MATHEMATICS SELF-EFFICACY OF COMMUNITY COLLEGE STUDENTS IN DEVELOPMENTAL MATHEMATICS COURSES

A Dissertation

Presented to

The Faculty of the School of Education

Liberty University

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Education

by

David W. Clutts

October 2010

Mathematics Self-Efficacy of Community College Students in Developmental Mathematics Courses

by David W. Clutts

APPROVED:

COMMITTEE CHAIR	Scott B. Watson, Ph.D.
COMMITTEE MEMBERS	Clarence Holland, Ed.D.
	Wheeler Conover, Ph.D.
CHAIR OF GRADUATE STUDIES	Scott B. Watson, Ph.D.

Abstract

David W. Clutts. MATHEMATICS SELF-EFFICACY OF COMMUNITY COLLEGE STUDENTS IN DEVELOPMENTAL MATHEMATICS COURSES. (Under the direction of Scott B. Watson, Ph.D., Chair of Graduate Studies) School of Education, October, 2010). Mathematics self-efficacy was defined as an individual's beliefs about how he or she would perform a specific math task or in a specific mathematics or related course. Mathematics self-efficacy was differentiated from self-esteem. Previous literature found self-efficacy in general and mathematics self-efficacy in particular to be significantly related to enrollment, retention, and completion. This study used the Mathematics Self-Efficacy Survey to investigate whether age, gender, developmental mathematics course, or developmental mathematics grade were significantly predictive of mathematics self-efficacy among developmental mathematics students course at a Kentucky community college. Multiple linear regression found that none of these variables were statistically significant predictors of mathematics self-efficacy among respondents. The study discussed the resulting implications and made recommendations for future research and practice.

Dedication/Acknowledgement

This dissertation is dedicated first and foremost to the LORD Jesus Christ who saved me and who will never leave me nor forsake me, and who gave me the opportunity to pursue the doctoral degree. It is then dedicated to Melody, my loving wife of 21 years, without whose love and support none of this would have been possible; to my wonderful sons Matthew and Nathaniel, who have been great when Dad had to work instead of play; to my mother, Frances Kay Caudill, for her continuous love and inspiration; to my Uncle David E. Clutts and grandmother Mary L. Clutts (Granny) who have gone on to Heaven before me and who continue to touch my life each day; to Ms. Carolyn Sundy, Dr. W. Bruce Ayers, and Dr. Wheeler Conover at Southeast Kentucky Community and Technical College for bringing me to the show and teaching me so much along the way; to the late Dr. Rebecca Carwile of Liberty University whose passion for the LU Distance Learning Program was contagious; and to the many others who have helped me in many ways great or small--I thank you all.

David Clutts

Putney, Kentucky

October 2010

TABLE OF CONTENTS

Page

LIST OF TABLES

Tables Page

LIST OF ABBREVIATIONS

ABE	Adult Basic Education
ACAD	Academic Factors
ACT	American College Test
ANOVA	Analysis of Variance
APA	American Psychological Association
ASSET	Assessment of Skills for Successful Entry and Transfer
ATT	Attendance
CI	Confidence Interval
COMPASS	Computer-Adaptive Placement Assessment and Support System
CPE	Council on Postsecondary Education
CRS	Future Math Courses Preparedness Imparted by the Course
I/E	Internal/external
INSTR	Instructor-Related Factors
KCTCS	Kentucky Community and Technical College System
MARS	Mathematics Anxiety Ratings Scale (Richardson & Suinn)
MPSS	Mathematics Performance Problems Scale (Dowling)
MSES	Mathematics Self-Efficacy Survey (Betz & Hackett)
MSES-R	Mathematics Self-Efficacy Scale-Revised (Pajares & Kranzler)
MSLQ	Motivated Strategies for Learning Questionnaire (Pintrich)
NADE	National Association of Developmental Educators
NCES	National Center for Education Statistics

NLSMA	National Longitudinal Study of Mathematics Ability
ORG	Organizational Factors
PISA	Programme for International Student Assessment
PRS	Personal, Non-Academic Issues
QEP	Quality Enhancement Plan
RSR	College Resources
SCCM	Social-Cognitive Career Choice Model (Lent, Brown, & Hackett)
SDQIII	Self-Description Questionnaire (Marsh)
SELMA	Self-Efficacy to Learn Mathematics Asynchronously
SES	Socioeconomic status
SME	Science, Math and Engineering
SPSS	Statistical Package for the Social Sciences
SSK	Study Skills
STEM	Science, Technology, Engineering and Mathematics
TSK	Math Task Preparedness Imparted by the Course

CHAPTER ONE: INTRODUCTION

The "little engine who could" said "I think I can, I think I can" (Piper, 1930). However, many community college developmental mathematics students didn't “think they can”. Developmental mathematics students often made statements indicating unpleasant past math experiences, displeasure with being in developmental math course(s), or doubt in their ability to succeed. Developmental courses represented an unexpected investment of time, money and effort for students who did not welcome the added academic and financial burden. Developmental courses did not count toward the student's major. Furthermore, developmental students, like all students, often encountered one or more life changes while attending college: Pregnancy, childbirth, legal issues, marriage, divorce, injury, illness, death in the family, childcare, or care for ill family members or relatives. These changes, added to the issues associated with developmental education, resulted in a unique and significant burden for developmental mathematics students. Proverbs 23:7 (King James Version) said “For as he thinketh in his heart, so is he”, suggesting that thought not only precedes action but molds its results. Mathematics self-efficacy has concerned the relationship between student thought, action, and the resulting degree of academic success.

Background

Developmental education has been a longtime phenomenon. Since the beginning of higher education, some students were "academically weak" or "poorly prepared" (Stephens, 2003, p. 16; Maxwell, 1979, p. 5). In the seventeenth century, Harvard began

admitting underprepared students in the 1600s to boost enrollment and providing some remediation for them. College enrollment and curriculum and the resulting need for entrance requirements, entrance exams and remedial services greatly increased in the nineteenth and twentieth centuries through a variety of legislation and postsecondary initiatives.

Underprepared students were often admitted simply to boost college revenue, as in the case of Harvard. The first and second Morrill Acts of 1862 and 1890 (National Institute of Food and Agriculture, 2009; U.S. Department of Agriculture, 2009) established land grant colleges and agriculture colleges, respectively. The second Morrill Act also prohibited discrimination in enrollment. Women's colleges were founded beginning with Wesleyan in 1836 and Rockford in 1849. The Hatch Act of 1887, supported by both Morrill Acts, added the applied science disciplines to the college curriculum and led to the offering of agricultural extension services and courses (Stephens, 2003). Following World War II, the GI Bill funded college for many returning soldiers and for supplementary services at colleges. The landmark U.S. Supreme Court decision *Brown v. Board of Education* (1954) eliminated separate but equal facilities and de facto segregation, boosting college minority enrollment.

As enrollment grew, the gap between high school preparation and college readiness widened, and the need for developmental resources increased. In the mid-1800s college entry requirements increased so more students arrived at college underprepared (Stephens, 2003). Some colleges established preparatory departments while others offered a degree of supplemental instruction to bring students up to the required entry standards (Stephens, 2003). Entrance requirements and exams began to

be formulated. The University of Michigan set basic entrance requirements in 1870. In 1871 Harvard introduced an entrance exam due to entrants' lack of "grammar and compositions skills" (Stephens, 2003). The New York Regents Exams were introduced in 1878 and during the 1890s the College Entrance Examination Board created testing centers to evaluate college readiness (Stephens, 2003).

Educators began to evaluate secondary and postsecondary curricula. In 1892 the National Education Association commissioned the Committee of Ten, which made recommendations on strengthening secondary curriculum and teacher preparation (Stephens, 2003). During the 1960s, developmental education began to be recognized as a field of its own. Professional initiatives such as the Kellogg Institute, which more fully trained existing developmental educators and the National Association of Developmental Educators (NADE), were established along with professional journals such as NADE's Journal of Developmental Education (Stephens, 2003).

Developmental or remedial courses have remained a widespread postsecondary phenomenon. In a 1996 remedial education study, the National Center for Education Statistics (NCES) stated that "remedial courses in mathematics, writing, or reading were offered by 100% of all public two-year colleges, 81% of all public four-year colleges, and 63% of all private four-year colleges" and that "nationwide, some 41% of freshmen at two-year institutions and 22% of those at four-year institutions were enrolled in developmental courses (Stephens, 2003, p. 27; NCES, 1996). Even more students not enrolled in developmental courses have used some supplemental resources such as tutoring.

College readiness in general and mathematics readiness in particular has remained a great concern in postsecondary education. However, educators have continued to debate the merits of lowering academic standards, and politicians have continued to debate the merits of the costs associated with developmental education. Remedial offerings at four-year postsecondary institutions are prevented or discouraged in at least ten states. Community colleges, then, have increasingly become the providers of postsecondary remedial education (Education Commission of the States, 2002).

Recent developmental education research concerned analysis of existing programming and best practices to improve it. The scope of best practices indicated that developmental education must include all aspects of the college: Administration, admissions and recruitment, hiring and professional development, academic, advising, counseling, and supplemental instruction (SKCTC QEP, 2006). Researchers have identified developmental courses, especially developmental math, as gateway courses with major impact on student access, success, and retention (Haycock, 2002; Hackworth, 2000; Noel-Levitz, 2005).

Greater numbers of students have typically required remediation in mathematics than in reading or writing. Of all Kentucky college entrants, for example, 45.9% had developmental needs in one or more college subjects, 35.4% had developmental needs in mathematics, and 28.6% had developmental needs in English (Council on Postsecondary Education, 2006). Developmental mathematics students were particularly "at-risk" (SKCTC QEP, 2006). Significant numbers of students have placed into or failed to succeed in developmental mathematics courses (SKCTC Office of Institutional Effectiveness, 2006).

Secondary schools have increasingly focused on college readiness, and postsecondary institutions have often instituted mandatory placement policies to assess entrants' college readiness. Twenty-two states have offered high school Science, Technology, Engineering and Mathematics (STEM) initiatives which "provide students with college-readiness assessments in mathematics and/or science" (Education Commission of the States, 2009). Of 47 responding states (excluding Hawaii, Idaho and Montana), twenty states determined college placement policies at the state level in some form, twenty-one states required college entrants who do not meet minimum performance standards to enroll in developmental courses, three states only advised these students to take remedial courses and seven states had a state-mandated placement exam (Education Commission of the States, 2002)

The state of Kentucky instituted a mandatory placement policy in fall 2001 (CPE, 2006). Students that scored less than 18 on the ACT were required to take remedial courses. College entrants were also allowed to take the COMPASS (http://www.act.org/compass/) or ASSET (http://www.act.org/asset/ index.html) placement exams, also published by ACT, Inc., both of which had scores correlated to placement mandates. Students with Algebra Domain scores of 30 - 34 were required to take Intermediate Algebra, and those scoring 16 - 29 were required to take Beginning Algebra. Students with Pre-Algebra Domain scores of 41 - 100 were required to take Beginning Algebra, and those scoring 17 - 40 were required to take Pre-Algebra. Students scoring less than 17 on the Pre-Algebra Domain were referred to Adult Basic Education (ABE) (CPE, 2006; KCTCS Administrative Policies, 2009). Students whose degrees require College Algebra had to complete the entire developmental sequence

(depending on their first placement course), while students whose degrees required only Applied Math were allowed to depart the developmental sequence upon completion of Beginning Algebra. Between 40% and 70% of college entrants in most of the rural eastern Kentucky counties scored below 18 on the ACT math (CPE county data, 2006).

Developmental education research and discussion often included legislation, postsecondary initiatives and professional evaluations of curricula. However, research in the educational field often overlooked the perspective of the developmental student, particularly the developmental mathematics student, who is the client of the remediation efforts at postsecondary institutions, particularly community colleges. Evaluation of this subjective aspect began in the field of social cognitive theory and the research of Dr. Albert Bandura. Social cognitive theory centered on human agency as the vehicle of change (termed an "agentic perspective") and the efficacy belief system as the foundation of human agency (Bandura, 2004). Bandura developed and defined the concept of self-efficacy as he sought a view of human agency in decision-making that was opposed to the prevailing social cognitive theory in the 1960s. Bandura's explanation for human agency centered on an internal locus of control based on intentionality, forethought, self-reaction, and self-reflection.

Cervone (2000), who cited Bandura (1977) and Cervone & Scott (1995), said the study of psychological control and self-referent thinking converged in research on perceived self-efficacy. Researchers have proven the value of self-efficacy as related to multiple domains of human endeavor (Cervone, 2000). These domains included technology/computer literacy, writing, choice of academic major, career choice, teacher preparation and mathematics learning (Center for Positive Practices, 2006).

Bandura (1994) cited four sources of self-efficacy: Mastery experiences, vicarious experiences provided by social models, social persuasion and reliance on somatic and emotional states. Pajares (2002) called the four sources mastery experiences, vicarious experiences, social persuasion and physiological states. Mastery experiences were the "interpreted results of purposive performance". Vicarious experience concerned "the effects produced by the actions of others". Social persuasion concerned the "social messages" received from others. Physiological states referred to "anxiety, stress, arousal, fatigue and mood".

Bandura (1994) stated that self-efficacy has affected human functioning through "four major psychological processes": Cognitive, motivational, affective and selection. These concerned thinking processes, reflection of motivation level in course of action, emotional states and reactions, and exercise of influence over one's own motivation.

Self-efficacy concerned "perceived capabilities to perform an activity. It had to be domain-, context-, and task-specific. It was dependent on mastery performances rather than normative criteria, and self-efficacy beliefs were typically assessed prior to engaging in a particular task or activity (Zimmerman & Cleary (2006). Self-efficacy as it pertained to self-referent thinking involved forethought, performance control, and self-reflection (Zimmerman & Cleary, 2006). Pajares & Miller's (1994) path analysis agreed that self-efficacy was an antecedent of the learning experience.

Bandura focused on self-efficacy in a variety of domains, but researchers like Pajares, Betz and Hackett have focused specifically on self-efficacy as it related to math. Mathematics self-efficacy has been defined as "a situational assessment of an individual's confidence in her or his ability to successfully perform or accomplish a particular

mathematical task or problem" (Kiamanesh, Hejazi, & Esfahani, 2005; Hackett & Betz, 1989; Pajares & Kranzler, 1997). Self-efficacy beliefs have been known to have a strong predictive role in mathematics problem solving, which supported Bandura's hypothesis of this role (Pajares & Miller, 1994; Pajares & Kranzler, 1995). Mathematics self-efficacy research has also indicated gender differences (Junge & Dretzky, 1995; Lent, Lopez & Bieschke, 1991; Mwamwenda, 1999)

Specificity has been considered the key to measuring mathematics self-efficacy. That is, the instrument had to be very specific to the situation and need to be investigated (Pajares, Hartley, & Valiante, 2001; Bandura, 2005). Several instruments were related either implicitly or explicitly to mathematics self-efficacy. These have been discussed in chapter 2. Researchers often discussed the instruments in general terms, or their results in specific terms, but it remained difficult to obtain a copy of specific instruments.

The Mathematics Self-Efficacy Survey (Betz & Hackett, 1983), in addition to being the most readily available instrument, also had some published, accessible validity data (Mindgarden, Inc., available online at www.mindgarden.com). None of the other instruments had either a free or for-pay source that the candidate could find. The Australian MSES (Marat, 2005) seemed the next most well developed instrument. It had been used some in Australia and New Zealand, but not as widely as the Betz-Hackett MSES. Pajares & Kranzler (1997) created a revised MSES (MSES-R), based on the Betz-Hackett instrument. This study used the Betz-Hackett MSES both for easy, complete availability, frequent usage, and in-depth validity data.

Problem Statement

Student ability to meet postsecondary academic and institutional goals depended on necessary increases in developmental mathematics course success. Student failure in developmental mathematics courses represented "a primary barrier to retention" (Noel-Levitz, 2005). Research has connected mathematics course success, mathematics self-efficacy and subsequent mathematics success (Bandura, 2005; Pajares, 2006; SKCTC QEP, 2006). Maxwell (1997) noted "researchers have found that high-risk students with low self-efficacy fail to learn even under optimal conditions" (p. 143). At-risk students often possessed an exterior locus of control while their non-developmental counterparts generally possessed an internal locus of control that more positively affects academic success (SKCTC QEP, 2006, p. 23; Armington, 2002; Maxwell, 1997).

Purpose Statement

The purpose of this study was to evaluate the mathematics self-efficacy of community college developmental mathematics students and to determine if gender, age, course, or grade were predictive of mathematics self-efficacy. The resulting implications were considered according to their impact on future research and practice in developmental mathematics education.

Research Questions

Research questions for this study were as follows:

(1) Do gender-based differences in mathematics self-efficacy exist in developmental mathematics courses at the community college?

(2) Do age-related differences in mathematics self-efficacy exist in developmental mathematics courses at the community college?

(3) Do differences in mathematics self-efficacy based on the level of developmental mathematics course exist at the community college?

(4) Does the grade received in a developmental mathematics course at the community college reflect students' levels of mathematics self-efficacy?

Research Hypotheses in Null Form

The researcher expected that, based on the research questions, age, gender, course, and grade would be predictive of the mathematics self-efficacy levels of developmental mathematics students at the community college. Null hypotheses were as follows:

1. Age - H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and age.
2. Gender - H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and gender.
3. Course1- H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and 16-week or first bi-term developmental mathematics course taken.
4. Course2- H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and second bi-term developmental mathematics course taken.
5. Grade1- H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and 16-week or first bi-term developmental mathematics course grade.

6. Grade2 H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and second bi-term developmental mathematics course grade.

Identification of Variables

Independent variables were age, gender, course, and grade. Age, gender, course and grade information was obtained via PeopleSoft, the community college's data system. Mathematics self-efficacy information was obtained via the Mathematics Self-Efficacy Survey (Betz & Hackett, 1983).

Age was the respondent's numeric age. Gender was coded 0 for female and 1 for male. Course was MT 55 Pre-algebra, MT 65 Beginning Algebra, or MT 120 Intermediate Algebra. Courses were coded 0 for MT 55, 1 for MT 65, and 2 for MT 120. Students who took bi-term courses may have had two courses per semester instead of one, as reflected by the variables Course1 and Course2. Course1 was the course taken during the traditional 16-week semester or during the first eight-week bi-term. Course2 was the course taken during the second eight-week bi-term. Respondents therefore may have had one (16-week, first bi-term, or second bi-term) or two (first bi-term and second bi-term) developmental mathematics courses during the semester. Likewise, students could have received one or two grades per semester as reflected by the variables Grade1 and Grade2. Grades were coded E = 0, D = 1, C = 2, B = 3, and A = 4.

The Mathematics Self-Efficacy Survey (MSES) (Betz & Hackett, 1983) was administered as a pretest and posttest. The MSES instrument was placed into Appendix A.

Statistical calculations performed included multiple linear regression for hypothesis testing, and frequency calculations to obtain basic counts and percentages. Research-based recommendations were developed for developmental mathematics program design and future research.

Definitions

Academic Success. Attainment of a final course grade of A, B, or C. A grade of D was passing but has not usually been considered indicative of course success (SKCTC QEP, 2006).

Agentic perspective. This term has been used in social cognitive theory to refer to human agency (an internal locus of control) as a vehicle of change (Bandura, 2004). That is, the individual, rather than external forces, was considered the catalyst for changes in the individual's life.

ACT. The American College Test published by ACT, Inc. and used for college placement. The test has been used to assess "high school students' general educational development and their ability to complete college-level work" (ACT Inc., 2008. Retrieved from http://www.act.org/aap/).

ASSET. The ASSET, a paper-and-pencil test published by ACT, Inc., has been used to for “placing students into postsecondary institutions" and has been used by "nearly 400 community and technical colleges” (ACT Inc., 2008. Retrieved from http://www.act.org/asset/index.html).

At-risk students. Students who test into “two or more developmental education classes” were considered “at-risk” students (SKCTC QEP, 2006, p. 35).

COMPASS. The COMPASS, published by ACT, Inc., has been used as a "computer adaptive placement test" equivalent to the ASSET (ACT, Inc., 2008. Retrieved from http://www.act.org/compass/index.html). Scores have been translated between COMPASS and ASSET. The difference was that as the student completes items correctly, the questions became more difficult, but as the student completed items incorrectly, the questions became less difficult.

Developmental education. Boylan (2002, p.3) defined developmental education as "courses or services provided for the purpose of helping underprepared college students attain their academic goals. Developmental mathematics, then, referred to courses or services provided for the specific goal of succeeding in degree-level mathematics courses.

Mandatory Placement. This term has been used to refer to the policy of placing students into course placement based on entrance exam results. More specifically, this study referred to Kentucky's mandatory placement policy as stated in the KCTCS Administrative Policy 4.13.1.1 (2009, retrieved from http://www.kctcs.edu/employee/policies/volumeII/volII4-13.pdf).

Mathematics Self-efficacy. Bandura (2005) defined perceived self-efficacy as "people's beliefs in their capabilities to produce given attainments". Kiamanesh, Hejazi & Esfahani (2005), citing Hackett & Betz (1989) and Pajares & Kranzler (1997), defined mathematics self-efficacy as "a situational assessment of an individual's confidence in her or his ability to successfully perform or accomplish a particular mathematical task or problem". Mathematics self-efficacy, then, has concerned whether mathematics students believed in their abilities to meet the course objectives. Pajares (2002) clearly

differentiated self-efficacy and self-esteem (or self-concept). Pajares (2002) found self-esteem instead "pertains to the evaluation of self-worth, which depends on how the culture values the attributes one possesses and how well one's behavior matches personal standards of worthiness". Both Pajares (2005) and Bandura (2005) found self-efficacy predictive of future academic success.

Social cognitive theory. Social cognitive theory "identifies human behavior as an interaction of personal factors, behavior and the environment" and "provides a framework for understanding, predicting, and changing human behavior" (Bandura 1977; Bandura 1986)(Retrieved from http://www.istheory.yorku.ca/socialcognitivetheory.htm).

Specificity. This term has been used to refer to the degree to which an instrument specifically addresses and is appropriate for the situation that it is used to assess.

CHAPTER TWO: REVIEW OF THE LITERATURE

The review of the literature included developmental education research and social cognitive theory research, specifically self-efficacy research. Studies of developmental mathematics students' self-efficacy represented a convergence of these fields. The review proceeded first with research from developmental education, then social cognitive theory, self-efficacy, and finally mathematics self-efficacy and related research. Mathematics self-efficacy instruments were discussed separately. Findings were grouped by major researchers whenever possible, as common or related findings caused much overlap in citations. Historical background information was integrated into the discussion of findings. Related efficacy research was discussed last, and the results of the literature review were summarized.

Theoretical Background

Remedial education and developmental education have not been necessarily synonymous (Boylan, 2001), although the term "remedial" has sometimes been used interchangeably with "developmental" when referring to developmental students or courses (Boylan & Saxon, 1999). For the sake of clarity and uniformity, this study referred to programming for underprepared students as "developmental". Developmental education has been considered a "more sophisticated concept" that combined elements "drawn from cognitive and developmental psychology" including a wide range of services to develop personal and academic growth (Boylan, 2001). Students in such programs have been referred to as "underprepared" rather than "remedial" to avoid negative connotations (Ring, 2001; Roueche & Roueche, 1999).

Historical Background

American colleges and universities have always admitted underprepared students (Boylan, 2001; Stephens, 2003). Community colleges, since their establishment in the early twentieth century, have offered developmental courses (Boylan & Saxon, 1999). The most recent developmental education study by the National Center of Education Statistics (NCES, 1996) said that 99% of the nation's public community colleges offer one or more developmental courses.

