non-traditional students do not have enough participants in their group to display statistical significance, the *t*-test was still completed. The mean MSES score for non-traditional students was 5.832 (SD = 1.427); and the mean MSES score for all traditional students was 5.494 (SD = 1.286). The results of the *t*-test (t = -1.206, p = .229) suggest there is no significant difference in the MSES scores when comparing non-traditional and traditional students.

An independent samples *t*-test was conducted to determine if there was a significant difference between the mathematics self-efficacy of students who placed into a lower developmental mathematics course (N = 96) and students who placed directly into Intermediate Algebra (N = 142) as measured by the MSES. The mean MSES score for all students placing in a lower course was 5.290 (SD = 1.320); and the mean MSES score for all students placing directly into Intermediate Algebra was 5.655 (SD = 1.253). The results of the *t*-test (t = -2.154, p = .032) suggest that the means are not equal. Therefore, a significant difference exists between the mathematics self-efficacy of students placing into a lower developmental mathematics course prior to enrolling in Intermediate Algebra. Students placing directly into Intermediate Algebra demonstrate a higher level of mathematics self-efficacy than students who place into Basic Algebra, or lower, developmental mathematics course.

An independent samples *t*-test was conducted to determine if there was a significant difference between the mathematics self-efficacy of students repeating Intermediate Algebra (N = 37) and students enrolled in Intermediate Algebra for the first time (N = 203) as measured by the

MSES. The mean MSES score for all students repeating Intermediate Algebra was 5.649 (*SD* = 1.261); and the mean MSES score for all students enrolling in Intermediate Algebra for the first time was 5.470 (*SD* = 1.296). The results of the *t*-test ($t = .773$, $p = .440$) suggest there is no significant difference in the MSES scores of students enrolling for the first time in Intermediate Algebra in comparison to students repeating the course.

A one-way analysis of variance was performed to determine the main effects of credit hours earned on the dependent variable MSES score (see Table 4). The results indicate no significant differences between and within credit hour groups $F(6, 233) = 1.544$, $p = .165$. These results suggest that the status of a student based upon credit hours does not have statistical significance regarding the mathematics self-efficacy of Intermediate Algebra students.

Table 4. One-Way Analysis of Variance of MSES Score by Credit Hours

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.201	6	2.534	1.544	.165
Within Groups	382.252	233	1.641		
Total	397.453	239			

A two-way analysis of variance was performed to determine the main effects and interactions of credit hours and gender on the dependent variable MSES score (see Table 5). The results indicate a significant main effect for gender ($F = 6.321$, $p = .013$) and no significant interaction between gender and credit hours on MSES score ($F = .280$, $p = .840$). Consistent with our gender *t*-test results, gender displays a significant difference in this ANOVA. However, when gender and credit hours are combined, this interaction does not appear to be a significant factor in the mathematics self-efficacy of Intermediate Algebra students.

Table 5. Two-Way Analysis of Variance of MSES Score by Gender and Credit Hours Earned

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	44.672[a]	10	4.467	2.925	.002
Intercept	997.257	1	997.257	653.016	.000
Gender	9.653	1	9.653	6.321	.013
Credit Hours	13.586	6	2.264	1.483	.185
Gender * Credit Hours	1.281	3	.427	.280	.840
Error	345.137	226	1.527		
Total	7527.450	237			
Corrected Total	389.809	236			

a. R Squared = .115 (Adjusted R Squared = .075)

5. DISCUSSION

Based upon the research findings in this study, students enrolled in Intermediate Algebra possess low levels of mathematics self-efficacy. Students with low levels of self-efficacy often tend to complete only simple academic tasks where they apply the minimal amount of effort necessary and do not persist when the task becomes challenging. In other instances, students will choose not to complete the academic assignment altogether. (Mills et al., 2007; Margolis & McCabe, 2006). The current study found the mean MSES score for all male students in Intermediate Algebra was 5.977 (SD = 1.174), which falls somewhere in the 30-40th percentile when interpreting the results based upon the approximate percentile chart provided by Betz and Hackett (1993). This indicates male students in Intermediate Algebra rank in the 30-40th percentile when comparing the mathematics self-efficacy of all male mathematics students. The findings are similar to previous research with Intermediate Algebra students. Hall and Ponton (2005) found male Intermediate Algebra students possessed a mean MSES score of 5.392 (SD = 1.301). However, an interesting difference between the studies indicates Hall and Ponton's (2005) male students would fall into the 20-30th percentile based upon the percentile chart. When comparing the two groups of male students, the mean MSES scores could be significantly different. Although the findings from each study could produce significant differences, both research studies consistently demonstrated male Intermediate Algebra students possess low levels of mathematics self-efficacy. Both studies confirm that male college students in Intermediate Algebra display less confidence in their mathematics abilities.