Boylan (2001), however, disagreed with those who believed developmental education should have been relegated entirely to the community colleges. He warned that universities following that logic would have either have insufficient enrollment or significantly decreased courses and services. The necessary relocation of developmental services to the community colleges would have caused a "dislocation of services" (Boylan, 2001). Community colleges would not have been able to handle the sudden influx of a massive number of underprepared students, and those students denied entrance to public universities might have chosen to attend less selective private colleges or colleges in other states rather than community colleges (Boylan, 2001). These students, once completing community college, were not guaranteed to subsequently enroll at a four-year college or university, and were significantly less likely to graduate with baccalaureate degrees than those who enter a four-year school (Boylan, 2001; Grubb, 1991). Successful remediation at the community college included an institution-wide commitment including administrative support, allocation of resources, and institutional acceptance of remediation as a valid part of the college's mission (Roueche & Roueche, 1993, 1999; Roueche & Baker, 1987).

The large number of underprepared students in postsecondary education served as evidence of a great need for developmental education (Boylan, 2001). Furthermore, developmental education was necessary for colleges to promote economic development and maintain sufficient levels of enrollment to continue operations (Boylan, 2001). Developmental education has strengthened rather than diluted academic standards and has been part of the solution to rather than the problem of having large amounts of underprepared students (Boylan, 2003; Boylan & Saxon, 1999).

Developmental Education Research Trends

Boylan & Saxon (1999) found two general trends in developmental education research: Methods and techniques characterizing effective instructional strategies (best practices) and components and structure of developmental programs. Developmental education has often been considered unworthy of research in its own right (Boylan & Saxon, 1999; Grubb, 1998). As a result, there have been few attempts to identify best practices in postsecondary developmental education and methodology errors caused much previous research to be disregarded upon review (Boylan & Saxon, 1999).

Between 1968 and 1978, Roueche and his colleagues were the most prolifically published developmental education researchers (Boylan, 1999). Roueche's findings were subsequently validated by many researchers. Roueche initially investigated the applicability of learning theory to developmental courses (Boylan, 1999; Roueche, 1968; Roueche & Wheeler, 1973). Roueche (1968, 1978) found that developmental courses should include clear goals and objectives which in turn would improve student performance (Boylan & Saxon, 1999; Donovan, 1974; Cross, 1976; Kulik & Kulik, 1991; Boylan, Bonham, Claxton, & Bliss, 1992). The clarity of goals and objectives facilitated

a "clear course structure" (Boylan & Saxon, 1999). A clearly defined philosophy should have formed the basis of any developmental programs (Boylan & Saxon, 1999; Roueche & Snow, 1977; Casazza and Silverman 1996; Maxwell, 1997; Boylan & Saxon, 1998).

Best Practices

Serving at-risk students. Roueche & Roueche (1993) made multiple recommendations for community colleges to serve at-risk students. Recommendations included offering proactive pre-enrollment activities, requiring orientation for entering students, abolishing late registration, making basic skills assessment and placement mandatory, eliminating dual enrollment for basic skill and regular academic courses, encouraging working students to reduce academic loads, offering more comprehensive financial aid and work-study opportunities, incorporating problem-solving and literacy activities into all courses, and regularly evaluating student programming and outcomes and disseminate the information.

Mastery learning. Roueche emphasized "mastery learning" (Boylan & Saxon, 1999), which incorporated small units of instruction and frequent testing, allowing mastery of each unit before progressing to the next (Cross, 1976; Kulik & Kulik, 1991). Mastery learning improved completion, grades, and retention levels for developmental students (Boylan & Saxon, 1999; Cross (1976), Kulik and Kulik (1991). Developmental students taught using mastery learning were more likely to succeed at a higher academic level than those taught without mastery learning (Boylan & Saxon, 1998).

Teaching methods. Developmental students benefited from a variety of teaching methods, such as class discussions, group projects and mediated learning rather than traditional lecture (Boylan & Saxon, 1999; Roueche, 1968; Roueche & Wheeler, 1973;

Cross, 1976; Kulik & Kulik, 1991; Casazza & Silverman, 1996). This largely related to the learning styles of developmental students, who had been more visual or hands-on than other students (Boylan & Saxon, 1999; Canfield, 1976; McCarthy, 1982; Lamire, 1998).

Learning communities. Learning communities improved the performance of developmental students (Boylan & Saxon, 1999), and increased their attitudes toward learning, course completion (Tinto, 1997) and retention (Tinto, 1998). Students and courses were also sometimes combined into cohorts linked together by a common theme and including instructor collaboration (Adams & Huneycutt, 1999). Paired courses increased student performance and satisfaction (Commander, Stratton, Callahan, & Smith, 1996).

Strategic learning. An emphasis on strategic learning also helps developmental students (Weinstein, 1982). This involves explicitly developing student metacognition (reflection on ones' own thinking processes) so students can recognize when they are not comprehending and take steps to improve their comprehension. A comprehensive strategic learning model (Weinstein & Rogers, 1985; Weinstein, 1988), when integrated into the curriculum, increased learning, grades and retention (Weinstein, Dierking, Husman, Roska, & Powdrill, 1998).

Effective courses and programs. Effective developmental courses have been based on sound cognitive theory (Boylan & Saxon, 1999; Roueche, 1973; Roueche & Wheeler, 1973; Roueche & Kirk, 1974; Bruner, 1976; Stahl, Simpson, & Hayes 1992; Casazza & Silverman 1996). Developmental programs should have been centralized and separated from other academic divisions (Boylan & Saxon, 1999; Roueche & Kirk, 1974; Roueche & Snow, 1977; Donovan 1974; Boylan, Bonham, Claxton, & Bliss 1992).

Although student success and retention were more likely to increase in centralized programs, however, decentralized programs which have strong coordination of developmental activities and strong communication between developmental course teachers were just as effective as centralized efforts (Boylan, Bliss, & Bonham, 1997).

Mandatory assessment and placement. Effective developmental programs incorporated mandatory assessment and placement (Boylan & Saxon, 1999; Roueche & Baker, 1987; Roueche & Roueche, 1993; Roueche & Snow, 1977; Casazza & Silverman, 1996; Maxwell, 1997; Morante, 1987; Morante, 1989). However, subsequent research suggested only mandatory assessment was "clearly associated with student and program success" (Boylan & Saxon, 1999; Boylan, Bonham, Claxton, & Bliss, 1992; Boylan, Bliss, & Bonham, 1997). Early identification of at-risk students was important (Adelman, 1999; Kulik, Kulik, & Schwalb, 1983), but mandatory *placement* had a statistically significant negative impact on student retention (Boylan, Bonham, & Bliss, 1994). This inconsistency may have resulted because developmental students not enrolled in optional developmental programs were not counted as developmental attrition statistics, whether or not they completed their studies (Boylan & Saxon, 1999; Boylan, Bliss, & Bonham 1997). Also, students who voluntarily participated in developmental programs may have been more highly motivated (Boylan & Saxon, 1999; Boylan, Bliss, & Bonham 1997). However, this was not an argument against mandatory placement, as "fewer than 10% of those needing remediation will survive in college without it" (Boylan & Saxon, 1999; Cross, 1976). Remediation with mandatory placement increased student success more than remediation without mandatory placement (Boylan & Saxon, 1999).

Entry and exit standards. Exit standards for developmental courses and entry

requirements for non-developmental courses should have been aligned (Boylan, Bonham, Claxton, & Bliss 1992; Roueche & Roueche, 1999). Boylan, et. al., (1996) found that many institutions failed to ensure this alignment. Students at institutions where this alignment was facilitated were more likely to succeed (Boylan & Bonham, 1992).

Structured learning. Developmental students required a high degree of structure for their learning experiences (Boylan, 1999; Roueche, 1973). Structured environments provided the "most benefit to the weakest students" (Boylan & Saxon, 1999; Cronbach and Snow 1977) who lacked the "organizational schema" necessary to understand "many educational concepts" (Boylan, 1999; Cross, 1976; Kulik & Kulik, 1991; Boylan, Bonham, Claxton, & Bliss, 1992).

Orientation. Freshmen orientation helped students, many of whom were first-generation college students, to understand the expectations of higher education (Upcraft & Gardner, 1989). Students who participated in such orientations were more likely to succeed than those who did not participate (Gardner, 1998).

Critical thinking. Developmental students may not understand the "types of thinking required for success in college courses" (Boylan & Saxon, 1999). Courses, programs and activities designed to enhance critical thinking skills improved student performance in reading and writing (Chaffee, 1992; St. Clair, 1994-95), attitudes toward learning (Harris & Eleser, 1997), grade point averages and retention (Chaffee, 1998).

Counseling. Effective developmental programs had a "strong counseling component" (Boylan & Saxon, 1999; Roueche & Mink, 1976; Roueche & Snow, 1977; Keimig 1983; Kulik, Kulik, & Schwalb, 1983; Boylan, Bonham, Claxton, & Bliss, 1992; Higher Education Extension Service, 1992; Casazza & Silverman, 1996). Counseling

was integrated into the program's structure (Kiemig, 1983), and was based on the program's goals, objectives (Casazza & Silverman, 1996) and sound principles of developmental theory (Higher Education Extension Service, 1992). It was implemented early in the semester (Kulik, Kulik, & Schwalb, 1983) by counselors specifically trained to work with developmental students (Boylan, Bliss, & Bonham, 1997).

Supplemental instruction. Tutoring has been found valuable to developmental students (Roueche & Snow, 1977) but Maxwell (1997) argued that results were inconclusive. This inconsistency was clarified by finding that the "effectiveness of tutoring is strongly influenced by the quality and the amount of training received by tutors" (MacDonald, 1994; Casazza & Silverman, 1996; Boylan, Bliss, & Bonham, 1997). Programs with increases in student success included a strong tutor training component (Boylan, Bonham, Claxton, & Bliss, 1992).

Effective developmental programs included supplemental instruction via small groups led by a student leader who attended the course (Boylan & Saxon, 1999). Underprepared students enrolled in supplemental instruction had higher retention rates than those who were not (Ramirez, 1997). Student enrolled in courses that utilized supplemental instruction often outperformed students enrolled in traditional courses (Martin & Arendale, 1994). Video-based supplemental instruction was also "particularly effective with underprepared students" (Martin & Arendale, 1998).

Computer-based tutoring also had "several positive effects": Students were able to learn more in less time, slightly raised grades on post-tests, and improved their attitudes toward learning ((Boylan & Saxon, 1999; Kulik & Kulik, 1991; Roueche & Roueche, 1999). However, Bonham (1992) found that the effectiveness of computer-

based instruction declined when the computer was used as the primary mode of instruction. Students found more success when the computer was used only as a supplemental resource (Bonham, 1992; Maxwell (1997); (Boylan & Saxon, 1998). Integration of classroom and laboratory instruction was associated with developmental student success (Boylan, Bliss, & Bonham, 1997; Boylan & Saxon, 1998).

Faculty training. Specific training was important to faculty working with developmental programs (Casazza & Silverman, 1996; Maxwell, 1997; Roueche, 1973; Boylan, Bliss, & Bonham, 1997). Boylan, Bonham, Claxton, & Bliss (1992) found that success, grades, and retention were increased where faculty and staff training were emphasized.

Systematic evaluation. Developmental education programs evaluated systematically on a regular basis were more effective than those that were not (Boylan & Saxon, 1999; Donovan, 1974; Roueche & Snow, 1977). Evaluation was positively related to student grades and long-term retention (Boylan, Bonham, Claxton, & Bliss, 1992). Program effectiveness was greater when evaluation was both formative and summative and when it was subsequently used to inform program delivery (Boylan, Bliss, & Bonham, 1997; Boylan & Saxon, 1998).

Legislation and Reform

Boylan (2001) showed little confidence in school reform initiatives, stating that they were not likely to improve the quality of high school graduates in the foreseeable future". Passing legislation did not equal finding a solution, and massive school reform expenditures have "failed to significantly improve the quality of high school graduates" and have not significantly improved ACT and SAT scores (Boylan, 2001; Hodgkinson,

1993, p. 47). Boylan (2001) expected the number of non-traditional students (those who enrolled in college later rather than immediately following high school) to continue to increase, further widening the gap between high school exit requirements and college entrance requirements and making high school reform efforts increasingly more irrelevant.

Many institutions failed to use the available research on best practices (Boylan & Saxon, 1999). Applying research to developmental programs increased the value of the programs (Boylan & Saxon, 1999; Claxton, 1992). Baily, Jeong, & Cho (2008) found that one-half of all students referred to developmental education did complete the developmental course sequence and subsequently successfully complete their first non-developmental class. Most of these students were lost early in the sequence and most failed because they never enrolled in their first developmental course or a subsequent developmental course rather than because they dropped out sometime within the sequence. Early counseling and guidance were essential if students were to remain in the developmental program long enough for its initiatives to have a positive effect (Baily, Jeong, & Cho, 2008).

McCabe (2000) suggested that the widespread perception, especially among politicians, that developmental programs were not successful has been based on a failure to recognize the disparity between high school exit requirements and college entrance requirements. He suggested that perhaps definitions of success should be widened. Although developmental students did not necessarily go on to complete bachelor's degrees (Boylan, 2001; Grubb, 1991), in nine years after graduation almost 90 percent would be employed above entry level with only two percent out of work. Nonetheless,

McCabe (2000) stated that developmental programs have historically been a failure for those underprepared students who are "seriously deficient", defined as "students required to take at least one developmental course before the standard developmental course". For example, some students needed adult education remediation to prepare to take even the most introductory college developmental course.

Opponents of high developmental education expenditures failed to realize that "only one percent of the higher education budget is spent on remediation" and "only four percent of the federal student financial aid" has been spent there (McCabe, 2000). McCabe characterized developmental education as the "most productive program we have", affording opportunity and access in keeping with the nation's demography and economy. McCabe also suggested that developmental education, rather than being detrimental to academic quality, was actually essential in maintaining quality.

Developmental testing and placement helped to assure that students actually were ready when entering degree-level courses. McCabe also stated that college faculty who did not value developmental education reasoned only from the perspective of their discipline and teaching experiences, rather than from the perspective of the larger society, and that teaching underprepared students required more effort. McCabe (2000), like Boylan & Saxon (1999), noted that sufficient funding (institutional commitment) was essential to effective developmental programs. Also, like Boylan (2000), McCabe did not believe K-12 initiatives would make college-level developmental programs obsolete.

McCabe (2000) noted that community colleges often did not make use of the available research, and suggested that they must make developmental education an institutional priority, vigorously making the case for developmental education funding to

the public and legislators. McCabe also suggested that testing and placement should be diagnostic, relating individual deficiencies to developmental program learning. McCabe (2000) expressed surprise at how far behind ethnic minorities were compared to non-minorities. McCabe (2000) stated in *No One to Waste*, a national study of community college developmental programs, that "helping under-prepared students may be the most important function that community colleges play in American life."

Social Cognitive Theory

Self-efficacy research originated with Dr. Albert Bandura in the field of social cognitive theory. Social cognitive theory centered on human agency as the vehicle of change (an agentic perspective) and the efficacy belief system as the foundation of human agency (Bandura, 2004). In other words, it was the individual, with an internal locus of control, working to create change for themselves, based on their self-efficacy beliefs, rather than change having come about as the result of external forces. Belief in ability to produce desired effects produced incentive to act or persevere in the face of adversity.

Social cognitive theory identified four core features of human agency: Intentionality, forethought, self-reactive elements, and self-reflective elements (Bandura, 2004). Intentionality concerned the intentions, action plans and strategies for realizing them. Forethought concerned goals and anticipated outcomes to guide and motivate efforts. Self-reactive elements consisted of the adoption of personal standards and monitoring and regulating actions by self-reactive influence. Self-reflective elements consisted of reflection on efficacy, the soundness of thoughts and actions, the meaning of the pursuits, and the making of necessary adjustments.

Bandura's theory stated that "psychological procedures, whatever their form, alter the level and strength of self-efficacy" (Bandura, 1977). He found the contributions of self-beliefs as a determinant of human behavior to be a missing link in social cognitive theory research (Pajares, 2002). Bandura sought a paradigm shift from the psychodynamic model of human behavior prevalent in the 1950s. Variants of this-model shared three characteristics (Bandura, 2004). First, the causes of behavior were not seen as residing within the individual. Second, behavior deviating from prevailing social norms was treated as a kind of "disease". Third, practitioners relied heavily on the interpretive interview as the vehicle of change and provider of client insight. That is, the practitioner would interpret data and provide insight to the individual, contributing to the perception that causality and insight must come from external sources.

In the 1960s, viewpoints on the causes of behavior shifted to transactional social dynamics (personal, behavioral, environmental). Troublesome behavior was represented as divergent rather than diseased, and action-oriented treatments replaced interpretive interviews (Bandura, 2004). Pajares (2002) said it this way: "People are viewed as self-organizing, proactive, self-reflecting and self-regulating rather than as reactive organisms shaped and shepherded by environmental forces or driven by concealed inner impulses". The determinants of human behavior included both personal and environmental factors (Pajares, 2002).

The importance of this shift was the modification in the content, locus, and agent of change (Bandura, 2004). Guided mastery experiences were used to equip people with competencies, enabling beliefs and social resources. Treatments were carried out not in the practitioner's office, but in the locations where the problems arose: In homes,

schools, and the larger community. Talented people implemented change programs under professional guidance; professionals were not considered the exclusive dispensers of treatments. Self-efficacy theory was the final necessary component to the "research puzzle" (Bandura, 2004).

Self-efficacy

The study of psychological control and self-referent thinking converged in research on perceived self-efficacy (Cervone, 2000; Bandura, 1977; Cervone & Scott, 1995). Cervone (2000) said two research questions have been solved through empirical study: That self-efficacy had a direct causal relationship to behavior change (Borkovec, 1978; Eysenck, 1978; & Wolpe, 1978) and that self-efficacy was a "critical cognitive mechanism" of change (Reiss, 1991). Researchers subsequently proved the value of self-efficacy as related to multiple domains of human endeavor (Cervone, 2000). These domains included technology/computer literacy, writing, choice of academic major, career choice, teacher preparation and mathematics learning (Center for Positive Practices, 2006).

Bandura (1994) defined perceived self-efficacy as "people's beliefs in their capabilities to produce effects", later revising the definition to include "people's beliefs in their capabilities to produce given attainments" (Bandura, 2005). Bandura (2005) described the influence of perceived self-efficacy on "human self-development, adaptation and change". Self-efficacy was differentiated from self-esteem. Self-esteem "pertains to the evaluation of self-worth, which depends on how the culture values the attributes one possess and how well one's behavior matches personal standards of worthiness" (Bandura, 2004). The transition from rote performance as in blue collar

labor to information age skills "placed a premium on the role of personal efficacy in educational self-development" (Bandura, 2004).

Pajares (2002) assumed that personal self-efficacy beliefs were "the very foundation of human agency", "vital forces in their success or failure in all endeavors", and "critical forces in their academic achievement". Pajares (2002), like Bandura (1994) and Marsh, Walker, & Debus (1991), emphatically differentiated self-efficacy and self-concept. Pajares & Miller's (1994) path analysis agreed that self-efficacy was an antecedent of the learning experience.

Zimmerman and Cleary (2006) also differentiated self-efficacy from self-concept, self-esteem, outcome expectations, and perceived control. Self-efficacy had four characteristics (Zimmerman & Cleary, 2006). First, self-efficacy concerned "perceived capabilities to perform an activity" rather than on personal or psychological characteristics. Second, it was domain-, context- and task-specific. Third, it was dependent on mastery performance rather than normative criteria. Fourth, self-efficacy beliefs were "typically assessed prior to engaging in a particular task or activity".

Self-efficacy as it pertained to self-referent thinking involved a three-fold cycle: Forethought (processes preceding action), performance control (processes occurring during learning), and self-reflection (processes that occur post-performance) (Zimmerman & Cleary, 2006). The forethought phase included goal setting and strategic planning while the self-reflective phase included self-evaluation and attributions (Zimmerman & Cleary, 2006).

Bandura (1994) cited four sources of self-efficacy: Mastery experiences, vicarious experiences provided by social models, social persuasion and reliance on

somatic and emotional states. Pajares (2002) defined the four sources. Mastery experiences were the "interpreted results of purposive performance". The culminating activity in a learning situation would have been a "mastery experience". It allowed students to apply concepts and prove what they'd learned. Vicarious experience concerned "the effects produced by the actions of others". Social persuasion concerned the "social messages" received from others. Physiological states referred to "anxiety, stress, arousal, fatigue and mood".

Bandura (1994) further stated that self-efficacy affected human functioning through "four major psychological processes": Cognitive, motivational, affective and selection. These processes concerned, respectively, thinking processes; reflection of motivation level in course of action; emotional states and reactions; and exercise of influence over one's own motivation.

Efficacy beliefs affected academic achievement through a variety of psychosocial influences: Parental sense of academic efficacy and child-related aspirations, and children's perceived social efficacy and perceived self-regulatory efficacy (Bandura, 1996). Bandura (2001) found that early adolescents' perceived efficacy rather than actual academic achievement determined perceived occupational self-efficacy which in turn predicted career choices. Path analysis revealed that self-efficacy played a key role in writing-course attainment (Bandura & Zimmerman, 1994).

Perceived affective self-regulatory efficacy increased efficacy to manage academic development, resist social pressures to engage in antisocial activities, and have empathy for others (Bandura, 2003). It was mediated by "behavioral forms of self-efficacy". Perceived empathic self-efficacy indicated prosocial behavior, low

delinquency, and a higher chance for depression in females. Bandura (2008) found a decline in self-regulatory efficacy from junior high to senior high school. Where the decline in self-regulatory efficacy was lesser, there was greater academic achievement and retention. Socioeconomic status, mediated by junior high grades, contributed to high school grades and to dropping out of school. Perceived filial self-efficacy (adolescents' ability to manage parental relationships) consistently predicted their satisfaction with-family life, including more open communications with parents, increased acceptance of parental monitoring, and less likelihood of discord escalation.

Bandura (2006) found "gender differences in perceived occupational efficacy, career choice, and preparatory development". Both males and females performed equally well academically, yet boys reported higher efficacy in science and technology careers while girls reported higher efficacy for "social, educational and health services" (Bandura, 2006; Betz, 1994; Lewin, 1998). However, women in majors related to science, technology, engineering and mathematics (STEM) perceived "additional gender-based obstacles" to their career path (Steele et. al., 2002).

Females also contended with gender-related biases from their families, schools, mass media, and organizational and societal systems (Bandura, 2006; Bandura, 1997; Bussey & Bandura, 1999; Hackett & Betz, 1981). Bandura (2006) suggested modeling coupled with mastery experiences increases females' efficacy in educational and occupational domains where low self-efficacy previously existed (Betz & Schifano, 2000; Gist, Schwoerer, & Rosen, 1989; Schunk & Lilly, 1984). However, gender characteristics could not be automatically imputed to all members of either diverse gender group (Bandura, 2006; Hackett, 1985).

Pajares found gifted middle school mathematics students to have higher levels of mathematics self-efficacy than non-gifted students (Pajares, 1996; Pajares & Graham, 1999). Another of his studies showed ability and self-efficacy to have strong direct effects on performance (Pajares & Kranzler, 1995). Self-efficacy beliefs had a strong predictive role in mathematics problem solving, which supported Bandura's hypothesis of this role (Pajares & Miller, 1994; Pajares & Kranzler, 1995).