Examining the mean MSES score for all female students in Intermediate Algebra compared to previous research displayed very consistent findings. This research found the mean MSES score for female students in Intermediate Algebra was 5.243 (SD = 1.272), which falls into the 30-40th percentile based upon the approximate percentile chart provided by Betz and Hackett (1993). Similar to previous research, Hall and Ponton (2005) found female Intermediate Algebra students possessed a mean MSES score of 5.294 (SD = 1.545). The female Intermediate Algebra students in the Hall and Ponton (2005) study fell into the into the 30-40th percentile based upon the percentile chart. Similar to the male findings, both research studies consistently demonstrate female Intermediate Algebra students possess low levels of mathematics self-efficacy.

Although male and female Intermediate Algebra students possess low levels of mathematics self-efficacy, one of the significant findings from this research indicated female students possess lower levels of mathematics self-efficacy than male students. The results from this study support previous research indicating females possess lower levels of mathematics self-efficacy than males (Betz & Hackett, 1983; Lent, Lopez, Brown & Gore, 1996; O'Brien, Martinez-Pons, & Kopala, 1999; Pajares, 2002). On the other hand, the results from this study do not support previous research by Hall and Ponton (2005) who found no significant difference regarding mathematics self-efficacy between males and females. The mean MSES score for the entire sample of this research study was 5.498 (SD = 1.290) while Hall and Ponton (2005) found Intermediate Algebra students possessed a mean MSES score of 5.33 (SD = 1.447). With very similar mean MSES scores, some possible differences in the studies should be considered. The current research has a larger sample size of Intermediate Algebra students (N = 240) compared with Hall and Ponton's (2005) sample size (N = 105). Breaking down the sample sizes indicates females (N = 158) have almost twice the amount of participants in this sample compared to our males (N = 79). Whereas Hall and Ponton (2005) had females (N = 63) in a lower ratio compared to males (N = 42). Another variable to consider within the sample includes how Hall and Ponton (2005) only analyzed Intermediate Algebra students who were of freshmen status. By not including all participants enrolled in Intermediate Algebra, like our sample, this could cause some differences in the data. However, the current research had 146/237, or 62%, that are considered freshmen status. Although multiple variables could be analyzed within each study, most research concludes that females possess lower levels of mathematics self-efficacy.

When determining what factors impact the mathematics self-efficacy of developmental mathematics students, one main factor in this study, along with previous research, are the gender differences. Developmental mathematics instructors need to be aware of the "gender dynamic routinely at work in the classroom and strive to involve the minority gender in discussions on content. Teachers need to remember that teacher gender also can influence participation from students and work to include both males and females in questions and answers" (Waycaster, 2001, p. 413). Developmental mathematics instructors should be aware how their gender could influence participation in the classroom. This study found females possess lower levels of self-efficacy than males. Females also consist of the majority gender in the developmental mathematics classroom. Instructors should make an effort to keep a balance of students from each gender responding to questions and providing answers. Also, previous research has indicated "social persuasions and vicarious experiences were critical sources of women's self-efficacy beliefs, and that they recalled those types of incidents to a greater extent than they recalled performance accomplishments" (Zeldin et al., 2007, p. 1039). As developmental mathematics instructors attempt to strengthen self-efficacy toward mathematics in each gender, females tend to improve their self-efficacy through cooperative learning in groups or finding a role model to provide support. However, males tend to rely more on successful experiences from previous attempts and working through the material on an individual level to build their confidence. Instructors could provide this opportunity in class or could possibly assign a group homework assignment. However, having students find their own group of students they are comfortable with would be ideal. Each gender may follow different paths in order to improve confidence and mathematics self-efficacy. Instructors should "convey the message that academic success is a matter of desire, effort, and commitment rather than of gender or established social structure" (Pajares, 2002, p. 123). Developmental mathematics instructors should attempt to incorporate multiple learning opportunities throughout their course in order to enhance the self-efficacy for all students which will ultimately enhance academic achievement.