Pajares & Kranzler (1994) used path analysis to test the influence of math self-efficacy and general mental ability on math-solving performance of high school students. Ability and self-efficacy had strong direct effects on performance. Ability had a strong direct effect on self-efficacy, which largely mediated the indirect effect of ability and background on performance. Self-efficacy had a strong direct effect on anxiety, which in turn had a weak direct effect on performance. Females reported higher anxiety, but the genders did not differ in ability, self-efficacy, or performance. Most students were overconfident about their mathematics capability, similar to the findings by Marat (2005). Results supported Bandura's (1986) hypothesis of the role of self-efficacy in social cognitive theory.

Pajares & Miller (1994) found no differences in self-efficacy resulting from different forms of assessment (multiple choice and open-ended), although those who took the multiple choice test scored higher and had better calibration of ability. Pajares &-Miller (1995) found that students' reported confidence to answer math problems was a greater predictor of performance than their math-related tasks or math-related courses self-efficacy.

Pajares & Miller (1994) conducted a path analysis to "test the predictive and

mediational role of self-efficacy beliefs in mathematical problem solving". They conducted the study with 350 undergraduates (229 women and 121 men) at a large southern university. One hundred thirty-seven were education majors while 213 represented a variety of majors. Pajares & Miller utilized six different instruments to test six different parameters: Mathematics self-efficacy (Dowling's Mathematics Confidence Scale, 1978); perceived usefulness of mathematics (adapted from Shell, Murphy, & Bruning, 1989); mathematics anxiety (math anxiety scale by Betz (1978), which was adapted from the Fennema-Sherman Mathematics Attitude Scales); math self-concept (math scale of the SDQIII); prior experience (specific instrument was not listed); math performance (Mathematics Problems Performance Scale). Pajares and Miller concluded that math self-efficacy was more predictive of problem solving than math self-concept,-perceived usefulness of mathematics, and prior mathematics experience, or gender. Their results supported Bandura's (1986) hypothesis concerning the role of self-efficacy in social cognitive theory. The resultant path analysis showed that self-efficacy was an antecedent to the learning experience.

Pajares, Urdan and Lapin (1997) administered attitude measures and a mathematics performance measure to eighth graders. They found that task and ability goals were moderately related. Task goals were strongly and favorably related to performance and motivation variable. They were positively related to self-efficacy, self-concept, grade point average, persistence, importance, and self-efficacy for self-regulated learning, and negatively related to anxiety. Ability goals were unrelated or had a weak positive correlation with motivation and performance. Ability goals had little or no effect on motivation or performance outcomes when gender, grade point average, and task goals

were controlled. Results suggested that students strong in pursuit of task goals were not helped by simultaneously pursuing ability goals. Findings supported previous results indicating a beneficial relationship between task goals and a variety of motivational and performance outcomes.

Pajares, Zeldin & Lapin (1999) examined personal stories of women to determine whether their academic paths were influenced by verbal persuasions and invitations. They found that these were "instrumental sources for the development of confidence", that "self-efficacy beliefs fostered resilience to academic and social obstacles, and that "invitations reemerged at critical points as self-invitations that women used to buttress themselves against challenges".

Pajares & Zeldin (2000) examined the personal narratives of 25 women who excelled in mathematics, science and technology careers. Their findings suggested that the perceived importance of self-efficacy beliefs may have been stronger for women in male-oriented domains that for those in traditional settings.

Pajares & Usher (2008) administered the Self-Efficacy for Self-Regulated Learning Scale taken from Bandura's Children's Self-Efficacy Scale to 3,760 students ranging from grades 4 to 11. They found that "elementary school students report higher self-efficacy for self-regulated learning that do students in middle and high school", similar to the findings by Bandura (2008).

Pajares, Zeldin & Britner (2008) examined the narratives of 10 males who selected careers in science, technology, engineering, and mathematics (STEM). Analysis revealed that mastery experience was the primary source of the respondents' self-efficacy beliefs. An earlier study by Zeldin & Pajares (2000) revealed the primary sources of

self-efficacy beliefs of females who chose STEM careers were social persuasions and vicarious experiences, suggesting a difference between males in male-dominated domains and females in male-dominated domains. Findings were consistent with Bandura's social cognitive theory.

Schunk did a lot of early self-efficacy research that investigated Bandura's self-efficacy theory and contributed to the knowledge base of later researchers like Pajares, Betz and Hackett. Most of his research dealt with elementary students and occasionally with elementary education majors. Schunk's research often utilized four treatment groups.

Schunk and Hanson (1985) used four modes of instruction to determine the effects on student learning: Mastery peer model (rapid acquisition of skills), coping peer model (gradual acquisition of skills), observation of a teacher model, or no model observation. Those who observed peer models showed higher self-efficacy for learning, self-efficacy on a posttest, and achievement than those in the other two conditions. Those who observed the teacher model scored higher than those who observed no model. There were no significant differences between types of peer modeled behavior (either mastery or coping).

Schunk (1986) also investigated the relationship of gender of model and type of modeled behavior influenced achievement outcomes in students with mathematical learning difficulties (Schunk & Hanson, 1985; Schunk, 1986). Children observed either a same-sex or opposite-sex peer model demonstrate either rapid (mastery) or gradual (coping) skill acquisition. Schunk (1986) found that children observing the coping models saw themselves more similar in competence to the models than did those who observed mastery models. The gender of the model did not produce a differential in

achievement, and the interaction of model gender and subject gender was not significant. Schunk (1987) found that children in the single-coping, multiple-coping, and multiple-mastery peer models demonstrated higher self-efficacy, skill, and training performance compared to those in the single-mastery model.

Schunk (1981) observed the effect of combining operational strategies and free verbalization on self-efficacy, skills, and interest. Children received instruction and received treatments in which they verbalized strategies, verbalized freely, did both, or did not verbalize. The combination of operational strategies with free verbalization produced greater skill development, higher self-efficacy, and greater subsequent interest. Skills were equally high among those with free verbalization alone. Verbalizing only resulted in no benefits as compared to not verbalizing. Self-efficacy was positively related to arithmetic interest across all treatments.

Schunk (1982) explored the effect of progress-contingent rewards of self-efficacy and achievement. Children received instruction then were offered rewards based on their actual progress, rewards for simply participating, or no rewards. Progress-contingent rewards led to "higher task involvement, skill development, perceived efficacy, and interest". In all treatments, perceived efficacy has a significant positive relationship to subsequent task interest in the absence of incentives. Schunk (1983) found that children given ability feedback demonstrated higher skill and self-efficacy than other groups. The groups receiving effort feedback and ability plus effort feedback did not differ but did outperform those given no feedback. Schunk (1983) found, consistent with predictions from Bandura's self-efficacy theory, offering performance-contingent rewards promotes task accomplishment, perceptions of efficacy, and skill development. Schunk (1982)

found that both self-monitoring and external monitoring led to "significantly higher perceptions of efficacy, skill, and persistence as compared to no monitoring.

Schunk (1984) examined the effect of feedback on children's self-efficacy. The children were treated according to four conditions: One group received ability feedback, a second group received effort feedback, a third group was given ability feedback and then effort feedback, and a fourth group was given effort feedback and then ability feedback. Children initially given ability feedback developed higher self-efficacy and skill and placed a greater emphasis on ability as the cause of task success.

Schunk (1981) found that cognitive modeling resulted in higher achievement, self-efficacy, and accuracy of self-appraisal than didactic instruction. Schunk & Phelps (1984) examined how different types of cognitive modeling influenced self-efficacy and skill acquisition. In one group, cognitive modeling stressed task strategies, in a second group it emphasized positive achievement beliefs, a third group received emphasis on both of these, and a fourth group received cognitive modeling along. A common thread in several of Schunk's studies was the use of four treatments. The task strategy emphasis enhanced student motivation and skill development, but the emphasis on both task strategies and achievement beliefs led to the highest level of self-efficacy.

Schunk (1985) found that participating in goal setting led to the highest self-efficacy and math task skill. Some children set proximal performance goals, some had these assigned, and some received training without goals. Schunk (1994) found that within each goal condition, half of the students regularly assessed their problem solving capabilities and half did not. Either state in the learning goal and the self-evaluative state in the performance goal led to "higher self-regulated performance, self-efficacy, skill,

task orientation, and lower ego orientation" that the performance state without self-evaluation. Learning goals with self-evaluation led to greater persistence than performance goals without self-evaluation. Task orientation was positively correlated with self-efficacy and skill, and ego orientation was negatively correlated to these measures.

Schunk (1995) gave 40 eighth grade students instruction on fractions. Half were given a learning goal of learning how to solve problems, and half were given a performance goal of solving problems. Results indicated that the learning goal "led to higher self-regulated performance, self-efficacy, skill, task orientation, self-evaluations, self-satisfaction, and lower ego orientation". Self-evaluation and self-satisfaction was positively correlated with self-efficacy, skill, motivation and task orientation. These outcomes were also promoted by allowing students to evaluate their capabilities or progress.

Schunk (1996) investigated the role of self-evaluation during self-regulated learning through two studies of fourth graders learning fraction skills and an ongoing project with elementary education majors enrolled in their first computer class. He found evidence for the importance of learning goals to self-regulation. Self-evaluation should have been frequent or conveyed information that students may not have acquired on their own. Self-evaluation should have been linked directly to learning goals, especially since other factors may have precluded self-evaluation. Schunk (1997) found that when elementary school students monitored their own learning progress, self-regulated learning was enhanced.

Schunk (1985) examined the influence of task strategies and attributions for

success influenced self-efficacy and skillful performance. Improvement on the math task (division skills) depended on self-efficacy and use of effective strategies. "Ability attributions exerted the strongest influence on changes in self-efficacy". Schunk (1986) found that attribution of success to high ability rather than to other factors strongly influenced increases in self-efficacy.

Lent et. al. (1991) found that "efficacy informational sources were significantly predictive of gender differences in predicting interest and choice indexes", and that "effects of self-efficacy on science-related career choice were mediated by interests". Among sources of self-efficacy information, Lopez & Lent (1992) found prior performance to be the most efficient predictor of self-efficacy. Students' mathematics/science interests mediated the effect of self-efficacy on the perceived utility of mathematics to future plans. Lent et. al. (1993) found that self-efficacy mediated the effects of past achievement on interest in math. Math grades were predicted by achievement and self-efficacy. Interest and enrollment intentions were predicted by outcome expectation and self-efficacy.

Lent (1993) found that self-efficacy (along with achievement) predicted math grades while self-efficacy (along with outcome expectations) predicted academic interests and enrollment intentions. Malpass (1996) found that self-efficacy was very negatively related to worry, related to self-regulation, and played a mediating role between prior and subsequent mathematics achievement.

Lent et. al. (1996) found that college students cited past performance as the most influential basis for their mathematics self-efficacy beliefs, with women citing physiological reactions and teaching quality more often than men. Thought-listing

procedures were a useful means of studying phenomena not otherwise measured by standard psychometric means.

Lent (1996), and Lent, Lopez, Brown, & Gore (1996) found support for a four-factor model of self-efficacy (performance, vicarious learning, social persuasion, emotional arousal). However, in a second study, support was also found for a five-factor model (performance, adult modeling, peer modeling, social persuasion, emotional arousal), that is, "previous learning experiences" were divided into adult modeling and peer modeling components (Lent, 1996).

Lent, Brown, & Gore (1997) examined global academic self-concept and self-efficacy beliefs varying in domain specificity among university students. Results revealed that each of the variables "represented separate, though related, latent dimensions of self-perception".

Project-specific information

Developmental mathematics has been an area of growing concern in postsecondary education. Haycock (2002) noted that while advanced placement courses were the "fastest growing part" of secondary curriculum in the 1980s and 1990s the "fastest growing part of the college mathematics curriculum" during that same time was developmental courses which repeated high school mathematics content. High failure rates in developmental mathematics courses resulted in poor retention rates (Hackworth, 2000). Student failure in developmental mathematics courses represented "a primary barrier to retention" and graduation rates should have increased as developmental math pass rates increased (Noel-Levitz, 2005). Developmental mathematics courses were the most difficult to pass in the college curriculum. The failure to pass these courses was

"one of the most significant obstacles to the achievement of higher education goals in the United States" (Noel-Levitz, 2005). Developmental mathematics courses were "gatekeeper" courses that both sought to help students meet college requirements but also served to eliminate students not qualified for further study (NADE, 2005). Mathematics self-efficacy was "a situational assessment of an individual's confidence in her or his ability to successfully perform or accomplish a particular mathematical task or problem" (Kiamanesh, Hejazi & Esfahani, 2005; Hackett & Betz, 1989; Pajares & Kranzler, 1997).

Betz & Hackett were among the pre-eminent researchers of self-efficacy as it pertained to mathematics, major choice, career choice, and gender differences. They created the Mathematics Self-Efficacy Survey (Betz & Hackett, 1983) which was modified and examined by Pajares & Langenfeld (1994).

Betz & Hackett (1981) said that due to women's socialization they "lack strong expectations of personal efficacy in relationship to career-related behaviors". As a result, they failed to "realize their capabilities and talents". Betz & Hackett (1982) found that male mathematics self-efficacy expectations were significantly stronger that those of females with regard to choice of a science-based college major.

Betz & Hackett (1983) found mathematics self-efficacy expectations to be significantly related to choice of a science-based college major. Hackett (1981, 1985) found that math self-efficacy predicted both math anxiety and math-related major choices.

Betz & Hackett (1984) tested several of Bandura's hypotheses. As expected, they found that measures of female mathematics self-efficacy were not affected by verbal-task failure. However, contrary to expectations, they found that "male mathematics self-

efficacy expectations rose significantly higher as a result of verbal-task failure". As related to math-task failure, contrary to expectations, female mathematics self-efficacy was significantly affected while that of males was not. A global rating of mathematics ability showed no task-failure affect. As expected, "all subjects responded to verbal-task failure with a decrease in verbal ability ratings". Contrary to expectations, subjects in the mathematics-failure condition "significantly increased their ratings of their verbal ability on posttest, indicating that the effects of failure had a facilitating, rather than a debilitating influence on self-efficacy with respect to a task irrelevant domain".

Hackett & Campbell (1986) found that subjects' self-efficacy and interest ratings decreased as the result of failure and increased as a result of a success experience. Females rated themselves lower than males and "rated luck as the cause of their successful performance".

Hackett & Campbell (1987) found that undergraduate students gave "only minimally competent responses to items related to agency in academic and career development". Levels of perceived efficacy were relatively high, while the strength of efficacy beliefs was relatively weak.

Betz & Hackett (1989) found "no support for a 1981 hypothesis that females' mathematics self-efficacy expectations were unrealistically low as compared to those of males". They also found "significant positive correlations between mathematics attitudes, masculine sex-role orientation, and a mathematics-related major". Betz & Gwilliam (2001) found significant gender differences in favor of males in both math and science self-efficacy, but no significant racial differences.

Paulsen & Betz, (2004) found that leadership confidence was the most important

factor in career decision-making self-efficacy, and that "confidence in mathematics, writing, using technology, and cultural sensitivity all contributed significant incremental variance."

Betz & Hackett (2006) found that researchers often overlooked the fact that "the concept of self-efficacy must be linked to a specific behavioral domain to have meaning". Therefore, self-efficacy measures must be developed with careful specificity to the domain in question. They also cited concern that many self-efficacy researchers were unfamiliar with the theoretical underpinnings of self-efficacy, specifically the theories of Bandura.

Mwamwenda (1999) stated that research has shown that males exhibited higher mathematics self-efficacy than females (Randhawa et al., 1993; Pajares and Miller, 1994; Skaalvik and Rankin, 1994). This was in keeping with findings of males having higher mathematics achievement than females (Tate, 1997; Nyangeni and Glencross, 1997; Voyer, 1996).

Hanson (2001) agreed that there was a gender disparity in mathematics education but noted that researchers disagreed on its causes. Some researchers believed the source was biological (Benbow & Stanley, 1982), while others believed the source was environmental factors such as “differential course work, home support, the sense of math as useful, the sense of math as a male domain, or the teacher-student interaction” (Pallas & Alexander, 1983; Belz & Geary, 1984; Fennema & Sherman, 1978; Fennema & Peterson, 1985). Hanson (2001) made multiple recommendations to help achieve gender equity in mathematics, including examining existing attitudes for evidence of gender bias, and providing children with early opportunities emphasizing non-stereotyped roles

in academic settings and teaching methods.

Stage & Kloosterman (1995) found a significant relationship between self-efficacy and previous math skills. However, they found that self-efficacy was unrelated to males' final course grades but significantly related to females' final course grade. Students, however, believed that mathematics was gender neutral (Kloosterman, et. al., 2001). Hanson (2001) said that girls were subject to a lifelong "complex system of unconscious exclusion".

Kloosterman (1991) found a correlation between seventh grade students' beliefs about how mathematics was learned and their achievement in mathematics. Results indicated that when beliefs were considered as a single construct, the relationship between beliefs and achievement was much stronger than when beliefs were considered as independent variables.

Randhawa (1989) found that for both male and female high school students, instructional approaches that increased motivation for and enjoyment of mathematics were most likely to increase participation and achievement in mathematics. Also, the usefulness and relevance of math to everyday life was more greatly emphasized.

Randhawa, et. al. (1992) found that math self-efficacy was a significant mediator between measures of mathematical attitude and mathematics achievement with an excellent goodness-of-fit statistic for both males and females. Randhawa (1994) found that "boys and girls exhibited different cognitive structures for processing mathematical problems".

Hall and Ponton (2005) found that among college freshmen, calculus students exceeded developmental students not only in mathematical ability, but in their self-belief

to succeed in a college mathematics course. Hall & Ponton said future teaching methods should be developed which not only increase mathematical ability but also increase an awareness of increased capability and that these "efficacy-enhancing instructional methods" should be tested for effectiveness to improve the teaching and learning process.

Hall & Ponton (2002) conducted a study to examine the relationship between mathematics self-efficacy and class level (i.e., course level). The study utilized the 34-item Mathematics Self-Efficacy Scale (Betz & Hackett, 1983). They administered a demographic questionnaire plus the Math Tasks and Math Courses subscales. The results suggested that the difference between two groups' levels of mathematics self-efficacy was statistically significant. The self-efficacy of the Calculus students was higher than that of Intermediate Algebra students.

Hodges (2008) found statistically a significant relationship between self-efficacy to learn mathematics asynchronously (SELMA) and achievement. Measurements within both the experimental and control groups taken at week 5 were significantly higher than previous and subsequent measurements with no significant differences detected between groups.

Usher & Spence (2007) found mathematics self-efficacy to be among the most significant predictors of mathematics achievement. They also found that computer self-efficacy and "computer playfulness" were associated with courseware engagement, and that self-regulation was an important component of e-learning.

Lapan et. al. (1996) found that math self-efficacy beliefs and vocational interests were important in predicting math/science majors. Extroverts and those with artistic tendencies were less likely to choose math/science majors. They also found that

aspirations, especially among females, had solidified before college. Lapan et. al. (1989) found that among university freshmen, path analyses "suggested a correlation where math self-efficacy and high school math preparation mediated gender differences".

Chen & Zimmerman (2007) compared mathematics self-efficacy beliefs of American and Taiwanese middle school students. Taiwanese students exceeded Americans in math achievement. Americans showed higher self-efficacy for easy items but less for moderate difficulty items, declining less than Taiwanese students. American students had less accurate self-efficacy beliefs and the accuracy of both groups declined with higher difficulty items. Zimmerman and Martinez-Pons (1990) examined self-regulated learning among academically gifted students in grades 5, 8 and 11. Results supported a triadic view of self-regulated learning.

Self-efficacy Instruments

Research on the relationship between self-efficacy and academic attainment has been extensive. The most commonly used instruments in self-efficacy research have been self-report scales. Bandura (2005) described methods of constructing highly predictive self-efficacy instruments and provided sample instruments that may be used or adapted. Research instruments had to be specific to the particular situation if they were to have high predictive validity (Bandura, 2005; Pajares, Hartley, Valiante, 2001; Pajares & Kranzler, 1997). .

A variety of instruments form the basis of mathematics self-efficacy measurement. The researcher found no piece of literature that listed all relevant instruments. Tapia & Marsh (2008, accessed on November 6, 2008 at http://www.rapidintellect.com/AEQweb/cho25344l.htm) provided a good list of the

evolution of efficacy-related mathematics instruments. These included the Dutton Scale (Dutton, 1954; Dutton & Blum, 1968); unidimensional scales by Gladstone, Deal, & Drevdahl (1960) and Aiken & Dreger (1961); scales to measure enjoyment of math and the value of math (Aiken, 1974); and multidimensional attitude scales developed by Michaels & Forsyth (1977) and Sandman (1980). Scales designed specifically to measure mathematics anxiety included the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972); Mathematics Anxiety Rating Scale–Revised (Plake & Parker, 1982); and the Mathematics Anxiety Questionnaire (Wigfield & Meece, 1988).

The instruments most frequently cited in the literature and which were most relevant to the researcher's purposes were the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972); Fennema-Sherman Mathematics Attitude Scales (1976); Dowling's Mathematics Confidence Scale (1978); and the Mathematics Self-Efficacy Scale (Betz & Hackett, 1983).

The Mathematics Anxiety Ratings Scale (MARS) (Richardson & Suinn, 1972) was designed to assess respondents' math anxiety levels. It was a 98-item instrument "depicting various life and academic situations involving mathematics" such as "being treasurer of a club" or "signing up for a math class" (Zettle & Raines, 2000). It used a 5-point Likert scale and yielded scores from 98 - 490. It had acceptable test-retest reliability coefficients, internal consistency, and construct validity (Zettle & Raines, 2000, citing Suinn, Edie, Nicoletti, & Spinelli, 1971; Richardson & Suinn, 1972; Suinn, Edie, & Spinelli, 1971; Suinn & Richardson, 1971). There was also a "significant negative correlation" between MARS results and math test performance (Zettle & Raines, 2000, citing Dew, et. al., 1984).

Fennema (1989) attributed math performance to an interaction of attitudes/math anxiety and "behavior during learning tasks" (Tapia & Marsh, 2004, accessed on November 6, 2008 at http://www.rapidintellect.com/AEQweb/cho25344l.htm). The Fennema - Sherman Mathematics Attitude Scale (1976) consisted of a group of nine instruments (Tapia & Marsh, 2004, accessed on November 6, 2008 from http://www.rapidintellect.com/AEQweb/cho25344l.htm): (1) Attitude toward success in mathematics scale, (2) Mathematics as a male domain scale; (3) Mother scale; (4) Father scale; (5) Teacher scale; (6) Confidence in learning mathematics scale; (7) Mathematics anxiety scale, (8) Effectance motivation scale in mathematics; and (9) Mathematics usefulness scale.

Doepken, Lawsky, & Padwa (2008, accessed November 6, 2008 at http://www.woodrow.org/ teachers/math/gender/08scale.html) showed how Fennema-Sherman was modified for other research purposes. Their instrument consisted of four subscales, each consisting of 12 items: Confidence, usefulness, the measurement of mathematics as a male domain and a teacher perception scale. The subscales each consisted of 12 items, six that measured a positive attitude and six that measured a negative attitude.

Betz & Hackett (1983) based the math problems section of their MSES on standardized tests such as Dowling's Mathematics Confidence Scale (Dowling, 1978). D.M. Dowling created the instrument "to assess the mathematics confidence of college students" (Pajares & Miller, 1994).