While gender differences were significantly different, this study did not find any significance between male and female Intermediate Algebra students when comparing racial backgrounds. Based upon previous research, minority students have consistently demonstrated lower self-efficacy than White/Non-Hispanic students (Stevens et al., 2004; O'Brien et al., 1999). Due to the limited number of research studies involving mathematics self-efficacy and race, previous research has only focused on high school students. Comparing high school students with college students causes some concern. Typically only the students who were academically successful in high school transition to the university level. The minority students at the university level were probably the more self-efficacious students from their high schools. Although no significant differences were found between the racial background of Intermediate Algebra students, examining the demographics of the university compared to the Intermediate Algebra sample demonstrates some stark differences. For example, this study has 34% of the sample being labeled as minority students. The university's overall demographics indicate 17% of the student body is minority students (University Facts, 2009). Intermediate Algebra students enroll twice the number of minority students than is typical at this university. Other interesting numbers indicate that this sample had 17% being labeled as Black/Non-Hispanic and 10% labeled as Hispanic. The university's overall demographics include only 6% of the student body being labeled Black/Non-Hispanic and 4% as Hispanic. Once again, our ANOVA'S indicate race does not significantly impact Intermediate Algebra student's mathematics self-efficacy. This would suggest that some extraneous variables we have not measured are somehow influencing the higher percentage of minority students in developmental courses.

Racial backgrounds did not significantly influence MSES scores and the same could be said about traditional students and non-traditional students. Cassazza (1999) has shown that the fastest growing segment of higher education is the number of non-traditional learners. Hall and Ponton (2005) called for more research involving the mathematics self-efficacy of non-traditional students and traditional students. In response to this call, this study compared the mathematics self-efficacy of non-traditional (N = 24) and traditional students (N = 207) as measured by the MSES. Although Cassazza (1999) determined this was a fast growing segment of the higher education population, the non-traditional students were not well represented in this sample. With only 24 participants in the non-traditional group, this sample size does not have enough participants for statistical purposes. The results also indicated no significant differences between traditional and non-traditional students. The comparison between traditional and non-traditional students should be conducted at the community college where a higher number of students likely would be classified as non-traditional students.

Similar to the traditional and non-traditional findings, when comparing credit hour information and Intermediate Algebra students, no significant differences were found. Previous research by Hall and Ponton (2005) found a significant difference between the mathematics self-efficacy of freshmen Calculus I students compared to freshmen Intermediate Algebra students. The Calculus I students displayed significantly higher levels of mathematics self-efficacy. The current study compares students only enrolled in Intermediate Algebra and shows no significant differences based upon credit hour status. With 62% of students being freshmen, 20% being sophomores, 11% being juniors, and only 4% labeled themselves as seniors, there are no significant differences in mathematics self-efficacy based upon whether you are a freshmen, sophomore, junior, or senior, enrolled in Intermediate Algebra. Since our sample of junior students (N = 27) and senior students (N = 9) are small, the statistical validity of comparing freshmen with seniors is not completely accurate. However, no significant differences occurred between and within gender and credit hours. This interaction does not appear to be a significant factor in the mathematics self-efficacy of Intermediate Algebra students.

Along with credit hour status not being a significant difference, students enrolling in Intermediate Algebra for a second or third attempt did not show any significance when compared to students enrolling for the first time. Based upon Bandura's (1986, 1997) self-efficacy theory, students who have failed to complete Intermediate Algebra on the first attempt would probably possess lower levels of self-efficacy. Mastery experiences are the primary source of self-efficacy information for almost every person. It could be assumed that withdrawing from, or failing, a course would negatively impact student's mathematics self-efficacy. However, the results indicated that students who are repeating Intermediate Algebra (N = 37) are not significantly different than students who are taking Intermediate Algebra for the first time (N = 203) based upon MSES scores. Some possible explanations include the fact that females comprise a strong majority of the students in Intermediate Algebra courses. Previous research indicated "social persuasions and vicarious experiences were critical sources of women's self-efficacy beliefs, and that they recalled those types of incidents to a greater extent than they recalled performance accomplishments" (Zeldin et al., 2007, p. 1039). Females may not necessarily gauge a tremendous amount of their mathematics self-efficacy from mastery experiences, or failed experiences, in this case. The results clearly show no significance between groups of students repeating Intermediate Algebra and students enrolling in Intermediate Algebra for the first time. This is encouraging to developmental mathematics instructors as they attempt to build repeat Intermediate Algebra student's mathematics self-efficacy. Knowing students enrolled in Intermediate Algebra for a second, or third attempt, do not have lower mathematics self-efficacy is one less barrier impeding student's academic achievement in a mathematics course.