Dowling also developed the Mathematics Performance Problems Scale (MPSS). The MPSS consisted of 18 multiple choice items of intermediate difficulty from the

National Longitudinal Study of Mathematics Ability (NLSMA) with three subscales: Math components, cognitive demand, and problem context (Pajares & Miller, 1994).

Betz & Hackett (1983) designed the Mathematics Self-Efficacy Scale (MSES) which was published by Mindgarden, Inc. (http://www.mindgarden.com). The original was a 75-item instrument divided into three subscales. This was distilled into 52 items within the same three subscales for the 1983 version (Betz & Hackett, 1989). Hall & Ponton (2002) and Langenfeld & Pajares (1983) refer to the 52-item MSES.

The mathematics tasks subscale (18 items) was based on the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972). It measured "confidence in ability to perform everyday math tasks" (Hall & Ponton, 2002). The mathematics courses subscale (16 items) was used to "assess confidence to persist in math-related courses with a grade of B or better" (Hall & Ponton, 2002). The mathematics problems subscale (18 items) was based on the Mathematics Confidence Subscale (Dowling, 1978). It was used to assess student confidence in their ability to solve math problems (Hall & Ponton, 2002). The most recent version of the MSES was the 1993 version. The instructions that came with this version were copyright Betz & Hackett (1989), even though they referred to the 1993 revision. It was not clear why Hall & Ponton (2002) chose to use the 52-item, 1983 version.

Pajares & Miller (1995) designed the Mathematics Self-Efficacy Scale-Revised (MSES-R) in response to problems they found with the predictive validity of the Betz & Hackett (1983) MSES (Langenfeld & Pajares, 1993; Pajares, 1996; Pajares, Hartley & Valiante, 2001). Specifically, Pajares & Langenfeld (1993) found limitations with the Mathematics Problems subscale and found that the college courses subscale measured

two separate constructs that each had different implications, in general meaning that they found the subscale to lack the necessary specificity to the task in question that Bandura (1986) found necessary. The efficacy measure had to be specific to the performance task to avoid "confounded relationships, ambiguous findings, and uninterpretable results" (Pajares & Langenfeld, 1993).

Pajares & Langenfeld (1993) found empirical evidence for the validity of the modified Mathematics Self-Efficacy Scale (MSES-R). They found that the college courses subscale measured two separate constructs that have "significantly different implications for differing substantive questions". Pajares & Kranzler (1997) found that the MSES was a multidimensional measure of math self-efficacy with reliable subscales, and that the scale taps different judgments.

Hodges (2005) described the three modifications made for the MSES-R: (1) The MSES-R replaced the solution of math problems subscale with an earlier one by Dowling (1978), on whose research the original MSES was based; (2) the MSES-R modified a question to refer to a calculator rather than a slide rule; and (3) the MSES-R used a 10-point Likert scale rather than the original MSES 5-point scale. It should be noted that the latest edition of the MSES by Betz & Hackett now used a 10-point Likert scale (Betz & Hackett, 1989). It was not clear whether the Math Problems subscale was modified as Pajares et. al. indicated, since that subscale was omitted in the latest published edition.

Other less frequently cited instruments included the Mathematics Anxiety Rating Scale–Revised (Plake & Parker, 1982); the Mathematics Anxiety Questionnaire (Wigfield & Meece, 1988); SDQIII math scale (Pajares & Miller, 1995); Shell, Murphy & Bruning (1989). Marat (2005) created an instrument also called the Mathematics Self-

Efficacy Scale. It was created for a dissertation and used for research in Australia and New Zealand but was not related to the MSES by Betz & Hackett (1983).

Marat (2007) examined high school students and teachers efficacy in using learning strategies in mathematics and the relationship with achievement. Findings showed that a sizeable number of student participants who did not achieve nonetheless exhibited "illusory-efficacy". It was important for students to have true efficacy and develop learning strategies "to reduce disparities and enhance achievement". Self-efficacy was based on the relationships between personal factors (cognition, emotion and biological events), behavior, and environmental factors (Marat, 2005; Maddux, 1995). Nielsen and Moore's (2003) psychometric data referred to the Marat MSES rather than the Betz & Hackett (1983) MSES. They found some evidence for the psychometric properties of the Marat MSES (2005) in both measurement reliability and validity of scores, but also found failure to counterbalance administration of the two Marat MSES forms. The Marat (2005) MSES had high predictive validity (Marat, 2005; Nielsen & Moore, 2003).

Related Research in Chronological Order

Tracz & Gibson (1986) examined the effects of teacher efficacy on academic achievement. Found that personal teaching efficacy (level of confidence in personal teaching abilities) correlated positively with reading achievement and whole class instruction and negatively with small group instruction. Teaching efficacy (general expectations of students' success) correlated significantly with language and mathematics achievement. The study supported the contention that a teacher's sense of efficacy was significantly related to classroom grouping of students and to student achievement

outcomes.

Meece, et. al., 1990 assessed the influence of past mathematics grades, performance expectancies, and value perceptions on math anxiety of 250 students grades seven through nine. Matsui et. al. (1990) assessed four sources of efficacy (achievement, modeling, verbal encouragement, and emotional response) among Japanese undergraduates with regard to high school math, locus of control, and math self-efficacy. Men reported significantly higher math self-efficacy. Of the four sources, only verbal persuasion did not make a unique contribution to math self-efficacy. Bieschke & Lopez (1991) tested a causal model of math/science career aspirations that incorporated key elements of math self-efficacy and identity development theories. Results were supportive of math self-efficacy and research.

Cooper & Robinson (1989) found a lack of any significant gender differences in regard to mathematical ability, anxiety, and performance. Cooper & Robinson (1991) investigated the relationships between Hackett's (1985) suggested variables of mathematics and career self-efficacy, perceived external support, math background and math performance background among students selecting math-based college majors. They found that self-efficacy beliefs, mathematics ability, mathematics anxiety and level of parental and teacher support was significantly related to mathematics performance. Matsui (1989) found that females in male-dominated occupations had lower self-efficacy, felt they had fewer female role models, considered themselves feminine, and had low mathematics confidence.

Bryan & Bryan (1991) examined the relationship between positive mood and math performance and found that students exposed to positive-mood induction completed

more math problems accurately than control children, and the secondary-level experimental group students expressed greater self-efficacy for math than did the control group students.

Rector (1993) found that autonomy and beliefs were integral to students' conception of mathematics and influenced how problems were approached and mathematics learned. Steinhauer et. al. (1993) assessed the self-protective function of self-handicapping (setting oneself up to fail a feared evaluation task to protect a sense of self-worth). Perceived math competence was generally accurate for most of the students. Contrary to expectations, students who overrated math competence did not self-handicap but those who underrated math competence did self-handicap. This suggested that the motive was not self-protection but self-consistency or verification, allowing individuals to maintain their current self-view. Students who overrated their competence claimed less anxiety and fewer excuses but tended to choose easier questions than other students, in effect setting themselves up to do well in a self-enhancing way.

Scott (1993) examined whether motivational patterns varied between courses of varying difficulty levels and the interactions between self-efficacy, attributional style, and academic achievement. Results indicated a relationship between motivational pattern and course difficulty, but not between motivational variables and academic achievement. Students seemed to need an adaptive motivational pattern before accepting the challenge of a difficult course of study.

Williams (1994) investigated gender differences in efficacy-expectation and performance discrepancies in English, math, reading and science. Those with greater efficacy performed at high levels, especially in math. Approximately equal numbers of

males and females inaccurately estimated performance capabilities. Norwich (1994). Found that among secondary female mathematics students, self-efficacy was the best predictor of learning intentions.

Hofer (1994) examined the relation between epistemological beliefs (what they think knowledge is and how they think it is learned), motivation and cognition among first-semester calculus students. Results indicated that intrinsic motivation and self-efficacy were correlated with sophistication of beliefs, though this was not true in experimental calculus sections. Those with more sophisticated beliefs were mastery-oriented and had high self-efficacy. Intrinsically motivated students reported relative disagreement with the view of math as an isolated activity. Findings also indicated the importance of group activities in math. There was some support for correlations between epistemological beliefs about math and type of instruction.

Garcia & Pintrich (1995) examined the role of possible selves (what students thought they may be like in the future) related to perceptions of competence and self-regulation. Findings generally supported expectations that "hoped-for" and "feared" possible selves should be more closely aligned to expectancies, while the importance assigned to these possible selves would be more closely related to behavior. Results suggested that possible selves added to the understanding of students' motivation and self-regulation.

Junge & Dretzke (1995) had 113 gifted and talented high school students completed the MSES. Males showed stronger self-efficacy expectations than females on more than one-fourth of the items, whereas females reported strong self-efficacy expectations on only a few items involving stereotypical female activities.

Brahier (1995) examined the dispositions of eighth graders accelerated into first-year algebra. Males demonstrated higher self-efficacy to perform in algebra and high school mathematics. Students showed a high level of perseverance but classroom performances indicated a negative disposition towards math. Students desired to please the teacher rather than exercise natural curiosity and interest. Neither students nor parents recognized the real-world applications of algebra.

Williams (1996) increased self-regulated learning was associated with higher student achievement in mathematics, science, social studies, and reading.

Bong (1996) found that students' self-efficacy perceptions generalized beyond the boundaries of specific tasks and of specific school subjects. There was more generalizability of academic self-efficacy among math and science subjects that verbal ones. Academic self-efficacy generalization depended in part on the degree of perceived similarity among tasks. Subject-specific and more global academic self-efficacy measures (verbal and quantitative) preserved the strong predictive utility for students' effort expenditure and academic achievement.

In 1996, Bong (1996) failed to find clear support for Marsh's (1986, 1990) internal/external (I/E) model, which points to the "relativistic nature of academic self-concept formation". The model argues that students spontaneously undergo two separate comparison processes when asked to report their own perceived competence. Externally, students compare their academic abilities to those of their peers, and internally they compare their own verbal skills to their mathematics skills, resulting in a negative correlation between verbal and mathematics self-concept. The verbal and mathematics self-perceptions of students surveyed did not show this negative correlation. It appeared

that their perceptions of capability were formed without the internal comparison process.

Bong (1998) compared two widely used academic self-efficacy techniques: Problem-referenced measurement and the Motivated Strategies for Learning Questionnaire (MSLQ). The relationship between students' verbal and mathematics self-efficacy perceptions was noticeably stronger with the former than with the latter. Student responses became more uniform in each subject as the assessment procedures referred to more global events and less specific problems.

Bong (1998) found that students' verbal and mathematics self-concepts were positively correlated after an external comparison, and negatively correlated after an internal comparison, as predicted by Marsh's (1986) internal/external frames of reference model. These findings in support of Marsh are in contradiction to Bong's (1996) earlier findings.

In a 2004 study, Bong corroborated results from her 2001 study that "students form motivational beliefs that are subject-matter specific and that some beliefs generalize more than others across multiple academic domains". Academic self-efficacy beliefs showed a moderate correlation, while performance-approach and performance-avoidance achievement-goal orientations demonstrated strong correlation across different contexts. Motivational beliefs in subject-specific areas were more strongly correlated with motivational beliefs in general school learning that with beliefs in other areas.

Bong (2008) examined the predictive relations among high school students' perceptions of their social-psychological environments, personal motivation beliefs, and academic behavior in math. Bong found that self-efficacy mediated all relations between contextual perceptions and academic behavior.

Laveault, Leblanc, & Leroux (1999) examined how self-evaluation strategies contribute to helping students take control over their own learning processes. It took into account the role of self-evaluation during classroom work and also homework assignments and the role of parents. Findings showed that 6th grade student results were significantly higher than those in grade 7 and grade 8, possibly indicating the math task was easier for grade 6 students. No gender differences were found between task completion in class or at home. Gifted students performed better and had more agreement with parents on homework.

Hofer (1999) examined student beliefs on knowledge, motivation, learning strategies, and academic performance in introductory Calculus classes. Sophistication of epistemological beliefs was positively correlated with motivation, self-efficacy, self-regulation, and grades. Students in the more active, cooperative classroom had more sophisticated beliefs than the students in the traditional classroom.

Asimeng-Boahene (1999) investigated the reasons for gender inequity in mathematics and science education in African schools and why females received neither the same quality nor quantity of education as male classmates in both subjects. Kennedy (1999) evaluated the hierarchical structure of self-efficacy hypothesized by Shavelson, Hubner & Stanton (1976). Interpretations of the Science Self-Efficacy Scale (Kennedy, 1996) supported a multifaceted, hierarchical interpretation. A second-order self-efficacy latent named academic self-efficacy was shown to be reflected by the three first-order self-efficacy factors of science, mathematics, and self-regulated learning.

Kennedy (1999) compared responses on three self-efficacy measures and assessed them based on Bandura's (1997) conceptualization. Results indicated that the self-

efficacy measures of science, mathematics, and self-regulated learning exhibited discriminant validity.

Hanlon & Schneider (1999) reported results of a pilot designed to improve students' math proficiency through self-efficacy training. Pre-college students attended a five-week summer program with whole class instruction, small group tutoring, and individual meetings with instructional coordinators. Students made self-efficacy judgments on each of ten daily quizzes and compared their judgments to their math quiz scores. Students took part in goal-setting and self-monitoring activities. Over time, math proficiency exam scores improved significantly, as did their confidence levels about passing the exam. Those who participated in the self-efficacy intervention outperformed students who did not.

O'Brien, Martinez-Pons, and Kopala (1999) examined relationships among eleventh-graders between math self-efficacy, gender, ethnic identity, career interests in math and science, socioeconomic status and academic achievement. Science career interest was predicted solely by science-mathematics self-efficacy. Self-efficacy was predicted by academic performance and ethnic identity. Academic performance was predicted by socioeconomic status (SES). Gender directly affected career interest.

Williams-Miller (2000) explored student use of internal and external comparisons in determining efficacy for self-regulated learning. High school students took an ACT practice test and Bandura's self-regulated learning subscale. Path analysis suggested that both male and female students depended primarily on external comparisons in determining efficacy for self-regulated learning. There was a strong association between English and math efficacy components which may provide some insight into the structure

of self-regulated learning.

Coyle (2001) examined the influence of self-efficacy on women's selection of math-related careers. Unlike Zeldin and Pajares (2000), this study included African-American women. The study centered on Bandura's (1986) four sources of self-efficacy perceptions by reviewing personal narratives. The research question was which of the four sources contributed the most to self-efficacy. Analysis indicated vicarious experiences and verbal persuasions were instrumental sources for developing and maintaining self-efficacy beliefs, and the women demonstrated great persistence and effort on their academic and career path. Participants did not totally rely on skill to succeed, rather they relied on people with whom they had positive relationships.

Garduno (2001) examined the influence of cooperative problem solving on gender differences in achievement, self-efficacy, and math attitudes. She found no difference in achievement of self-efficacy between cooperative learning mixed gender or single gender groups. Differences in mathematics attitudes were found favoring the whole-group, competitive instructional setting.

Marsh & Yeung (2001) responded to Bong (1998) by evaluating and reanalyzing date from Bong's study of the I/E frame of reference and academic self-concept. They found strong support for the original I/E model, some support for the internal/external comparison process, and "good support for a new extension to incorporate a wider range of academic domains". Martin & Marsh (2008) examined the "academic buoyancy" of high school students, defined as "students' ability to successfully deal with academic setbacks and challenges that are typical of the ordinary course of school life (such as poor grades, competing deadlines, exam pressure, or difficult schoolwork). At mid-term and

at the end of the school year, students were asked to rate their academic buoyancy and a set of hypothesized predictors such as self-efficacy, control, academic engagement, anxiety, and teacher-student relationship). Pretest results showed that anxiety (negatively), self-efficacy and academic engagement significantly predicted academic buoyancy. Posttest results showed that anxiety (negatively), self-efficacy, academic engagement, and teacher-student relationships explained variance in academic buoyancy over and above that explained by academic buoyancy in the pretest. Of the significant predictors of academic buoyancy, anxiety explained the bulk of the variance.

Ferguson & Dorman (2001) examined the relationship between classroom environment and academic self-efficacy among mathematics students in grades 8 and 10. Improved levels of involvement, investigation and task orientation were associated with higher levels of academic efficacy. Conventional classrooms may have fostered academic efficacy more effectively than constructivist classrooms.

Dorman (2001) investigated associations between classroom environment and academic efficacy in Australian secondary schools. The study found that classroom environment has a positive relationship with academic efficacy.

Skaalvik (2002) explored relationships among four dimensions of goal orientation (self-defeating ego, self-enhancing ego, task, and avoidance orientations) and math achievement, self-concept, self-efficacy, anxiety and intrinsic motivation. Results showed that goal orientations were systematically related to achievement, self-conceptions, anxiety and motivation. Self-defeating and self-enhancing ego orientation related differently to all these variables. Results failed to show that goal orientation affected subsequent anxiety, motivation and achievement, but had some predictive value

for subsequent self-concept and self-efficacy. Results also indicated that achievement, self-conceptions, motivation and anxiety have predictive value for subsequent goal orientation.

Fouad, Smith and Zao (2002) found support for the social-cognitive career choice model (Lent, Brown & Hackett, 1994). Results indicated support for the SCCM relationships in each of the 4 subject areas (art, social science, math/science, and English) and showed that these relationships were remarkably similar across subject areas.

Dorman, Adams & Ferguson (2002) found that classroom environment scales accounted for variance in self-handicapping beyond what could be attributable to academic efficacy.

Pietsch, Walker & Chapman (2003) examined the relationship among self-concept, self-efficacy and mathematics performance. Results supported the existence of two self-concept components: Competency and affective.

Nauta & Epperson (2003) did a 4-year longitudinal design to predict the choice of science, math and engineering college major, self-efficacy and outcome expectations. 204 high school girls attended SME career conferences. College SME outcome expectations were associated with plans to become a leader in an SME field.

Tanner & Jones (2003) said that although summative assessment was a significant element of educational policy, research indicated that formative assessment was more likely to raise student achievement. They indicated that although most students believed in the value of revision, they often failed to use assessment results formatively and employ effective revision strategies.

Stevens, Olivarez, Lan, & Tallent-Runnels (2004) examined self-efficacy and

motivational orientation across Hispanic and Caucasian students to predict variables related to mathematics achievement. Results supported the finding the self-efficacy predicts motivational orientation and mathematics performance. The relationship between prior mathematics achievement and self-efficacy was stronger for Hispanic students. Similar motivational systems existed to predict math achievement across ethnicity. Hispanic students placed more emphasis on prior mastery experiences, suggesting that other factors influence the self-efficacy of Caucasian students.

Merenluoto (2004) examined cognitive-motivational profiles of Finnish lower secondary students dealing with decimals and fractions. Results suggested that if students' cognitive distance to the task demand was too wide, the cognitive conflict was passed unnoticed. Moderate sensitivity combined with high estimation of self-efficacy and low tolerance seemed to be restrictive to a more radical change and deeper understanding of the concepts.

Turner, Steward, & Lapan (2004) tested a causal model base on social cognitive career theory (Lent, Brown, & Hackett, 1994, 2000). Consistent with the theory, they found that career gender-typing, parental support for pursuing math and science careers, and the family structure itself predicted young adolescents' math self-efficacy. Career gender-typing and mother's support predicted math outcome expectations. Math self-efficacy and outcome expectations predicted math and science career interests.

Cerezo (2004) examined problem-based learning and how middle grades math and science students perceived its effectiveness. Changes in perceptions were analyzed through student interviews. Change components included self-confidence, group dynamics, and self-motivation. Results indicated that students perceived that problem-

based learning helped their confidence in taking control of their learning, and that problem-based learning enhances group dynamics and its effects on at-risk students. Students believed group involvement enable them to be more successful in understanding assignments, noting positive changes in their self-confidence.

Hong & Aqui (2004) compared cognitive and motivational characteristics among different types of gifted students, unlike much previous research which had compared gifted and non-gifted students. The study compared math-gifted, math-creatively talented, and non-gifted. They found no differences in ability beliefs among the three groups. Gifted females reported greater effort expenditure than gifted males. Creatively talented males put forth greater effort than gifted males, and the creatively talented in general used more cognitive strategies than the gifted. Gifted or creatively talented perceived general self-efficacy, use of cognitive strategies, perceived their math ability and self-efficacy to be high, and valued learning math more than their non-gifted age peers.

Klassen (2004) studied the mathematics efficacy beliefs of 270 South Asian immigrant and Anglo Canadian nonimmigrant seventh grade students. Self-efficacy beliefs strongly predicted mathematics performance for both cultural groups, but the groups showed differences in the sources of self-efficacy, the predictiveness of secondary motivation variable, and the vertical dimensions of individualism and collectivism. They argued that Indo Canadian students were more vertical or hierarchical and that comparison with others strongly influences motivation beliefs and self-efficacy belief formation.

Ho (2004) found a positive relationship between self-regulated constructs and

achievement in reading, math and science domains in Hong Kong students. The most important performance-related strategies in all three domains were control strategies and self-efficacy, but instrumental motivation and memorization had negative associations with mathematical and scientific literacy performance. Hong Kong students used self-regulated learning strategies much less frequently than students in other PISA countries (except competitive strategies). The author suggested adjusting the educational environment to teach self-regulation and intrinsic motivation to Hong Kong students as part of educational reform. Ho (2007) investigated the association between self-related cognition and mathematics performance among Hong Kong high school students. She found that self-efficacy and self-concept were significantly associated with math performance. Also, high levels of math anxiety may not have directly affected mathematics achievement but may have reduced the self-concept and self-efficacy of girls, in turning possibly affecting their math performance.

Carmichael & Taylor (2005) hypothesized that motivation was a key factor in determining student success or non-success. The course in question had high drop out rates. Initial results "suggested that only specific measures of student confidence predict their performance and that both gender and age mediate the strength of this prediction".

Lapoint, Legault, and Batiste (2005) examined student perceptions of teacher behavior in three motivational variables (self-efficacy beliefs, intrinsic value, and test anxiety in mathematics). Respondents included learning disabled, average and talented students. Results showed that perceptions of teacher proximity and influence have implications for average and talented, but are not significant in students with learning disabilities.

Lloyd, Walsh, & Yailagh (2005) tested the hypothesis that gender-related math achievement differences were related to gender differences in achievement-related beliefs. Findings indicated that girls equaled or exceeded boys' achievement, and that their attribution patterns were more self-enhancing than those found in previous studies. Girls were more apt than boys to display under-confidence related to actual math achievement and to attribute math failure to a lack of teachers' help.

Schweinle, Meyer, & Turner (2006) examined the relationship between motivation and affect in upper elementary math classes. Their results suggested that "emphasizing the balance of challenge and skill, supporting self-efficacy and value for mathematics, and fostering positive affect can enhance students' motivation in the classroom".

Stevens, Olivarez, & Hamman (2006) investigated the role of cognition, motivation and emotion on math achievement gap between white and Hispanic students. Results supported assumptions that self-efficacy, its sources, and emotional feedback were all stronger predictors of math performance than general mental ability.

Kenney-Benson, Pomerantz, Ryan, and Patrick (2006) examined whether the tendency for girls to outperform boys in the classroom was due to differences in approach to school work. Results showed that girls were more likely to hold mastery over performance goals and to refrain from disruptive behavior. This predicted girls' greater effortful learning over time. The difference in academic performance was explained by the difference in learning strategies. There was no gender difference on achievement tests or self-efficacy, possibly because self-efficacy was the central predictor of achievement test performance.