Conversely, students enrolled in Intermediate Algebra after completing a lower developmental mathematics course did have significantly lower levels of mathematics self-efficacy compared to students placing directly into Intermediate Algebra. Previous research by Hall and Ponton (2005) found a significant difference between the mathematics self-efficacy of freshmen Calculus I students compared to freshmen Intermediate Algebra students. The Calculus I students displayed significantly higher levels of mathematics self-efficacy. Calculus I and Intermediate Algebra are separated by usually three or four mathematics courses. By only separating the students with one mathematics course, the results from this current study support Hall and Ponton (2005) findings of significant differences between two mathematics courses. The results from this study also support previous research indicating students who perform at lower academic levels report significantly less self-efficacy than students operating at higher academic levels. Whether comparing gifted and regular students (Zimmerman & Martinez-Pons, 1990) or regular and low achieving students (Multon, Brown, & Lent, 1991), the students in the higher courses displayed significantly higher self-efficacy than students in the lower level courses. The current study is in contrast to previous research by Young and Ley (2002) which found students in developmental mathematics courses had similar levels of mathematics self-efficacy as students placing in regular mathematics courses. Based upon Bandura's (1997) self-efficacy theory, mastery experiences, or previous experiences, with mathematics is the most influential aspect of a person's self-efficacy. Students taking a lower mathematics course than Intermediate Algebra have probably experienced many negative feelings toward mathematics by not having experienced much success in previous mathematics courses. The results from this study seem to support the principles of self-efficacy theory and previously established research.

5.1. CONCLUSION

Developmental mathematics educators have been attempting to improve underprepared student's mathematical abilities for decades. Increasing the developmental mathematics student's self-efficacy should improve their confidence in mathematics while simultaneously improving their mathematical ability. Adjusting instructional methodologies to incorporate more mastery experiences, verbal persuasion, and cooperative learning in the classroom are some strategies for instructors to implement. However, instructors must realize there are no quick fixes to improve low levels of mathematics self-efficacy. Students with low levels of mathematics self-efficacy have faced an uphill battle to comprehend mathematics for many years. Nevertheless, continual attempts, however slow and arduous, to improve developmental mathematics student's self-efficacy should be implemented by developmental mathematics instructors to improve student's chances of successfully completing their college degree. As developmental mathematics educators seek teaching excellence, incorporating the improvement of developmental mathematics students' self-efficacy throughout the process of improving instructional methods should lay the groundwork for building a solid mathematical foundation for underprepared students to succeed.

6. REFERENCES

Albers, D. J., Loftsgaarden, D. O., Rung, D. C., & Watkins, A. E. (1992). *Statistical abstracts of undergraduate programs in the mathematical sciences and computer science in the United States*. 1990-91 CBMS Survey (MAA Notes Number 23). Washington DC: Mathematical Association of America.

Attewell, P., Lavin, D., Domina, T., Levey, T. (2006). New evidence on college remediation. *The Journal of Higher Education, 77*(5), 886-924.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191-215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1997). Self-Efficacy: The exercise of control. New York: W.H. Freeman and Company.

Bassarear, T. J. (1991). An examination of the influence of attitudes and beliefs on achievement in a college developmental mathematics course. *Research & Teaching in Developmental Education, 7*(2), 43-56.

Betz, N. E., & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. *Journal of Vocational Behavior, 23*, 329-345.

Betz, N. E., & Hackett, G. (1993). *Mathematics self-efficacy scale*. Palo Alto, CA: Mind Garden Press.

Hackett, G. (1985). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education, 20*(3), 261-73.