Meece, Glienke, and Burg (2006) examined the role of gender in shaping achievement motivation. They explained gender differences in motivation using four contemporary theories of achievement motivation: Attribution, expectancy-value, self-efficacy, and achievement goal perspectives. Findings indicated both genders' motivation-related beliefs and behaviors followed gender role stereotypes. Boys reported strong ability an interest beliefs in math and science, while girls had more confidence in language arts and writing. Gender effects were moderated by ability, ethnicity, socioeconomic status, and classroom context. Gender differences in motivation were evident early in school, and increase for reading and language arts over the course of school.

Shores & Shannon (2007) investigated the relationships between self-regulated learning, motivation, anxiety, attributions and achievement in mathematics through a quantitative study of 761 fifth- and sixth-grade students (58.1% female). Motivation and anxiety contributed significantly to test score and math grade for fifth grade students. Self-efficacy, anxiety, and failure were related to academic performance while failure attribution was significantly related to math grade. For sixth graders, relationships existed between motivation, anxiety, and academic performance with self-efficacy, intrinsic value, and worry significantly predicting both test score and math grade. Motivation and anxiety interacted to facilitate self-regulation while developing expertise in a domain such as mathematics.

Inoue (2007) found that undergraduates with higher individual interest levels chose more challenging number puzzles to solve, attributing their choices to interest rather than perceived competence. Those with higher perceived competence and low

levels of individual interest generally did not choose challenging puzzles. Students received no performance feedback during the session. Findings suggested a limitation in relying on self-reported confidence in ability and the contribution of individual interest as the reason behind choosing challenging tasks in a low-pressure environment.

Nokelainen, Tirri, & Merenti-Valimaki (2007) examined the influence of attribution styles on the development of mathematical talent. Highly, moderately, or mildly mathematically gifted Finnish adolescents and adults completed a Self-Confidence Attitude Attribute Scale questionnaire. Findings showed that items attributing success to effort and failure to lack of effort were the best predictors for the level of mild mathematical giftedness and gender (females). Those in the mild category saw effort as leading to success. Those of high and moderate mathematics giftedness reported that ability was more important for success than effort. Moderate and mild students attributed failure to lack of effort, while the highly gifted category attributed failure to lack of ability.

Friedel, Cortina, Turner & Midgley (2007) found that children's' perceptions of both parent and teacher mastery and performance goal emphases predicted children's personal goals, with mediated the relation between the perceived parent and teaching goals and the children's efficacy beliefs and coping strategies. Children's perceptions varied slightly by gender but not by ethnic background. Variance across groups in perceptions of mastery emphases, and relationships between goal perceptions, personal goals, efficacy and coping strategies did not vary significantly by gender or ethnic background. The perceived goals emphasis was important for adaptive beliefs and behaviors in mathematics.

Ackerman and Wolman (2007) sought to determine the accuracy of self-estimates of cognitive abilities. They obtained estimates of ability before and after objective testing (without feedback). Self-estimates showed small to large effect-size correlations with objective tests--larger for math and smaller for verbal. Self-efficacy and self-esteem variables showed the highest correlations with verbal ability self-estimates and the lowest correlations with math ability self-estimates.

Siegle and McCoach (2007) investigated increasing student mathematics self-efficacy through teacher training. They found that teachers who capitalized on the strongest sources of self-efficacy (past performance, observation of models, and verbal persuasion) produce more confident students. Positive instructional practices to increase self-efficacy included reviewing accomplishments; stating, emphasizing and reviewing objectives; asking students to record daily learning experiences; facilitating student metacognitive skills and providing positive feedback, and using student models to demonstrate mastery.

Navarro, Flores, & Worthington (2007) examined the effect of socio-contextual and socio-cognitive variables on math/science goals. They examined 409 Mexican American youth using a modified version of the social cognitive career theory of Lent, Brown & Hackett (1994). Gender did not moderate variable relations. Results supported most of the hypotheses: Social class predicted past math/science performance accomplishments. Past accomplishments and perceived parental support predicted self-efficacy. Self-efficacy predicted outcome expectations, and with math/science interests, predicted math/science goals. Contrary to expectations, past performance accomplishments were not predicted by generation status, Anglo orientation or Mexican

orientation, and past accomplishments did not predict outcome expectations. Also, Anglo orientation and perceived social support from parents, teachers, classmates, and a close friend did not predict math/science goals.

Chouinard, Karsenti, and Roy (2007) examined 759 students in grades 7 to 11 with respect to motivation as a factor in the learning process and school achievement. Results indicated that effort in mathematics was mainly explained by mastery goals and competence beliefs. The perception of parental support chiefly explained variables associated with valuing math while teacher support acted most on competence beliefs. They had two conclusions: Mastery goals had an important and significant impact on students' efforts in learning mathematics; and the relationships between competence beliefs, utility value, achievement goals and effort were not significantly influenced by age and gender, at least in mathematics.

Otunuku and Brown (2007) stated that research indicates attitudes toward a subject and one's self-confidence predict academic performance. Immigrant minority students generally have positive attitudes and low academic performance. They examined those attitudes among Tongan, Pasifika and Asian students as related to math, writing and reading by self-reported ethnicity. Groups with positive attitudes did not differ significantly in mean scores, and the correlation between liking and self-efficacy was either weakly positive or zero. The results questioned the power of self-efficacy and liking attitudes to predict academic performance for immigrant students from agrarian or traditional societies. The data suggested that "school effects" rather than lack of attachment, opposition, or deficiency were the most likely explanations for this relationship.

Goetz, Frenzel, Pekrun, Nathan & Ludtke (2007) corroborated assumptions of domain specificity concerning academic emotions. The between-domain specificity relations were weak and inconsistent, while within-domain relations were clearly differentiated.

Hailikari, Nevgi, & Komulainen (2008) examined the relationships between prior knowledge, academic self-efficacy, and previous study success in predicting mathematics course achievement. Domain-specific prior knowledge was found the strongest predictor of achievement over and above other models, and along with previous study success, explained 55% of the variance. They found that academic self-beliefs were strongly correlated with academic self-beliefs and had a strong direct influence on prior knowledge test performance. However, self-beliefs only indirectly predicted student achievement via prior knowledge. Implications were that both prior knowledge and self-beliefs should be considered in instructional support issues to provide insight about future performance.

Hoffman & Spatariu (2008) examined the influence of self-efficacy and metacognitive prompting on math problem-solving efficiency. Students completed a math background inventory then assessed their self-efficacy. They were assigned to a prompting group or a control group with no prompting. They found that self-efficacy and metacognitive prompting increased problem-solving performance and efficiency separately through activation of reflection and strategy knowledge, supporting their "motivational efficiency hypothesis".

Byars-Winston & Fouad (2008) found that parental involvement directly and indirectly predicted goals through a strong relationship with outcome expectations, which

combine with interests, directly predicted goal intentions. Findings suggested that coping efficacy mediated the relationship between perceived career barriers and goals.

In a cross-national analysis of the relationship between student achievement and self-perception, Shen & Tam (2008) found a positive relationship between achievement and how much they liked a subject, their perceptions of competence, and the perceived ease of the subject. In a between-country analysis, the relationship was opposite, that is, there was a negative relationship between self-perceptions and achievement. The authors suggested that the results "may reflect high academic standards in high-performing countries and low academic standards in low-performing countries".

Hoffman & Schraw (2009) found that "self-efficacy increased problem-solving efficiency through strategic performance rather than faster solution times, and were consistent with the motivational efficiency hypothesis" which predicted that "motivational beliefs such as self-efficacy, increase problem-solving efficiency through focused effort and strategy use".

McMahon, Wernsman & Rose (2009) examined the relationship of classroom environment and school belonging to academic self-efficacy. They found that greater satisfaction and school belonging, as well as less friction, were associated with higher efficacy in language arts. School belonging was the most important contextual influence. Less difficulty was the only contextual variable associated with higher math and science self-efficacy. Student perceptions of the classroom and school environment had to be considered in relation to academic outcomes and have had differential influences depending on the subject.

Summary

The research showed that there was both prevalence of and need for higher education programming specifically for underprepared students. Although political and societal views may have negatively stigmatized developmental education, developmental education has contributed to the institutions by raising instead of lowering academic standards by preparing students to meet institutional goals and objectives. Developmental education also contributed to society by increasing employability.

Although there has perhaps been a lack of quantity of best practices research for developmental education, there has been some quality research which has produced a number of generally agreed upon best practices. These were easily identified by colleges and universities for use in developmental program delivery.

Social cognitive theory concerned the mechanisms of human agency and the efficacy belief system. Self-efficacy concerned beliefs of ability to succeed in specific domains, and should not have been confused with self-esteem. Self-efficacy had four features, four sources, and four processes. Self-efficacy research related to one or more of these features, sources, and processes, and was able to be organized according to that context. Issues with gender or ethnicity were able to be integrated into these areas.

The features of self-efficacy included intentionality, forethought (planning and goal-setting), self-reactive elements (self-regulatory processes during learning), and self-reflective elements (self-evaluative processes following learning, including attributions). Self-efficacy was increased when students are involved in planning and goal-setting, and when the goals were aligned to the program's goals. Instruction should have promoted self-regulatory and self-evaluative processes, which in turn increased self-efficacy. Self-

efficacy was increased when students attribute success to effort or ability rather than other factors.

The sources of self-efficacy included mastery learning, vicarious experiences (including instructional and modeling procedures, along with prior experience), social influences (including student perceptions of parent, teacher and peer practices and perspectives), and emotion (including motivational and interest-related findings). Mastery learning experiences promoted student self-efficacy (and female self-efficacy in male-dominated domains). Modeling, especially peer modeling coupled with a coping model, increased self-efficacy. Prior experience was highly predictive of self-efficacy. Motivational instructional techniques promote self-efficacy. Students who perceived high parental or teacher self-efficacy in turn had higher self-efficacy themselves.

Self-efficacy concerned four processes: Cognitive, motivational, affective, and selection. These processes were integrated in both the features and sources of self-efficacy. Self-efficacy had a direct causal relationship to behavioral change (Cervone, 2000; Borkovec, 1978; Eysenck , 1978; & Wolpe, 1978, Bandura, 2007; Pajares, 2002) and was a critical cognitive mechanism of change (Cervone, 2000; Reiss, 1991). It had value to multiple domains of human endeavor (Cervone, 2000; Center for Positive Practices, 2006) and predicted future academic success (Bandura, Pajares). Mathematics self-efficacy was a critical component of higher education success (Noel-Levitz, 2005), making it worthy of further investigation

CHAPTER THREE: METHODOLOGY

The literature review revealed a significant amount of research to support the importance of mathematics self-efficacy to retention and academic success. Developmental mathematics program design related directly to leadership at all levels of the institution: Administrative commitment and leadership, finances, resources and personnel (SKCTC Quality Enhancement Plan, 2006; Sheldon, 2005). Most self-efficacy studies in the literature review reported whether correlations existed between variables, and if so, whether the relationships were strong or weak. This study hypothesized (in null form) age, gender, course, and grade would not be significantly predictive of mathematics self-efficacy. The hypotheses were evaluated through pretest and posttest administration of the MSES (Betz & Hackett, 1983), analysis of final course grades, course attendance, and examination of demographic data

The candidate obtained permission from the Liberty University Institutional Review Board (IRB), the KCTCS Institutional Review Board, and the Office of the President of the community college. IRB approvals were placed in Appendix A. Appropriate college personnel were briefed, including President of the college, Chief Academic Officer, Natural Sciences, Mathematics and Related Technologies Division Chair, Mathematics Department Chair, Institutional Research Officer, and developmental mathematics faculty.

Design of the Study

The study used quantitative research, which included MSES pretest and posttest responses, age data, gender data, developmental mathematics course enrollment, and course grades. Multiple linear regression with SPSS was performed to see whether

the null hypotheses could be rejected. Mathematics self-efficacy (subscale 1, subscale 2, and overall) was the independent variable while age, gender, course1, course2, grade1, and grade2 were the dependent variables. The hypotheses were evaluated through pretest and posttest administration of the MSES, analysis of final course grades, and age, gender and enrollment data.

Null hypotheses were as follows:

1. Age - H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and age.
2. Gender - H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and gender.
3. Course1- H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and 16-week or first bi-term developmental mathematics course taken.
4. Course2- H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and second bi-term developmental mathematics course taken.
5. Grade1- H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and 16-week or first bi-term developmental mathematics course grade.
6. Grade2 H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and second bi-term developmental mathematics course grade.

Participants

The population included all students enrolled in one or more developmental mathematics courses at a Kentucky community college during spring 2008. The college's developmental mathematics program included three courses: Pre-algebra (MT 55), Beginning Algebra with Measurement (MT 65), and Intermediate Algebra with Applications (MT 120). The population of all students registered in MT 55, MT 65, and MT 120 was 372. This included neither students who registered but dropped before the drop/add date nor students in classes that were canceled due to insufficient enrollment.

Table 1

Developmental mathematics course descriptions

Course	Description
Pre-Algebra	Students enhance their understanding and manipulative skills in the arithmetic of rational numbers. Topics include whole numbers, powers and square roots, fractions, decimal fractions, percents, ratios, proportions signed numbers, order of operations, prime factorization, basic formulas in geometry, measurement and tables and graphs. Lecture: 3 credits (45 contact hours).
Beginning Algebra with Measurement	Basic algebra course covering variable expressions, linear equations and inequalities, exponents polynomials, factoring, square and cube roots, scientific and engineering notation, elementary graphing, and measurement unit and conversions. Prerequisite: MT 055 or equivalent as determined by KCTCS placement examination. Lecture: 3 credits (45 contact hours).
Intermediate Algebra with Applications	Exponents, factoring, polynomials, radicals, radical expressions, graphing in the plane, functions, linear and quadratic equations, systems of linear equations, and appropriate applications. Not available for students with credit in MAH 080, MAH 083, MA 108, MT 122, MA 109, MT 109, or any MT math course numbered above 140. Prerequisite: MT 65 or equivalent as determined by KCTCS placement examination. Lecture: 3 credits (45 contact hours).

Source: KCTCS 2010 - 2011 catalog.

Formal course descriptions have been included in Table 1. The college's mandatory placement policy required placement into these courses depending on a students' ACT or COMPASS test scores. Remedial courses not tied to mandatory placement or belonging to Adult Basic Education (ARI prefix) were excluded from this study. The population and enrollment by course and section has been included in table 2.

Setting

The study was conducted at one of sixteen colleges in the Kentucky Community and Technical College system. The multi-campus community college has had an annual enrollment of approximately 5,000. The college's service area has traditionally been considered economically depressed with a preponderance of at-risk students. Broader definitions of "at-risk" included background, internal, and environmental factors (Bulger & Watson, 2006). This study defined at-risk students as those who "tested into two or more developmental courses" (SKCTC QEP, 2006).

Table 2

Developmental Mathematics Course Spring 2008 Enrollment

Course	Sections	Enrollment
MT 55	6	88
MT 65	8	179
MT 120	5	105
	Total	372

Source: PeopleSoft (Retrieved from https://kctcs.mycmsc.com/)

Sampling Procedures

The sample size was determined based on the population size at the beginning of the spring 2008 semester. As seen in table 2, the total population was 372. The required

sample size was 189 (approximately 50.8% of the population) for 95% confidence and a 5% margin of error (Gay & Airasian, 2003, p. 113). The names of students in the population were put in an alphabetical list, and assigned a number from 001 to 372 (all numbers were written with three digits). "Research Randomizer" at http://www.randomizer.org was used to generate another list of random numbers from 1 to 372. The first 189 numbers on this list were used for the sample. This allowed every person to have an equal chance of being chosen for the sample. For example, if the first number on the second list was 175, then person number 175 was included in the sample, and so on, until the sample size of 189 was reached.

Sample members addresses were obtained from the community college. Sample members were sent via postal mail the MSES pretest, posttest, interview questionnaire, an explanation of the study, and the confidentiality agreement (see Appendix C). Pretest respondents were sent posttest and interview reminders near the end of the spring 2008 semester. Seventy-two respondents completed both pretest and posttest, submitted valid surveys, and completed the exit interview questionnaire. An invalid survey was defined as a survey that omitted eight or more question responses (Betz & Hackett, 1983). Respondents who did not meet these criteria were not included in data analysis.

Instrumentation

The Mathematics Self-Efficacy Survey (Betz & Hackett, 1983) pretest/posttest (see Appendix B), exit interview questionnaire (see Appendix B), instructions and confidentiality agreements (see Appendix C) were sent by postal mail to a random sample of the population. Respondents who completed the pretest were sent reminders at the end of the semester to complete the posttest. Instrument-related data collection

included the MSES pretest and posttest. Additional non-instrument data collection regarding grades and demographic information such as gender, age and ethnicity was accomplished through PeopleSoft (www.kctcs.mycmsc.com), the community college's comprehensive personnel and student data system.

The study utilized the Mathematics Self-Efficacy Survey (Betz & Hackett, 1983) as a pretest and posttest for the respondents in the sample. The Mathematics Self-Efficacy Scale measured "beliefs regarding ability to perform various math-related tasks and behaviors" (Betz & Hackett, 1989). The 34-item instrument was divided into two subscales: Mathematics task self-efficacy (18 items) and math-related school subjects self-efficacy (16 items). The mathematics tasks subscale measured "confidence in ability to perform everyday math tasks" (Hall & Ponton, 2002). The math-related school subjects subscale assessed "confidence to persist in math-related courses with a grade of B or better (Hall & Ponton, 2002).

The MSES yielded scores on Mathematics Task Self-Efficacy, Math-Related School Subjects Self-Efficacy and total Mathematics Self-Efficacy. Respondents indicated their responses on a 10-point Likert scale, with 0 meaning "no confidence at all" and 9 meaning "complete confidence". An invalid MSES was one that contained eight or more blank responses (Betz & Hackett, 1983). Betz & Hackett (1989) maintained that there was significant evidence for the content validity, concurrent validity, and construct validity of the MSES.

The Betz & Hackett (1983) MSES had reliability coefficient alphas of .96 on the total scale, .92 for the Tasks subscale, .96 for the problems subscale, and .92 for the courses subscale" (Hall & Ponton, 2002; Betz & Hackett, 1989). The item-total (item

discrimination) correlations for the math tasks subscale ranged from .24 to .63; ranges for the math problems subscale was .38 to .68; ranges for the math courses subscale was .16 to .70. Research has provided ample evidence for the "reliability (coefficient alpha) and validity of all three sections of the MSES" (Betz & Hackett, 1989).

The MSES which was said to lack specificity (Langenfeld & Pajares, 1993; Pajares (1996); Pajares, Hartley & Valiante, 2001) was an earlier version of the MSES. The math problems section with which fault was found was no longer included in the published version of the MSES. The self-efficacy instrument had to be specific to the situation and desired performance tasks (Bandura, 2005; Pajares, Hartley, & Valiante, 2001). Specificity increased predictive validity (Pajares, Hartley, & Valiante, 2001; Pajares & Kranzler, 1997). However, while Pajares & Langenfeld (1993) found the college courses subscale to lack task specificity, their variation on the MSES to create the MSES-R (Pajares & Langenfeld, 1993; Hodges, 2005) did not impact the college courses subscale other than the substitution of a 10-point Likert scale for the original 5-point scale. The current published version of Betz & Hackett's MSES likewise has replaced the earlier scale with a 10-point Likert scale. In other words, the only significant research challenges to the MSES have been addressed in the published version of the instrument.

Age, gender, course and grade information were collected via PeopleSoft, the college system's comprehensive information and personnel system. Possible relationships between mathematics self-efficacy and ethnicity were not considered since the population was not ethnically diverse (virtually all students were Caucasian).

Data Analysis

Data were analyzed using the SPSS statistical software. The statistical test used to

accept or reject the null hypotheses was multiple linear regression. Regressions were run on posttest MSES scores, as recommended by the dissertation committee. Mathematics self-efficacy score (an average of the Math Tasks and Math Subjects subscale scores) was the independent variable while age, gender, course (1 and 2), and grade (1 and 2) were the dependent variables.

Independent variables were coded so that they could be used in multiple linear regression. MSES results were coded 0-9 according to the survey instructions. Age was the numeric age. Gender was coded 0 for female and 1 for male. Course was coded 0 for MT 55, 1 for MT 65, 2 for MT 120. Grade was coded 0 for E, 1 for D, 2 for C, 3 for B, and 4 for A. SPSS statistics relevant to the results were descriptive statistics, ANOVA, regression coefficients (standardized and non-standardized), error, and Pearson r correlations.

CHAPTER FOUR: FINDINGS

Statistical analysis was conducted via SPSS statistical software with some data entry and importation into and out of SPSS done through Microsoft Excel. The primary statistical test performed was multiple linear regression, which was appropriate to investigate relationships between several independent variables and a single dependent variable. The posttest MSES scores were used for the regression analysis, as directed by the dissertation committee.

Independent variables were age, gender, course, and grade. Course consisted of two variables, course1 and course2. Course1 represented either a traditional 16-week course or a first bi-term (first eight weeks) course. Course2 represented a second bi-term (second eight weeks) course. Likewise, grade consisted of two values: Grade1 corresponded to Course1 and Grade2 corresponded to Course2. Null hypotheses were to be rejected only when specific probability values (namely, the probability values of the standardized beta coefficients) were less than 0.05. This was the test for the alpha = 0.05 level and 95% confidence.

Quantities pertinent for reporting multiple linear regression statistics according to APA format were the unstandardized coefficients of the independent variables (B), the standard error of these coefficients (SE B), the standardized or beta coefficients (b), the significance of the coefficients (denoted by asterisks in the tables), the change in the F statistic and its significance, the R statistic, and the R-square statistic.

The p-value of the F test determined whether the overall model was statistically significant. R^2 gave the proportion of variance in the dependent variable that was

accounted for by the independent variables in the model. The unstandardized coefficients (B) for each independent variable indicated the amount of change in the dependent variable one could expect given a one-unit change in that variable if all other model variables were held constant. The B coefficients were measured in units of the variable. The standardized forms (beta) of these coefficients, like z-scores, were measured in standard deviations and thus could be compared to each other to determine relative strength. Outliers were account for in SPSS by checking the menu option residuals, casewise diagnostics, and outliers outside three standard deviations.

Respondent enrollment was as follows: Six in MT 55 (8.3%), fifty-nine in MT 65 (81.9%), and seven (9.7%) in MT 120. Thirty-two (44.4%) were also enrolled in a second bi-term (second eight weeks) MT 120 course, which was the source of the "course2" and "grade2" independent variables. Forty (55.6%) were not enrolled in a bi-term MT 120 course, which meant that either they were enrolled in a traditional full-semester MT 55, MT 65, or MT 120 course, or that they were enrolled in a first bi-term course (first eight weeks) only.

Forty-three respondents (59.7%) were female while 29 (40.3%) were male. There were six MT 55 respondents: Four (66.7%) were male and two (33.3%) were female. There were 59 MT 65 respondents: Thirty-six (61%) were female and 23 (39%) were male. There were seven MT 120 respondents: Two (28.6 %) were male and five (71.4%) were female. Of those enrolled in a second bi-term course, 18 were female and 14 were male.

The mean age was M = 24 (SD = 9.06) and the median age was 20. The range was 49 (18 years to 67 years). The age frequencies were summarized in Table 4. Final

course grades were summarized in Table 5 according to course and gender.

Table 3

Age Frequencies of Respondents

Age	Frequency	Percent
18	16	22.2
19	17	23.6
20	4	5.6
21	6	8.3
2	2	2.8
23	2	2.8
24	1	1.4
25	3	4.2
26	3	4.2
28	2	2.8
29	1	1.4
30	2	2.8
32	2	2.8
33	1	1.4
34	1	1.4
36	1	1.4
38	2	2.8
39	2	2.8
44	2	2.8
49	1	1.4
67	1	1.4

N=72

Table 4

Respondent Developmental Math Grade Distribution by Course and Gender

	Grade 1							Grade 2						
	Freq	Pct	M	F	55	65	120	Freq	Pct	M	F	55	65	120
A	19	26.4	6	13	2	14	3	17	23.6	5	12	*	*	17
B	22	30.6	9	13	3	19	0	8	11.1	6	2	*	*	8
C	21	29.2	8	13	1	17	3	3	4.2	2	1	*	*	3
D	10	13.9	6	4	0	9	1	4	5.6	1	3	*	*	4

N=72; *MT 55 and MT 65 were not offered as second bi-term courses.

Hypothesis One: Age

H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and age. The results of the regression analysis were summarized in Table 6. The standardized beta coefficient for age was not significant at the .05 level (*p*=.229). Therefore the study failed to reject the null hypothesis.

Table 5

Summary of Regression Analysis of Age as Predictor of Mathematics Self-Efficacy

B	SE B	b	R^2	F	ΔR^2	Δ F	(95% CI)
-.023	.019	-.150	.095	1.141	.095	1.141	[-.060, .015]

Note: N=72. CI = confidence interval.

Hypothesis Two: Gender

H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and gender. The results of the regression analysis were summarized in Table 7. The standardized beta coefficient for gender was significant at the .05 level (*p*=.052), therefore the study rejected the null hypothesis. No significant relationship was found between mathematics self-efficacy and gender. However, *p*-value's proximity to .05 suggested a need for further study.

Table 6

Summary of Regression Analysis of Gender as Predictor of Mathematics Self-Efficacy

B	SE B	b	R^2	F	ΔR^2	Δ F	(95% CI)
.668	.337	.241	.095	1.141	.095	1.141	[-.005, 1.342]

Note: N=72. CI = confidence interval. 0=female, 1=male..

Hypothesis Three: Course1

H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and 16-week or first bi-term developmental mathematics course taken. The results of the regression analysis were summarized in Table 8. The standardized beta coefficient for the course1 variable was not significant at the .05 level (*p*=.687). Therefore, the study failed to reject the null hypothesis.

Table 7

Summary of Regression Analysis of Course1 as Predictor of Mathematics Self-Efficacy

B	SE B	b	R^2	F	ΔR^2	Δ F	(95% CI)
.156	.386	.049	.095	1.141	.095	1.141	[-.615, .928]

Note: N=72. CI = confidence interval. MT55=0, MT65=1, MT120=2

Hypothesis Four: Course2

H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and second bi-term developmental mathematics course taken. The standardized beta coefficient for the course2 variable was not significant at the .05 level (*p*=.418). Therefore, the study failed to reject the null hypothesis. Table 9 summarized the results of the regression analysis.

Table 8

Summary of Regression Analysis of Course2 as Predictor of Mathematics Self-Efficacy

B	SE B	b	R^2	F	ΔR^2	ΔF	(95% CI)
-.357	.564	-.130	.095	1.141	.095	1.141	[-1.483, .770]

Note: N=72. CI = confidence interval. MT55=0, MT65=1, MT120=2.

Hypothesis Five: Grade1

H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and 16-week or first bi-term developmental mathematics course grade. The results of the regression analysis were summarized in Table 10. The standardized beta coefficient for the grade1 variable was not significant at the .05 level (p=.229). Therefore, the study failed to reject the null hypothesis.

Table 9

Summary of Regression Analysis of Grade1 as Predictor of Mathematics Self-Efficacy

B	SE B	b	R^2	F	ΔR^2	Δ F	(95% CI)
.218	.180	.162	.095	1.141	.095	1.141	[-.141, .577]

Note: N=72. CI = confidence interval. 0=E, 1=D, 2=C, 3=B, 4=A.

Hypothesis Six: Grade2

H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and second bi-term developmental mathematics course grade. The standardized beta coefficient for the grade1 variable was not significant at the .05 level (p=.753). Therefore, the study failed to reject the null hypothesis. Table 11 summarized the results of the regression analysis.

Table 10

Summary of Regression Analysis of Grade2 as Predictor of Mathematics Self-Efficacy

B	SE B	b	R^2	F	ΔR^2	ΔF	(95% CI)
.079	.249	.066	.095	1.141	.095	1.141	[-.419, .576]

Note: N=72. CI = confidence interval. 0=E, 1=D, 2=C, 3=B, 4=A

Summary

The research hypotheses were tested by multiple linear regression in SPSS with age, gender, course (1 and 2) and grade (1 and 2) as the dependent variables. The null hypotheses stated that each of the variables would not be significantly predictive of mathematics self-efficacy as represented by responses to the Mathematics Self-Efficacy Survey (Betz & Hackett, 1983).

Multiple linear regression analysis resulted in failure to reject all null hypotheses: 1 (age), 2 (gender), 3 (course1), 4(course2), 5(grade1), and 6(grade2). There was no statistically significant relationship found between age, gender, course, or grade and mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey). However, the significance of the standardized beta coefficient for gender was .052. This suggested a need for further study of mathematics self-efficacy concerning gender.

Pearson r correlations and two-tailed t-test significance values formed the basis for further discussion and for attempts to explain the findings. These values were summarized in table 11. Gender was the only variable that was significantly correlated to MSES score (p=.031). However, the criterion for hypothesis rejection was $p<.05$ for the standardized beta coefficient of an independent variable. Therefore, the correlation's significance could not have been the basis for rejection of the null hypothesis.

Age and grade1 were significantly correlated (p=.006). Older students tended to have higher grades than younger students. Course2 and grade2 were significantly correlated (p=.000). This meant that students in the higher-numbered second bi-term course were more likely to have correspondingly higher grades. However, only 32 of the 72 respondents (44.4%) took a second bi-term developmental mathematics course.

Table 11

Correlations Between Variables in the Regression Model

		MSES Score	Age	Gender	Course 1	Course 2	Grade 1	Grade 2
MSES Score	Pearson correlation	1.000	-.109	.221	-.008	-.102	.099	-.047
	Sig. (2-tailed)	.	.182	.031	.475	.197	.203	.347
Age	Pearson correlation	-.109	1.000	-.061	.010	-.017	.292	.100
	Sig. (2-tailed)	.182	.	.305	.468	.444	.006	.201
Gender	Pearson correlation	.221	-.061	1.000	-.160	-.063	-.144	-.091
	Sig. (2-tailed)	.031	.305	.	.089	.299	.113	.225
Course 1	Pearson correlation	-.008	.010	-.160	1.000	.029	-.087	.023
	Sig. (2-tailed)	.475	.468	.089	.	.404	.233	.423
Grade 1	Pearson correlation	.099	.292	-.144	-.087	-.077	1.000	.161
	Sig. (2-tailed)	.203	.006	.113	.233	.260	.	.089
Course 2	Pearson correlation	-.102	-.017	-.063	.029	1.000	-.077	.791
	Sig. (2-tailed)	.197	.444	.299	.404	.	.260	.000
Grade 2	Pearson correlation	-.047	.100	-.091	.023	.791	.161	1.000
	Sig. (2-tailed)	.347	.201	.225	.423	.000	.089	.

CHAPTER FIVE: DISCUSSION

The purpose of this study was to evaluate the mathematics self-efficacy of postsecondary developmental mathematics students before and after a developmental mathematics course and to determine if a relationship existed between mathematics self-efficacy and age, gender, course, and grade. The resulting implications were considered according to their impact on future research and practice in developmental mathematics education. Students were considered the ultimate beneficiaries of any findings and recommendations.

Null hypotheses were as follows:

1. Age - H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and age.
2. Gender - H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and gender.
3. Course1- H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and 16-week or first bi-term developmental mathematics course taken.
4. Course2- H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and second bi-term developmental mathematics course taken.
5. Grade1- H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and 16-week or first bi-term developmental mathematics course grade.

6. Grade2 - H_0 stated that there would be no relationship between mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey) and second bi-term developmental mathematics course grade.

Null hypotheses were tested via multiple linear regression in SPSS. Age, gender, course (1 and 2), and grade (1 and 2) were the independent variables, while the Mathematics Self-Efficacy Scale (Betz & Hackett, 1983) score was dependent variable. Null hypotheses were rejected if the standardized beta coefficient of the independent variable in a hypothesis was significant at the .05 level.

Summary of Findings

Hypothesis one: Age

Multiple linear regression including age as an independent variable and mathematics self-efficacy as the dependent variable yielded no significant results at the .05 level (b =-.150). The results failed to reject the null hypothesis. No statistically significant relationship was found between mathematics self-efficacy and age.

Hypothesis two: Gender

Multiple linear regression including gender (0 = female; 1 = male) as an independent variable and mathematics self-efficacy as the dependent variable yielded no significant results at the .05 level (b =.241). The results narrowly failed to reject the null hypothesis. No statistically significant relationship was found between mathematics self-efficacy and gender.

Hypothesis three: Course1

Multiple linear regression including Course1 as an independent variable and mathematics self-efficacy as the dependent variable yielded no significant results in

model one (*b* =.049) at the .05 level. The results failed to reject the null hypothesis. No statistically significant relationship was found between mathematics self-efficacy and the 16-week or first bi-term developmental mathematics course.

Hypothesis four: Course2

Multiple linear regression including Course2 as an independent variable and mathematics self-efficacy as the dependent variable yielded no significant results at the .05 level (*b*=-.130). The results failed to reject the null hypothesis. No statistically significant relationship found between the mathematics self-efficacy and the second bi-term course.

Hypothesis five: Grade1

Multiple linear regression including developmental mathematics grade (Grade1) as an independent variable and mathematics self-efficacy as the dependent variable yielded no significant results at the .05 level (*b*=.162). Therefore the study failed to reject the null hypothesis. No statistically significant relationship was found between mathematics self-efficacy and the grade in the 16-week or first bi-term developmental mathematics course.

Hypothesis six: Grade2

Multiple linear regression including developmental mathematics grade (Grade2) as an independent variable and mathematics self-efficacy as the dependent variable yielded no significant results at the .05 level (b=.066). Therefore, the study failed to reject the null hypothesis. No statistically significant relationship was found between mathematics self-efficacy and the grade in the second bi-term developmental mathematics course.

Discussion of Findings and Implications Related to the Literature

Hypothesis One: Age

The typical assumption has been that non-traditional students were at-risk academically. However, this study did not find age to be a significant predictor of mathematics self-efficacy. Analysis of grades, however, showed that non-traditional students often performed at higher levels than their younger counterparts.

Boylan (2001) expected the number of non-traditional students to continue to increase, widening the gap between high school exit and college entry requirement and making high school reform efforts irrelevant. Community colleges in Kentucky have been the first choice for non-traditional students. Sixteen community colleges located throughout the state, most with multiple campuses, have made postsecondary education accessible to many who otherwise could not have attended college.

Also, non-traditional students have been of concern due to the gap between their high school and college careers. The Council on Postsecondary Education has drafted common core standards to which all curricula, k-12 and postsecondary, must be aligned (www.corestandards.org). This effort was designed to close the gap between high school exit and college entry requirements. Community college students in Kentucky, including the non-traditional students, were to be beneficiaries of this alignment.

Hypothesis Two: Gender

This study did not find gender to be a significant predictor of mathematics self-efficacy at the .05 level (b=.241). Gender was coded as F=0 and M=1. The gender p-value was .052, which was close enough to suggest a need for further research. Neither gender was more likely to have higher levels of mathematics self-efficacy than the other.

This finding was not uncommon in the literature. Cooper & Robinson (1989) found no significant gender differences in mathematical ability, anxiety, and performance. Garduno (2001) likewise found no gender differences in achievement of self-efficacy. Pajares & Kranzler (1994) found no achievement or self-efficacy differences between genders among high school students.

Other researchers have found significant relationships between gender and self-efficacy. Bandura (2006) found equal achievement levels between the genders but found that males exhibited higher science/technology career self-efficacy. Betz & Hackett (1982) found higher levels of male self-efficacy pertaining to science-based careers. Betz & Hackett (1989) found "no support for a 1981 hypothesis that females' mathematics self-efficacy expectations were unrealistically low as compared to those of males". Betz & Gwilliam (2001) found significant gender differences in favor of males in both math and science self-efficacy. Meece, Glienke, and Burg (2006) also found that boys reported strong ability an interest beliefs in math and science, while girls had more confidence in language arts and writing.

Mwamwenda (1999), Tate (1997), Nyangeni & Glencross (1997), and Voyer (1996) found that males exhibited higher mathematics self-efficacy than females. Hanson (2001) and Lapan (1989) found that a gender disparity existed in females. Junge & Dretzke (1995) and Brahier (1995) also found males to have greater self-efficacy. Lloyd, Walsh, & Yailagh (2005) also supported this finding. Contrarily, Kenney-Benson, Pomerantz, Ryan, and Patrick (2006) noted a tendency for girls to outperform boys. Stage and Kloosterman (1995) found a significant relationship between self-efficacy and previous math skills. However, they found that self-efficacy was unrelated to males' final

course grades but significantly related to females' final course grade.

Pajares & Miller (1994) found gender to be less predictive of self-efficacy and problem-solving ability than other factors. Research on the factors in the formation of gender-based self-efficacy beliefs (Pajares, Zeldin, & Lapin, 1999; Pajares & Zeldin, 2000; Pajares, Zeldin & Britner 2008; Betz & Hackett, 1984; Hanson, 2001); gender bias (Bandura, 2006; Bandura, 1997; Bussey & Bandura, 1999; Hackett & Betz, 1981); gender inequity (Asimeng-Boahene, 1999); and gender-typing (Turner, Steward, & Lapan, 2004) were beyond the scope of this study.

Hypotheses three and four: Course1 and Course2

The developmental math course in which a respondent was enrolled was not a significant predictor of mathematics self-efficacy (course1 *b*=.049; course2 *b*=-.130). Since the literature did not differentiate between 16-week and bi-term courses, these hypotheses were discussed together to avoid redundancy.

The only research that specifically investigated the relationship of mathematics self-efficacy and course level was Hall & Ponton (2002). They found that calculus students had higher self-efficacy levels than intermediate algebra students.

Pajares & Miller (1995) found that students' reported confidence to answer math problems was a greater predictor of performance than their math-related tasks or math-related courses self-efficacy. This referred to the three-subscale MSES (math problems, math tasks, math courses). The updated MSES only used the math tasks and math courses subscales. This study found no significant results in these areas. Lapan et. al. (1996) found that math self-efficacy beliefs and vocational interests were important in predicting math/science majors.

The remainder of the research discussed positive programming strategies, to which the MT 55, MT 65, and MT 120 courses were compared. Comparison was designed to aid understanding of the context of the study.

Haycock (2002) noted the disconnect between the increase in high school advanced placement courses and the simultaneous increase in college developmental math courses. MT 55, MT 65, and MT 120 courses did, in fact, repeat content from high school pre-algebra, algebra 1, and algebra 2.

The developmental courses were not separated into their own academic division at the time of research, but were scheduled to be separated in 2011 or 2012. Students would have benefited from centralized developmental programming (Boylan & Saxon, 1999; Roueche & Kirk, 1974; Roueche & Snow, 1977; Donovan 1974; Boylan, Bonham, Claxton, & Bliss 1992). Decentralized programs which had strong coordination of developmental activities and strong communication between developmental course teachers were just as effective as centralized efforts (Boylan, Bliss, & Bonham, 1997).

The courses had clearly defined curricular objectives Roueche (1968, 1978) (Boylan & Saxon, 1999; Donovan, 1974; Cross, 1976; Kulik & Kulik, 1991; Boylan, Bonham, Claxton, & Bliss, 1992) as evidenced by their course curriculum documents. The clarity of goals and objectives facilitated a "clear course structure" (Boylan & Saxon, 1999) as evidenced by the curriculum documents and course syllabi.

.Incoming students were offered freshmen orientation (Upcraft & Gardner, 1989). (Gardner, 1998). Students placed into one developmental course had to take an eight-week GE 100 Introduction to College course. Students placed into more than one developmental course had to take a 16-week GE 101 course Strategies for College

Success.

Assessment and placement were mandatory for the developmental mathematics courses (Roueche & Roueche, 1993; Boylan & Saxon, 1999; Roueche & Baker, 1987; Roueche & Roueche, 1993; Roueche & Snow, 1977; Casazza & Silverman, 1996; Maxwell, 1997; Morante, 1987; Morante, 1989). However, subsequent research suggested only mandatory assessment was "clearly associated with student and program success" (Boylan & Saxon, 1999; Boylan, Bonham, Claxton, & Bliss, 1992; Boylan, Bliss, & Bonham, 1997).

Students were placed into the developmental mathematics courses by ACT or COMPASS exam, but exited by passing the course final and related assignments. Alignment between entrance and exit exams was desirable (Boylan, Bonham, Claxton, & Bliss 1992; Roueche & Roueche, 1999) but not implemented (Boylan, et. al., 1996). The college offered Adult Basic Education services for those who tested too low for even the most basic developmental mathematics courses McCabe (2000).

Developmental education programs evaluated systematically on a regular basis were more effective than those that were not (Boylan & Saxon, 1999; Donovan, 1974; Roueche & Snow, 1977). Instructors were evaluated each semester by student evaluations and annually by division chairs. Overall programming was evaluated annually by student exit surveys. Specific courses were not evaluated as such.

Teaching methods were primarily traditional lecture. Developmental students benefited from a variety of teaching methods, such as class discussions, group projects and mediated learning rather than traditional lecture (Boylan & Saxon, 1999; Roueche, 1968; Roueche & Wheeler, 1973; Cross, 1976; Kulik & Kulik, 1991; Casazza &

Silverman, 1996).

Early counseling and guidance were essential if students were to remain in the developmental program long enough for its initiatives to have a positive effect (Baily, Jeong, & Cho, 2008). Counseling was not integrated into the program's structure (Kiemig, 1983), but was offered through Student Support Services/Academic Advantage and advertised through freshmen orientation and GE 100/101 courses.

All campuses offered student tutoring to increase retention rates (Ramirez, 1997) and student performance (Martin & Arendale, 1994). Tutors had to complete a tutor training course (Boylan, Bonham, Claxton, & Bliss, 1992). The student tutors have attended the courses for which they offered tutoring (Boylan & Saxon, 1999). Supplemental library resources, including video (Martin & Arendale, 1998) were available to students and were actively publicized in some of the courses but not all of them.

Computer tutoring (Boylan & Saxon, 1999; Kulik & Kulik, 1991; Roueche & Roueche, 1999) was increasing in prevalence, through Blackboard and PLATO. The college was due to implement My Math Lab supplemental instruction (Bonham, 1992; Maxwell (1997); (Boylan & Saxon, 1998) in 2010. Integration of classroom and laboratory instruction was associated with developmental student success (Boylan, Bliss, & Bonham, 1997; Boylan & Saxon, 1998).

Hypotheses five and six: Grade1 and grade2

Grade was not a significant predictor of mathematics self-efficacy (Grade1 *b*=.162; Grade2 *b*=.066). Since the literature did not differentiate between 16-week and bi-term course grades, the discussion of these hypotheses was undertaken jointly so as to

avoid redundancy.

This study sought to find whether grade was predictive of self-efficacy, rather than using the more common approach in the literature, which was to find whether self-efficacy was a predictor of grade. This approach was not without precedent in the literature. Pajares & Miller (1994) and Zimmerman & Cleary (2006) considered mathematics self-efficacy to be an antecedent to the learning experience and hence the course grade (Pajares & Miller, 1994; Zimmerman & Cleary, 2006).

Usher & Spence (2007) found mathematics self-efficacy to be among the most significant predictors of mathematics achievement. Lent (1993) found that self-efficacy (along with achievement) predicted math grades while self-efficacy (along with outcome expectations) predicted academic interests and enrollment intentions. Lent (1993) found that self-efficacy (along with achievement) predicted math grades while self-efficacy. Stage and Kloosterman (1995) found that self-efficacy was unrelated to males' final course grades but significantly related to females' final course grade. Kloosterman (1991) also found a correlation between seventh grade students' beliefs about how mathematics is learned and their achievement in mathematics. Shores & Shannon (2007) found that motivation and anxiety contributed significantly to test score and math grade for fifth grade students. Self-efficacy, anxiety, and failure were related to academic performance while failure attribution was significantly related to math grade. Courses, programs and activities designed to enhance critical thinking skills improved student attitudes toward learning (Harris & Eleser, 1997), grade point averages and retention (Chaffee, 1998). Contrary to these findings, this study did not find self-efficacy predictive of grades in either males or females.

Study Limitations and Recommendations for Future Research

Sample

The sample was chosen randomly from the population of all students enrolled in one of the three developmental mathematics courses: MT 55, MT 65, and MT 120. Population members were assigned three-digit numbers then a random number generator was used to select sample members from the population until the sample size was reached. The population was 372 and the calculated desired sample size was n = 189 (approximately 50.8% of the population) for 95% confidence and a 5% margin of error (Gay & Airasian, 2003, p. 113). However, the number of respondents who returned pretest, posttest, and exit interview was n = 72.

Also, none of the 72 respondents received a grade of "E" in any course. Therefore, the students who would have concerned educators the most, i.e., those who did not successfully complete the course provided no feedback regarding the survey or questionnaire items, making it impossible to obtain findings on their experience. Generally, non-success also includes those who earned a grade of "D", but for practical purposes, those with a grade of "D" or better have been allowed to receive course credit and move on to the next course in the mathematics sequence, both developmental and non-developmental.

The sample members all resided within a three-county community college service area in southeastern Appalachia. The sample did not have enough ethnic diversity to investigate ethnic differences in mathematics self-efficacy, which was why this variable was not considered in any hypothesis testing or correlations. The population and sample were almost entirely Caucasian.

Instruments

The Betz & Hackett (1983) MSES had reliability coefficient alphas of .96 on the total scale, .92 for the Tasks subscale, .96 for the problems subscale, and .92 for the courses subscale" (Hall & Ponton, 2002; Betz & Hackett, 1989). The item-total (item discrimination) correlations for the math tasks subscale ranged from .24 to .63; ranges for the math problems subscale was .38 to .68; ranges for the math courses subscale was .16 to .70. Research has provided ample evidence for the "reliability (coefficient alpha) and validity of all three sections of the MSES" (Betz & Hackett, 1989).

Reliability

The Betz & Hackett (1983) MSES had reliability coefficient alphas of .96 on the total scale, .92 for the Tasks subscale, .96 for the problems subscale, and .92 for the courses subscale" (Hall & Ponton, 2002; Betz & Hackett, 1989). The item-total (item discrimination) correlations for the math tasks subscale ranged from .24 to .63; ranges for the math problems subscale was .38 to .68; ranges for the math courses subscale was .16 to .70. Research has provided ample evidence for the "reliability (coefficient alpha) and validity of all three sections of the MSES" (Betz & Hackett, 1989).

Threats to Internal Validity

The posttest MSES score (taken at the end of the semester) was the basis for the multiple linear regression analysis. A maturation threat might have resulted if both a pretest and posttest (and the resultant gap between the two) had been considered. The posttest-only approach eliminated this problem. Nonetheless, maturation would not have been a significant factor since the study encompassed 16 weeks rather than many months or years. Subjects were chosen randomly, which minimized a threat due to selection of

subjects. The study was subject to an experimental mortality threat. One hundred-seventeen sample members were lost due to failure to complete pretest, posttest, and/or exit interview. The number of respondents for which statistics could thus be calculated was 72.