Hackett, G., & Betz, N. E. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education, 20*(3), 261-73.

Hall, J. M., & Ponton, M. K. (2005). Mathematics self-efficacy of college freshmen. *Journal of Developmental Education, 28*(3), 26-33.

Lent, R. W., Lopez, F. G., & Bieschke, K. J. (1991). Mathematics self-efficacy: Sources and relation to science-based career choice. *Journal of Counseling Psychology, 38*(4), 424-430.

Lent, R.W., Lopez, F.G., Brown, S. D., & Gore, P. A. (1996). Latent structure of the sources of mathematics self-efficacy. *Journal of Vocational Behavior, 49*, 292-308.

Lutzer, A. J., Maxwell, J. W., & Rodi, S. B. (2002). Statistical abstract of undergraduate programs in the mathematical sciences in the United States. Fall 2000 Conference Board of Mathematical Sciences (CBMS 2000). American

Margolis, H., & McCabe, P. P. (2006). Improving self-efficacy and motivation: What to do, what to say. *Intervention in School and Clinic, 41*(4), 218-227.

Mills, N., Pajares, F., Herron, C. (2007). Self-efficacy of college intermediate French students: Relation to achievement and motivation. *Language Learning, 57*(3), 417-442.

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology, 38*, 30-38.

O'Brien, V., Martinez-Pons, M., Kopala, M., (1999). Mathematics self-efficacy, ethnic identity, gender, and career interests related to mathematics and science. *Journal of Educational Research, 92*(4), 231-235.

Pajares, F. (2002). Gender and perceived self-efficacy in self-regulated learning. *Theory Into Practice, 41*(2), 116-125.

Pajares, F. (2003). Self-efficacy beliefs, motivation, and achievement in writing: A review of the literature. *Reading & Writing Quarterly, 19*(2), 139.

Pajares, F., & Valiante, G. (2006). Self-efficacy beliefs and motivation in writing. In C. A. Macarther, S. Graham, & J. Fitzgerald (Eds.), *Handbook of writing research* (p. 158-170). New York: Guilford Press.

Quinn, R. J. (1997). Effects of mathematical methods courses on the mathematical attitudes and content knowledge of preservice teachers. *The Journal of Educational Research, 91*(2), 108-113.

Richardson, F. C., & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. *Journal of Counseling Psychology, 19*, 551-554.

Scherer, M. (2002). Love and hate for math and science. *Educational Leadership, 5*(61), 5.

Shields, D. J. (2006). *Causes of math anxiety: The student perspective.* Unpublished doctoral dissertation, Indiana University of Pennsylvania.

Smittle, P. (2003). Principles for effective teaching in developmental education. *Journal of Developmental Education,26*(3), 10-16.

Stevens, T., Olivarez A., Jr., & Hamman, D. (2006). The role of cognition, motivation, and emotion in explaining the mathematics achievement gap between Hispanic and White students. *Hispanic Journal of Behavior Sciences, 28*, 161-186.

Stevens, T., Olivarez A., Jr., Lan, W. Y., & Tallent-Runnels, M. (2004). Role of mathematics self-efficacy and motivation in mathematics performance across ethnicity. *Journal of Educational Research, 97*(4), 208-221.

University College. Illinois State University. COMPASS math placement exam: What is the COMPASS exam? http://universitycollege.illinoisstate.edu/testing/compass/, retrieved October 6, 2016.

University Facts. (2009, Fall). Planning and Institutional Research Office. Illinois State University, Normal, IL.

Usher, E. L., & Pajares, F. (2009). Sources of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology, 34*(1), 89-101.

Waycaster, P. (2001). Factors impacting success in community college developmental mathematics courses and subsequent courses. *Community College Journal of Research and Practice, 25*, 403-416

Young, D. B., & Ley, K. (2002). Self-efficacy of developmental college students. *Journal of College Reading and Learning, 33*(1), 21-31.

Zeldin, A. L., Britner, S. L., Pajares, F. (2008). A comparative study of the self-efficacy beliefs of successful men and women in mathematics, science, and technology careers. *Journal of Research in Science Teaching, 45*(9), 1036-1058.

Zeldin, A. L., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal, 37*, 215-246.

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology, 25*(1), 82-91.