Threats to External Validity

There was no experimental hindrance to generalizing results to non-experimental settings (reactive effects of experimental arrangements). Multiple treatments would have resulted if a respondent had more than one developmental math course in a semester (multiple treatment inference threat).

Analysis

Multiple linear regression was the appropriate statistical test for the several independent variables and the math self-efficacy dependent variable. SPSS calculated beta coefficients for each independent variable in an attempt to find a regression equation that could have been used for prediction of the dependent variable(s). No significant linear regression equation was found. The study did not investigate possible non-linear correlations between variables. This was seen as a task for further research. SPSS compensated for outliers during the regression analysis. SPSS calculated correlations and significances between variables. These values formed the basis for further interpretation of this study's findings.

Implications

Hypothesis One: Age. Age has been of concern since older students have been out of school longer, and because there has typically been a gap between high school exit requirements and college entry requirements. Educators have usually assumed that non-

traditional students are at-risk due to these factors.

This study, however, did not find age to be a statistically significant predictor of mathematics self-efficacy. There was no need for the development of age-specific programming related to mathematics self-efficacy. Program improvements could simply apply equally to all students. Age-based initiatives could, however, bolster retention.

The community college in this study served its students with equity in services offered. All students were eligible to receive supplemental instruction or to participate in federal college preparation initiatives such Student Support Services (SSS). The community college also sought to improve the transition from high school to college through Upward Bound, a college preparatory program for high school students in the college service area.

Hypothesis Two: Gender. Most research in the literature review concerning gender-based self-efficacy differences found that males exceeded females in mathematics self-efficacy or in science-based course self-efficacy. However, some researchers found no significant gender-based differences in self-efficacy. This study fell into the latter category. It found that gender was not a statistically significant predictor of mathematics self-efficacy. Neither gender was more likely to have higher mathematics self-efficacy beliefs than the other. However, the p-value of .052 was very close to significance at the .05 level. This suggested a need for further research.

The literature did not offer solutions on what to do about gender-based differences in efficacy. It would be quite politically incorrect to suggest that a program initiative was only for either gender group. The best one could do would be to create twin initiatives, one for males and one for females, but the context would have to be right or it would

likely cause gender bias problems. It would be far better, as described in the implications of the age hypothesis, to simply address programming to all students so that those who desire improvement can achieve it. Gender-based research would continue to be descriptive rather than proscriptive, except as it informed general program evaluation and improvement. Gender-based initiatives should be general to the college rather than specific to mathematics, and could also improve retention.

Hypotheses Three and Four: Course1 and Course2. These hypotheses have been discussed together to avoid redundancy. There were few studies in the literature which considered the relationship between course and self-efficacy. This study did not find either the 16-week or first bi-term course (Course1) or the second bi-term course (Course2) to be significant predictors of mathematics self-efficacy. One could not assume that the mathematics self-efficacy of students in a higher-level developmental mathematics course was any greater than that of students in a lower-level course.

Students take these developmental mathematics courses at this community college because they have been placed there by a mandatory placement test. Perhaps efficacy might be more pertinent non-developmental courses chosen by students rather than by a mandatory placement policy. The college had no need, based on the results of this study, to address self-efficacy levels in the developmental mathematics courses other than through general program improvement.

Hypotheses Five and Six: Grade1 and Grade2. These hypotheses will be discussed together to avoid redundancy. Most research investigated whether self-efficacy was a predictor of grade. Some research, however, did take the opposite approach, which was investigating whether grade was a predictor of self-efficacy. This study took the latter

approach.

This study did not find the grade in the 16-week or first bi-term course or the grade in the second bi-term course to be significant predictors of mathematics self-efficacy. Mathematics self-efficacy did not necessarily increase with a higher grade. This meant that self-efficacy problems still existed after the course, which is counter to the goals of the developmental mathematics courses. The courses were designed explicitly to improve certain subject-area skills, with self-efficacy only present implicitly. This should not be seen as an indication of grade inflation, which has long been an incendiary accusation leveled at the community college, but rather perhaps an indication that students have succeeded in the course by focusing on incremental skills but have not for whatever reason added to their overall conceptual self-efficacy framework. It was also a potential indication that more work was needed than was possible in the time allotted.

Recommendations for Future Research and Practice

Recommendation One. Perform additional research on gender as a predictor of mathematics self-efficacy. Investigate factors in the formation of gender-based self-efficacy beliefs as described in the literature. Programming need not be gender-specific unless it was necessary to bolster retention. This recommendation was based on the findings concerning hypothesis two.

Recommendation Two. Perform research with the MSES math tasks and math courses subscales considered separately. The researcher ran more regression analyses than were pertinent for this study (i.e., subscale 1 only, subscale 2 only). Sometimes significant beta coefficients were obtained on one or both of the subscales but not on the overall

instrument, or significance levels varied between subscales. More specificity was needed. This recommendation was based on the findings concerning hypotheses three, four, five and six.

Recommendation Three. Seek greater math tasks specificity by creating an instrument or instruments based on the approved curriculum documents for the MT 55, MT 65, and MT 120 courses. These documents are extensively peer reviewed by the college curriculum committee, the faculty senate and its subcommittees and are the agreed-upon outcomes which the instructors must teach and which the courses must impart. This recommendation was based on the need for greater specificity as described in the literature.

Recommendation Four. Provide respondents with definition of and/or sample activities from subsequent math or math-related courses. Respondents' activating schema pertaining to these courses may be widely varied and subject to much speculation. Therefore their estimation of their ability to perform well in those courses, either on the pretest or the posttest, may be based on erroneous assumptions. This recommendation was based on the need for greater specificity as described in the literature and was closely related to recommendation three.

Recommendation Five. Evaluate and modify programming according to the best practices described in the literature. Programming need not be age-specific unless it is needed to bolster retention. This recommendation was based on the findings concerning hypothesis one.

Recommendation Six. Align freshmen college orientation course content to include components found to be significantly correlated to mathematics self-efficacy. Administer

relevant surveys in mathematics or English/reading/writing during the orientation course. This recommendation was based on the researcher's desire to integrate self-efficacy theory into the freshmen college experience and on best practices as described in the literature.

Recommendation Seven. Investigate instructor professional development needs and offer professional development events to align content knowledge with the approved curriculum documents, and to align instructor behaviors with positive teaching behaviors that focus on student service with an awareness of self-efficacy theory. This recommendation was based on best practices as described in the literature.

Conclusion

The purpose of this study was to evaluate the mathematics self-efficacy of postsecondary developmental mathematics students before and after a developmental mathematics course and to determine if a relationship existed between self-efficacy and age, gender, course, or grade. This study did not find any of the independent variables to be significant predictors of mathematics self-efficacy (as indicated by the Mathematics Self-Efficacy Survey).

Age was not a significant predictor of mathematics self-efficacy (regression analysis), but older students tended to outperform younger ones (correlation). This correlation was supported in the literature. Gender was not a significant predictor of mathematics self-efficacy, which supported the findings in a portion of the literature. Developmental mathematics course taken was not a significant predictor of mathematics self-efficacy. Most researchers addressed self-efficacy as a possible predictor of grade. Some used the opposite approach, as did this study, and investigated grade as a possible

predictor of self-efficacy. Findings in most of the literature were not directly comparable to this study since the literature concerned general self-efficacy or course achievement. Recommendations for future research were made either on the basis of specific hypotheses or related findings in the literature.

The literature has proven the importance of self-efficacy in academic endeavors and the field of education. Several community colleges in Kentucky have reported record enrollments on their campuses. Adverse economic factors continue to boost enrollment as people leave the workforce either voluntarily or involuntarily. The Council on Postsecondary Education (CPE) raised cut scores for on ACT and COMPASS for placement into developmental courses. CPE has also created College Readiness Standards to which all courses, including developmental math courses, must be aligned. This study was an introductory investigation into the field of self-efficacy as it relates to developmental mathematics. This study, in addition to the emerging trends and needs in the field of developmental education, demonstrates the importance of mathematics self-efficacy to community college developmental mathematics. Although none of the null hypotheses in this study were rejected, the results were still informative for future research and practice. There has been an ongoing need for quality research to guide practice as community colleges sought to fulfill their primary goal, which was to enable students to obtain the degree, certificate, or diploma of their choice and successfully enter the workforce.

REFERENCES

ACT, Incorporated. (2009). *The ACT test*. Retrieved from http://www.act.org/aap/

ACT, Incorporated. (2009). *ASSET: A student advising, placement and retention service.* Retrieved from http://www.act.org/asset/index.html.

ACT, Incorporated. (2009). *COMPASS: College placement tests*. Retrieved from http://www.act.org/compass/index.html.

Adams, S., & Huneycut, K. (1999, April). *Learning communities at Sandhills Community College*. Paper presented at the North Carolina Community College System Conference on Alternatives to Remediation, Boone, NC.

Adelman, C. (1999). *Answers in the tool box: Academic intensity, attendance patterns, and bachelor's degree attainment*. Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Aiken, L. R. (1974). Two scales of attitude toward mathematics. *Journal for Research in Mathematics Education, 5*, 67-71. Retrieved from the ERIC database.

Aiken, L. R. & Dreger, R. M. (1961). The effect of attitudes on performance in learning mathematics. *Journal of Educational Psychology, 52*, 19-24. Retrieved from the ERIC database.

American Psychological Association. (2001). *Publication manual of the American Psychological Association.* Washington, D. C.: American Psychological Association:

Armington, T. (2002). Working with developmental students. In T. Armington (Ed.), *Best Practices in Developmental Mathematics, Volume 1*.

Bailey, T., Jeong, D. W., Cho, S. (2008). *Referral, enrollment, and completion in developmental education sequences in community colleges.* CCRC Working Paper No. 15. Retrieved from http://www.eric.ed.gov/ ERICWebPortal/ contentdelivery/servlet/ERICServlet?accno=ED503962

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavior change. *Psychological Review*, 2, 191 - 215.

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

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior*. (pp. 71 - 81). New York: Academic Press. Retrieved from http://www.des.emory.edu/mfp/BanEncy.html

Bandura, A. (2004). *Swimming against the mainstream: The early years from chilly tributary to transformative mainstream.* Behavior and Research Therapy 42, 613 - 630. Retrieved from http://www.des.emory.edu/mfp/Bandura2004BRT.pdf

Bandura, A. (2005). Guide for constructing self-efficacy scales. In F. Pajares & T. Urdan (Eds.), *Self-efficacy beliefs of adolescents*. Greenwich, CT: Information Age Publishing. Retrieved December 1, 2005, from http://www.emory.edu/ EDUCATION/mfp/SEff-Guide2005Revised.html

Bandura, A. (2006). Adolescent development from an agentic perspective. In F. Pajares & T. Urdan (Eds.), *Self-efficacy beliefs of adolescents*, 5, 1-43. Greenwich, CT: Information Age Publishing. Retrieved from http://www.des.emory.edu/mfp/001-BanduraAdoEd2006.pdf

Benbow, C. P., & Stanley, J. C. (1982). Consequences in high school and college of sex differences in mathematical reasoning ability: A longitudinal perspective. *American Educational Research Journal*, 19, 598-622.

Belz, H. F., & Geary, D.C. (1984). Fathers' occupations and social background: Relation to SAT scores. *American Education Research Association Journal,* 21, 473-478.

Betz, N. E. (1994). Career counseling for women in the sciences. In W. B. Walsh & S. H. Osipow (Eds.), *Career counseling for women,* 237-262. Hillsdale, NJ: Erlbaum.

Betz, N., & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. *Journal of Vocational Behavior,* 23, 329-45.

Betz, N., & Hackett, G. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education,* 20, 3, 261 - 273.

Betz, N., & Hackett, G. (1989). Mathematics performance, mathematics self-efficacy, and the prediction of math-related college majors. *Journal for Research in Mathematics Education,* 20, 261-273.

Betz, N., & Hackett, G. (1993). *Mathematics self-efficacy scale sampler set*. San Francisco, CA: Mindgarden, Inc.

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

Bonham, B. (1992). *Research findings on developmental instruction*. Paper presented at the First National Conference on Research in Developmental Education. Charlotte, NC.

Borkovec , T. D. (1978). Self-efficacy: Cause or reflection of behavioral change? In S. Rachman (Ed.), *Advances in behavior research and therapy*, 1, 163-170. Oxford: Pergamon.

Boylan, H. (2002). *What works: a guide to research-based best practices in developmental education.* Continuous Quality Improvement Network and National Center for Developmental Education.

Boylan, H. (2001). Making the case for developmental education. *Research in Developmental Education*, 12 (2), 1 - 4. Retrieved from http://www.nade.net/documents/articles/makingthecase/pdf.

Boylan, H., Abraham, A., Allen, R., Anderson, J., Bonham, B., Bliss, L., Morante, E., Ramirez, G., & Vadillo, M. (1996). *An evaluation of the Texas Academic Skills Program*. Austin, TX: Texas Higher Education Coordinating Board.

Boylan, H., Bliss, L., & Bonham, B. (1997). Program components and their relationship to student performance. *Journal of Developmental Education, 20*, 2-9.

Boylan, H., & Bonham, B. (1992). The impact of developmental education programs. *Research in Developmental Education*, 9(5), 1-4.

Boylan, H., Bonham, B., & Bliss, L. (1994). Characteristic components of developmental programs. *Research in Developmental Education*, 11(1), 1-4.

Boylan, H., Bonham, B., Claxton, C., & Bliss, L. (1992, November). *The state of the art in developmental education: Report of a national study*. Paper presented at the First National Conference on Research in Developmental Education, Charlotte, NC.

Boylan, H., & Saxon, D. (1998). *An evaluation of developmental education in Texas public colleges and universities.* Retrieved from http://www.ncde.appstate.edu/reserve_reading/tasp2pt1.htm

Boylan, H., & Saxon, D. (2005). *What works in remediation: Lessons from 30 years of research.* National Center for Developmental Education. Retrieved from http://www.ncde.appstate.edu/reserve_reading/what_works.htm.

Boylan, H., & Saxon, D. (1998). *An evaluation of developmental education in Texas public colleges and universities*. Austin, TX: Texas Higher Education Coordinating Board.

Brown, J. D., Childers, K. W., & Waszak, C. S. (1990). Television and adolescent sexuality. *Journal of Adolescent Health Care*, 11, 62-70.

Brown, S. D., Lent, R. D., & Larkin, K. C. (1989). Self-efficacy as a moderator of scholastic aptitude-academic performance relationships. *Journal of Vocational Behavior*, 35, 64-75.

Bruner, J. (1966). *Towards a theory of instruction*. New York, NY: Norton & Co.

Bulger, S., & Watson, D. (2006). Broadening the definition of at-risk students. Community College Enterprise. Retrieved from http://findarticles.com/p/articles/mi_qa4057/is_200610/ai_n17191868/.

Bussey, K., & Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychological Review*, 106, 676-713.

Callan, P. M. (2000, Fall). An interview: Robert McCabe. *National Crosstalk. 8, 4.* Retrieved from: http://www.highereducation.org/crosstalk/ct1000/ interview1000.shtml.

Canfield, A. (1976). The Canfield learning styles inventory: Technical manual. Ann Arbor, MI: Humanics Media.

Casazza, M., & Silverman, S. (1996). *Learning assistance and developmental education: A guide for effective practice*. San Francisco, CA: Jossey-Bass.

Center for Positive Practices. (2008). *Self-efficacy*. Retrieved from http://www.positivepractices.com/Efficacy/SelfEfficacy.html

Cervone, D. (2000). Thinking about efficacy. *Behavior Modification*, 24, 30-56. Retrieved from the ERIC database.

Cervone, D. & Scott, W.D. (1995). Self-efficacy theory of behavioral change. In W. O'Donohue & L. Krasner (Eds.), *Theories of behavior therapy*, 349-383. Washington, DC: American Psychological Association.

Chaffee, J. (1992). Critical thinking skills: The cornerstone of developmental education. *Journal of Developmental Education*, 15, 2-8, 39.

Chaffee, J. (1998). *Critical thinking: The cornerstone of remedial education*. Paper presented at the Conference on Replacing Remediation in Higher Education, Stanford University, Palo Alto, CA.

Claxton, C. (1992). *The adult learner*. Presentation at the Kellogg Institute for the Training and Certification of Developmental Educators, Boone, NC: National Center for Developmental Education.

Cohen, A., & Brawer, F. (1989). *The American community college*. San Francisco, CA: Jossey-Bass.

Commander, N., Stratton, C., Callahan, C., & Smith, B. (1996). A learning assistance model for expanding academic support. *Journal of Developmental Education*, 20, 8-16.

Council on Postsecondary Education. (2006). *Kentucky postsecondary education county profiles.* Retrieved from http://cpe.ky.gov/research/countyprofiles/.

Council on Postsecondary Education. (2006). *CPE Mandatory Placement Report*. Retrieved from http://cpe.ky.gov/NR/rdonlyres/5BA72241-5997-423D-85EC-FF7F3A847798/0/MandatoryPlacementRev806.pdf.

Dew, K. M. H., Galassi, J. P., & Galassi, M.D. (1984). Math anxiety: Relation with situational test anxiety, performance, physiological arousal, and math avoidance behavior. *Journal of Counseling Psychology*, 31, 590-583.

Doepken, D., Lawsky, E., & Padwa, L. (2008). *Modified Fennema-Sherman attitude scales*. Retrieved from http://www.woodrow.org/teachers/math/gender/08scale.html.

Dowling, D. M. (1978). *The development of a mathematics confidence scale and its application in the study of confidence in women college students.* Columbus, OH: Ohio State University.

Dutton, W. H. (1954). Measuring attitudes toward arithmetic. *Elementary School Journal*, 54, 24-31.

Dutton, W. H. & Blum, M. P. (1968). The measurement of attitudes toward arithmetic with a Likert- type test. *Elementary School Journal*, *68*, 259-264.

Education Commission of the States. (2009). *Remedial policy report*. Retrieved from http://www.communitycollegepolicy.org/pdf/FINALREMEDIALPOLICY.pdf

Eysenck, H. J. (1978). Expectations as causal elements in behavioral change. *Advances in behavior research and therapy*, 1, 171-175.

Fennema, E. (1989). The study of affect and mathematics: A proposed generic model for research. In D. B. McLeod & V. M. Adams (Eds.), *Affect and mathematical problem solving: A new perspective,* 205—219. Berlin: Springer-Verlag.

Fennema, E., & Peterson, P. L. (1985). Teacher-student interactions and sex-related differences in learning mathematics. *Teaching & Teacher Education*, 2, 19-42. Retrieved from the ERIC database.

Fennema, E. & Sherman, J. A. (1976). Fennema-Sherman Mathematics Attitudes Scales: Instruments designed to measure attitudes toward the learning of mathematics by males and females. *Catalog of Selected Documents in Psychology*, 6, 31. Retrieved December 1, 2008, from the ERIC database.

Fennema, E., & Sherman, J. (1978). Sex related differences in mathematics achievement and related factors: A further study. *Journal for Research in Mathematics Education*, 9, 189-203.

Gall, M. D., Borg, W. R., & Gall, J. P. (1996). *Educational research: An introduction (6th ed.)*. White Plains, NY: Longman Publishers.

Gay, L., & Airasian, P. (2003). *Educational research: Competencies for analysis and applications, 7th ed.* New Jersey: Pearson Education.

Gay, L. R., Mills, G. E., & Airasian, P. (2006). *Educational research: Competencies for analysis and applications* (8th ed.). Upper Saddle River, NJ: Pearson-Merrill Prentice Hall.

Gardner, J. (1998). *The changing role of developmental educators in creating and maintaining student success.* Keynote address delivered at the College Reading and Learning Association Conference, Salt Lake City, UT.

Gist, M. E., Schwoerer, C., & Rosen, B. (1989). Effects of alternative training methods on self-efficacy and performance in computer software training. *Journal of Applied Psychology*, 74, 884-891.

Gladstone, R., Deal, R., & Drevdahl, J. E. (1960). Attitudes toward mathematics. In M. E. Shaw & J. M. Wright (1967). *Scales for the measurement of attitudes*. NY: McGraw Hill. 237-242.

Grubb, N. (1991). The decline of community college transfer rates: Evidence from national longitudinal surveys. *Journal of Higher Education*, 62, 194-217.

Grubb, N. (1998). *From black box to Pandora's box: Evaluating remedial/ developmental education.* Paper presented at the Conference on Replacing Remediation in Higher Education, Stanford University, Palo Alto, CA.

Hackett, G. (1985). The role of mathematics self-efficacy in the choice of math-related majors of college women and men: A path analysis. *Journal of Counseling Psychology*, 32, 47-56.

Hackett, G., & Betz, N. E. (1981). A self-efficacy approach to the career development of women. *Journal of Vocational Behavior*, 18, 326-339.

Hackett, G., & Betz, N. (1989). An exploration of the mathematics self-efficacy/ mathematics performance correspondence. *Journal for Research in Mathematics Education*, 20, 261-273.

Hackworth, B. (2000). Developmental mathematics traditions and alternatives: An interview with Bob Hackworth. *Journal of Developmental Education,* 23, 20-22.

Hall, M., & Ponton, M. (2002). *A comparative analysis of mathematics self-efficacy of developmental and non-developmental freshman mathematics students.* Retrieved from http://maa.mc.edu/proceedings/spring2002/michael.hall.michael.ponton.pdf

Hanson, K. (2001). *Teaching Mathematics Effectively and Equitably to Females.* Retrieved from http://www2.edc.org/gdi/publications_SR/teachmathwp.pdf

Harris, J., & Eleser, C. (1997). Developing critical thinking: Melding two imperatives. *Journal of Developmental Education*, 21, 12-19.

Haycock, K. (2002). Add it up: Mathematics education in the U.S. does not compute. *Thinking K-16*, 6, 1-2.

Higher Education Extension Service. (1992). *The academic performance of college students: A handbook on research, exemplary programming, policies and practices.* New York, NY: Higher Education Extension Service, Teachers College, Columbia University.

Hill, D. L. (2006). *The urban choice: A case study of high school graduates career choices*. Dissertation, University of Phoenix.

Hodges, C. (2005). *Self-efficacy, motivational email, and achievement in an asynchronous mathematics course.* [Dissertation submitted to Virginia Polytechnic Institute and State University in November, 2005]. Blacksburg, VA: Virginia Polytechnic Institute.

Hodgkinson, H. (1993). *Southern crossroads: A demographic look at the southeast.* Tallahassee, FL: Southeastern Regional Vision for Education.

Institute for Higher Education Policy. (1998). *College remediation: what it is, what it costs, what's at stake.* Washington, DC: Institute for Higher Education Policy.

Joo, Y. J., Bong, M., & Choi, H. J. (2000). Self-efficacy for self-regulated learning, academic self- efficacy, and internet self-efficacy in web-based instruction. *Educational Technology Research and Development*, 48, 5-17.

Junge, M. E., Dretzke, B. J. (1995). Mathematical Self-Efficacy Gender Differences In Gifted/Talented Adolescents. *Gifted Child Quarterly*, 39, 22-26.

Kentucky Community & Technical College System. (2005). *KCTCS 2006 - 2010 Strategic Plan*. Versailles, KY: KCTCS. Retrieved from http://www.kctcs.net/ strategicplanning/200610.html.

Kentucky Community and Technical College System. (2008). *KCTCS administrative policies and procedures*. Retrieved from http://www.kctcsedu/employee/policies/ volumeII/volII4-13.pdf

Kentucky Community & Technical College System. (2010). *KCTCS 2010 - 2011 catalog*. Retrieved from http://www.kctcs.net/catalog/.

Kentucky Community & Technical College System. (2010). *Mathematics course competencies*. Retrieved from http://unity.kctcs.edu.

Kiamanesh, A., Hejazi, E., & Esfahani, Z. (2005). *The role of math self-efficacy, math self-concept, perceived usefulness of mathematics and math anxiety in math achievement.* Tehran, Iran: Teacher Training University. Retrieved from http://self.uws.edu.au/Conferences/2004_Kiamanesh_Hejazi_Esfahani.pdf

Kloosterman, P., Tassell, J. H., Ponniah, A. G., & Essex, N. K. (2001). *Mathematics as a gendered domain in the United States*. Paper presented at the annual meeting of the American Educational Research Association, Seattle, WA.

Kuczynski, L. (2003). *Handbook of dynamics in parent-child relations*. Thousand Oaks, CA: Sage. Retrieved from http://www.ladeonline.org/resource.php.

Kulik, C. L., & Kulik, J. (1986). Effectiveness of computer-based education in colleges. *AEDS Journal*, 19, 81-108.

Kulik, C. L., & Kulik, J. (1991). *Developmental instruction: An analysis of the research.* Boone, NC: National Center for Developmental Education, Appalachian State University.

Kulik, C. L., Kulik, J., & Schwalb, B. (1983). College programs for high risk and disadvantaged students: A meta-analysis of findings. Review of Educational Research, 53, 397-414.

Lamire, D. (1998). Three learning styles models: Research and recommendations for developmental education. *The Learning Assistance Review*, 3, 26-40.

Langenfeld, T., & Pajares, F. (1993). *The mathematics self-efficacy scale: A validation study.* Paper presented at the Annual Meeting of the American Educational Research Association (Atlanta, GA, April 1993).

Larsen, R. J. (2000). Toward a science of mood regulation. *Psychological Inquiry*, 11, 129-141.

Lent, R. W., & And, O. (1993). Predicting Mathematics-Related choice and success behaviors: Test of an expanded social cognitive model. *Journal of Vocational Behavior*, 42, 223-36.

Lent, R. W., & And, O. (1996). Cognitive assessment of the sources of mathematics self-efficacy: A thought-listing analysis. *Journal of Career Assessment*, 4, 33-46.

Lent, R. W., Lopez, F. G., Brown, S. D., & Gore, J. P. A. (1996). Latent Structure of the Sources of Mathematics Self-Efficacy. *Journal of Vocational Behavior*, 49, 292-308.

Lent, R. W.; Lopez, F. G.; Bieschke, K. J. (1992). Mathematics self-efficacy: Sources and relation to science-based career choice. *Journal of Counseling Psychology*. 38, 424-430. Retrieved from http://psycnet.apa.org/index.cfm.

Lent, R. W., Brown, S. D., Brenner, B., et al. (2001). The role of contextual supports and barriers in the choice of math/science educational options: A test of social cognitive hypotheses. *Journal of Counseling Psychology*, 48, 474-483.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, 45, 79-122.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. *Journal of Counseling Psychology*, 31, 356-362.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. *Journal of Counseling Psychology*, 33, 265-269.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1987). Comparison of three theoretically derived variables in predicting career and academic behavior: Self-efficacy, interest congruence, and consequence thinking. *Journal of Counseling Psychology*, 34, 293-298.

Lent, R. W., Brown, S. D., Nota, L., & Soresi, S. (2003). Testing social cognitive interest and choice hypotheses across Holland types in Italian high school students. *Journal of Vocational Behavior*, 62, 101-118.

Lent, R. W., Lopez, F. G., & Bieschke, K. J. (1993). Predicting mathematics-related choice and success behaviors: Test of an expanded social cognitive model. *Journal of Vocational Behavior*, 42, 223-236.

Lewin, T. (1998). How boys lost out to girl power. *New York Times*, October 4, p. A21.

MacDonald, R. (1994). The master tutor: A guidebook for more effective tutoring. Williamsville, NY: The Cambridge Stratford Study Skills Institute.

Malpass, J. R., & And, O. (1996). *Self-regulation, goal orientation, self-efficacy, and math achievement*. Paper presented at the Annual Meeting of the American Educational Research Association (New York, NY, April 8-12, 1996).

Marat, D. (2005). Assessing mathematics self-efficacy of diverse students from secondary schools in Auckland: Implications for academic achievement. *Issues in Educational Research*, 15. Retrieved from http://education.curtin.edu/au/iier/iier15/marat.html.

Marsh, H., Walker, & Debus, R. (1991). Subject-specific components of academic self-concept and self-efficacy. *Contemporary Educational Psychology*, 16, 331-345.

Martin, D., & Arendale, D. (1994). Supplemental instruction: Increasing achievement and retention. *New directions in teaching and learning*. San Francisco, CA: Jossey-Bass.

Martin, D., & Arendale, D. (1998). *Mainstreaming of developmental education: Supplemental instruction and video based supplemental instruction.* Paper presented at the Conference on Replacing Remediation in Higher Education, Stanford University, Palo Alto, CA.

Maxwell, M. (1997). *Improving student learning skills*. Clearwater, FL: H & H Publishing Co.

McCabe, R. (2000). *No one to waste: The national study of community college remedial education.* Washington, D.C.: Community College Press.

McCabe, R. (2003). *Yes we can! A community college guide for developing America's underprepared.* Phoenix, AZ: League for Innovation in the Community College and American Association of Community Colleges.

McCarthy, B. (1982, July). *Learning styles and developmental education.* Paper presented at the Kellogg Institute for the Training and Certification of Developmental Educators, Appalachian State University, Boone, NC.

Michaels, L. A & Forsyth, R. A. (1977). Construction and validation of an instrument measuring certain attitudes toward mathematics. *Educational and Psychological Measurement*, 37, 1043-1049.

Morante, E. (1987). A primer on placement testing. In D. Bray & M. Belcher (Eds.), *Issues in student assessment*, 55-63. San Francisco, CA: Jossey-Bass.

Morante, E. (1989). Selecting tests and placing students. *Journal of Developmental Education*, 13, 2-4,6.

Mwamwenda, T.S. (1999). Gender differences in mathematics self-efficacy. *Research in Education*, May 1999. Retrieved from http://findarticles.com/p/articles/mi_qa3765/is_199905/ai_n8832134.

National Association of Developmental Educators. Retrieved December 1, 2005, from http://www.etsu.edu/devstudy/spin/bestpractices.pdf

National Center for Education Statistics. (1996). *Remedial education at higher education institutions*. Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement. Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=97584.

National Institute of Food and Agriculture. (2009). *First Morrill Act*. Retrieved from http://www.nifa.usda.gov/about/offices/legis/morrill.html.

National Institute of Food and Agriculture. (2009). *Second Morrill Act of 1890*. Retrieved from http://www.csrees.usda.gov/about/offices/legis/secondmorrill.html

Nielsen, I., & Moore, K. (2003). Psychometric data on the mathematics self-efficacy scale. *Educational and Psychological Measurement*, 63, 128-138.

Noel-Levitz (2005). *Student success in developmental math: Strategies to overcome a primary barrier to retention*. Iowa City: Noel-Levitz. Retrieved from

http://www.noellevitz.com/NR/rdonlyres/B4148B72-C135-4AD4-A04C-2F66821C872C/0/MathSuccess.pdf.

Nyangeni, N. P., and Glencross, M. J. (1997). Sex differences in mathematics achievement and attitude toward mathematics. *Psychological Reports*, 80, 603-8.

O'Hear, M., & MacDonald, R. (1995). A critical review of research in developmental education, Part I. *Journal of Developmental Education*, 19(2), 2-6.

Pallas, A.M., & Alexander, K. L. (1983). Sex differences in quantitative SAT performance: New evidence on the differential coursework hypothesis. *American Educational Review Journal*, 20, 165-182.

Pajares, F. (1996). Self-efficacy beliefs and mathematical problem-solving of gifted students. *Contemporary Educational Psychology*, 21, 325-344.

Pajares, F. (2002). *Self-efficacy beliefs in academic contexts: An outline*. Retrieved, from http://www.emory.edu/EDUCATION/mfp/efftalk.html.

Pajares, F. (2006). *Self-efficacy beliefs of adolescents.* Charlotte, NC: Information Age Publishing, Incorporated.

Pajares, F., & Graham, L. (1999). Self-efficacy, motivation constructs, and mathematics performance of entering middle school students. *Contemporary Educational Psychology*, 24, 124-139.

Pajares, F., Hartley, J., & Valiante, G. (2001). Response format in writing self-efficacy assessment: Greater discrimination increases prediction. *Measurement and Evaluation in Counseling and Development*, 33, 214-221.

Pajares, F., & Kranzler, J. (1995). Self-efficacy beliefs and general mental ability in mathematical problem-solving. *Contemporary Educational Psychology*, 20, 426-443.

Pajares, F., & Kranzler, J. (1997). An exploratory factor analysis of the mathematics self-efficacy scale revised (MSES-R). *Measurement and Evaluation in Counseling and Development*, 29(4), 215-228. Retrieved from the ERIC database.

Pajares, F., & Miller, M. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal of Educational Psychology*, 86, 193-203. Retrieved December 1, 2005, from www.earlylearning.ubc.ca/documents/2007/SC2workshop/ Path_analysis_2.pdf

Pajares, F., & Miller, M. (1995). Mathematics self-efficacy and mathematics performances: The need for specificity of assessment. *Journal of Counseling Psychology*, 42, 190-198.

Plake, B. S. & Parker, C. S. (1982). The development and validation of a revised version of the Mathematics Anxiety Rating Scale. *Educational and Psychological Measurement*, *42*, 551-557.

Piper, W. (1930). *The little engine that could*. Platt & Munk Publishing.

Ring, S. 2001. *The underprepared student initiative at Paradise Valley Community College*. Retrieved from http://www.pvc.maricopa.edu/usi/usiResearch.doc

Ramirez, G. (1997). Supplemental instruction: The long-term effect. *Journal of Developmental Education*, 21(1), 2-10.

Roueche, J. (1968). *Salvage, redirection, or custody?* Washington, DC: American Association of Junior Colleges.

Roueche, J. (1973). *A modest proposal: Students can learn.* San Francisco, CA: Jossey-Bass.

Roueche, J., & Baker, G. (1983). *Access and Excellence*. Washington, DC: Community College Press.

Roueche, J., & Kirk, R. (1974). *Catching up: Remedial education.* San Francisco, CA: Jossey-Bass.

Roueche, J., & Mink, O. (1976). *Helping the "unmotivated" student: Toward personhood development.* Community College Review, 3(4), 40-50.

Roueche, J., & Snow, J. (1977). *Overcoming learning problems.* San Francisco, CA: Jossey-Bass.

Roueche, J., & Roueche, S. (1993). *Between a rock and a hard place: The at risk student in the open door college.* Washington, DC: American Association of Community Colleges, Community College Press.

Roueche, J., & Roueche, S. (1994). Climbing out from between a rock and a hard place: Responding to the challenges of the at-risk student. *Leadership Abstracts*, 7, 3. Retrieved from the ERIC database.

Roueche, J., & Roueche, S. (1999). *High stakes, high performance: Making remedial education work*. Washington, DC: American Association of Community Colleges, Community College Press.

Roueche, J., & Wheeler, C. (1973). Instructional procedures for the disadvantaged. *Improving College and University Teaching*, 21, 222-225.

Randhawa, B. S., Beamer, J. E., and Lundberg, 1. (1993). Role of mathematics self-efficacy in the structural model of mathematics self-efficacy in the structural model of mathematics achievement. *Journal of Educational Psychology* 85, 41-8.

Reiss, S. (1991). Expectancy model of fear, anxiety, and panic. *Clinical Psychology Review*, 11, 141-153.

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

Sandman, R. S. (1980). The mathematics attitude inventory: Instrument and user's manual. *Journal for Research in Mathematics Education,* 11, 148-149.

Saxon, D.P., et al. (1998). *Annotated research bibliographies in developmental education.* Boone, NC: National Center for Developmental Education.

Schunk, D. H., & Lilly, M. W. (1984). Sex differences in self-efficacy and attributions: Influence of performance feedback. *Journal of Early Adolescence*, 4, 203-213.

Sheldon, C. (2005). *Building an instructional framework for effective community college developmental education.* Retrieved from http://www.findarticles.com/p/articles/mi_pric/is_200210/ai_405490351

Shell, D. F., Murphy, C. C., & Bruning, R. H. (1989). Self-efficacy and outcome expectancy mechanisms in reading and writing achievement. *Journal of Educational Psychology*, 81, 91-100.

Skaalvik, E. M., and Rankin, R. J. (1994). Gender differences in mathematics and verbal achievement, self-perception and motivation. *British Journal of Educational Psychology*, 64, 419-28.

SKCTC Strategic Plan 2006 - 2010. (2005) Retrieved from http://www.southeast.kctcs.edu/ planning/resources1/StrategicPlan/ strategic_plan2002-07.pdf

SKCTC Mandatory Placement Policy. (2006). Retrieved from http://www.kctcs.net/catalog/.

SKCTC Quality Enhancement Plan. (2006). Retrieved from http://www.secc.kctcs.edu/qep/.

SKCTC Credentials Awarded by Type. (2007). Cumberland, KY: Office of Institutional Effectiveness.

Spann, M.G., & Drewes, S. (1998). *The annotated bibliography of major journals in developmental education 1991-1998, Volume 2*. Boone, NC: National Center for Developmental Education.

St. Clair, L. (1995). Teaching students to think: Using library research and writing assignments to develop critical thinking. *Journal of College Reading and Learning*, 26, 65-74.

Stahl, N., Simpson, M., Hayes, C. (1992). Ten recommendations from research for teaching high risk college students. *Journal of Developmental Education*, 16(1), 2-4,6,8,10.

Stage, F. K., & Kloosterman, P. (1991). Relationships between ability, belief, and achievement in low level college mathematics classrooms. *Research and Teaching in Developmental Education*, 8, 27-36.

Steele, J., James, J., & Barnett, R. (2002). Learning in a man's world: Examining the perceptions of undergraduate women in male-dominated academic areas.

Psychology of Women Quarterly, 26 46-50. Retrieved from http://www.atkinson.yorku.ca/Ejsteele/files/Steeleetal_PWQ_2002.pdf

Stephens, D. (2003). *Pathways through history: Underprepared students go to college. In Developmental education.* Duranczyk, I.M., White, W.G., eds. Findlay, OH: National Association for Developmental Education.

Suinn, R. M., Edie, C. A., & Spinelli, P. R. (1970). Accelerated massed desensitization: Innovation in short-term treatment. *Behavior Therapy*, 1, 303-311.

Suinn, R. M., Edie, C. A., Nicoletti, J., & Spinelli, P. R. (1972). The MARS, a measure of mathematics anxiety: Psychometric data. *Journal of Clinical Psychology*, 2, 498-510.

Suinn, R. M., & Richardson, F. C. (1971). Anxiety management training: Nonspecific behavior therapy control. *Behavior Therapy*, 2, 498-519.

Sproull, N. D. (2004). *Handbook of research methods: A guide for practitioners and Students in the social sciences* (3rd Ed.). New Jersey: The Scarecrow Press.

Tapia, M., & Marsh, G. (2008). An instrument to measure mathematics attitudes. *Academic Exchange Quarterly*, Summer 2004, 8, 2. Retrieved from http://www.rapidintellect.com/AEQweb/cho25344l.htm

Tate, F. (1997). Race-ethnicity, SES, gender and language proficiency trends in mathematics achievement: an update. *Journal for Research in Mathematics Education* 28, 652-79.

Tinto, V. (1997). Classrooms as communities: Exploring the educational character of student persistence. *Journal of Higher Education*, 68, 599-623.

Tinto, V. (1998). *Learning communities and the reconstruction of remediation in higher education.* Paper presented at the Conference on Replacing Remediation in Higher Education, Stanford University, Palo Alto, CA.

Upcraft, M. L., & Gardner, J. N. (1989). *The freshman year experience.* San Francisco: Jossey-Bass.

Voyer, D. (1996). The relation between mathematical achievement and gender differences in spatial abilities: a suppression effect. *Journal of Educational Psychology*, 88, 563-71.

Waycaster, P. (2001). A study of success in developmental mathematics classes. *Inquiry*, 6. Retrieved from http://www.vccaedu.org/inquiry/inquiry-spring2001/i-61-waycaster.html

Weinstein, C. (1982). Learning strategies: The meta-curriculum. *Journal of Developmental Education*, 5, 6-7,10.

Weinstein, C. (1988). Executive control process in learning: Why knowing about how to learn is not enough. *Journal of College Reading & Learning*, 21, 48-56.

Weinstein, C., Dierking, D., Husman, J., Roska, L., & Powdrill, L. (1998). The impact of a course on strategic learning on the long-term retention of college students. In J. Higbee & P. Dwinnel (Eds.), *Developmental education: Preparing successful college students* (pp. 85-96). Columbia, SC: National Research Center for the First Year Experience and Students in Transition.

Weinstein, C., & Rogers, B. (1985). Comprehension monitoring: The neglected learning strategy. *Journal of Developmental Education*, 9, 6-9, 28-29.

Wigfield, A. & Meece, J. L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80,* 210 - 216.

Wolpe, J. (1978). Self-efficacy theory and psychotherapeutic change: A square peg for a round hole. *Advances in behavior research and therapy,* 1, 231-236.

Woodward, T., & Burkett, S. (2005). Comparing success rates of developmental math students. *Inquiry,* 10, 54-63.

York University. (2006). *Theories used in IS research: Social cognitive theory.* Retrieved from http://www.istheory.yorku.ca/socialcognitivetheory.htm

Zettle, R. D. & Raines, S.J. (2000). The relationship of trait and test anxiety with mathematics anxiety. *College Student Journal*, June 2000. Retrieved from http://findarticles.com/p/articles/mi_m0FCR/is_2_34/ai_63365180/pg_1?tag=artBody;col1.

Zimmerman, B., & Cleary, T. (2006). The role of self-efficacy beliefs and regulatory skill. Chapter two in *Self-Efficacy Beliefs of Adolescents,* 45 - 69. Information Age Publishing. Retrieved from http://www.des.emory.edu/mfp/ZimmermanClearlyAdoEd5.pdf

APPENDIX A: INSTRUMENTS

MATHEMATICS SELF-EFFICACY SURVEY

Mathematics Self-Efficacy Survey (Betz & Hackett, 1989)

No Confidence at all Very little Confidence Some Confidence

0 1 2 3 4 5

Much Confidence Complete Confidence

6 7 8 9

Part I: Everyday Math Tasks

How much confidence do you have that you could successfully:

1. Add two large numbers (e.g., 5379 + 62543 in your head.
2. Determine the amount of sales tax on a clothing purchase.
3. Figure out how much material to buy in order make curtains.
4. Determine how much interest you will end up paying on a $675 loan over 2 years at 14 3/4% interest.
5. Multiply and divide using a calculator.
6. Compute your car's gas mileage.
7. Calculate recipe quantities for a dinner for 3 when the original recipe is for 12 people.
8. Balance your checkbook without a mistake.
9. Understand how much interest you will earn on your savings account in 6 months, and how that interest is computed.
10. Figure out how long it will take to travel from Columbus to Chicago driving at 55 mph.

11. Set up a monthly budget for yourself taking into account how much money you earn, bills to pay, personal expenses, etc.
12. Compute your income taxes for the year.
13. Understand a graph accompanying an article on business profits.
14. Figure out how much you would save if there is a 15% mar-down on an item you wish to buy.
15. Estimate your grocery bill in your head as you pick up items.
16. Figure out which of 2 summer jobs is the better offer: one with a higher salary but no benefits; the other with a lower salary but with room, board, and travel expenses included.
17. Figure out the tip on your part of a dinner bill total split 8 ways.
18. Figure out how much lumber you need to buy in order to build a set of bookshelves.

Part II: Math Courses

Please rate the following college courses according to how much confidence you have that you could complete the course with a final grade of "A" or "B". Circle your answer according to the 10-point scale below:[note: same scale as Part I]

19. Basic College Math
20. Economics
21. Statistics
22. Physiology
23. Calculus
24. Business Administration
25. Algebra II

26. Philosophy
27. Geometry
28. Computer Science
29. Accounting
30. Zoology
31. Algebra I
32. Trigonometry
33. Advanced Calculus
34. Biochemistry

APPENDIX B: PARTICIPANT LETTER

CONSENT FORM

Title of Study: Mathematics Self-efficacy of Community College Students in Developmental Mathematics Courses

Title of Project: Research for partial fulfillment of requirements for Liberty University EDUC 980 Dissertation Seminar

Principal Investigator: David Clutts

Liberty University

Department of Education

You are invited to be in a research study of developmental mathematics students' beliefs on how well they can perform specific course-related tasks. You were selected as a possible participant because you are currently enrolled in one or more developmental mathematics courses. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by: David Clutts, Principal Investigator, who is a doctoral candidate through the Graduate Education Department, Liberty University, Lynchburg, Virginia.

Background Information

The purpose of this study is: To examine students' beliefs about how well they can perform specific math tasks or math courses and to determine whether those beliefs are related age, gender, course or grade.

Procedures

If you agree to be in this study, we would ask you to do the following things:

- Complete the Mathematics Self-Efficacy Survey at the beginning and end of the current semester.
- Grant the principal investigator permission to view your community college records to obtain academic and demographic information pertinent to this study.

Risks and Benefits of being in the Study

The risks of this study are minimal. They are no more than the participant would encounter in everyday life. The benefits to participation are increased understanding of:

- The participant's beliefs on how well he or she may perform on specific course-related tasks.
- How those beliefs were or were not modified during the present developmental mathematics course.
- How the participant may use information gained to positively affect future performance in mathematics courses.

Compensation

You will receive no payment or compensation for participation in this study.

Confidentiality

The records of this study will be kept private. In any sort of report we (the principal investigator, Liberty University, or this community college) might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records.

Participant data will be coded to make identification of participants by anyone other than the principal investigator impossible. The data will be stored by and may be accessed by the following:

- In the computer of David Clutts, principal investigator, at Cumberland, Kentucky
- In the Graduate Education Department at Liberty University, Lynchburg, Virginia;
- In the Office of Institutional Effectiveness at this community college.

Voluntary Nature of the Study

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University, the Kentucky Community and Technical College System, this community college or the principal investigator. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

The researcher conducting this study is David Clutts, a doctoral candidate at Liberty University, Lynchburg, Virginia. The researcher's dissertation committee chair is Dr. Scott Watson, Chair, Graduate Studies. You may ask any questions you have now. If you have questions later, you are encouraged to contact Mr. Clutts at 700 College Road, Cumberland, Kentucky 40823, (606) 589-2145 Ext. 13062, David.Clutts@kctcs.edu or Dr. Watson at Liberty University, 1971 University Boulevard, Lynchburg, Virginia, 24502, (434) 582-2445, swatson@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to contact the Human Subject Office, 1971 University Blvd, Suite 2400, Lynchburg, VA 24502 or email at irb@liberty.edu; or the Human Subjects Review Board, Office of the Chancellor, 300 North Main, Versailles, KY 30282 or email at Christina.Whitfield@kctcs.edu
You will be given a copy of this information to keep for your records.

Statement of Consent

I have read the above information. I have asked questions and have received answers. I consent to participate in this study.

Signature: _____Date:_____

Signature of Parent or Guardian:_____Date:_____
(If minors are involved)

Signature of Investigator:_____Date:_____