IMPROVING MATHEMATICS PLACEMENT FOR COMMUNITY COLLEGE STUDENTS: AN EVALUATION OF PLACEMENT IMPROVEMENT PROGRAMS

by

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ABSTRACT

New incoming community college students are not aware of placement tests, their importance, and how to prepare for them. Consequently, many are placed into mathematics classes below their ability level. This study is a quantitative evaluation of two placement improvement programs, placement preparation workshops and three-week review courses, which were created by a community college to help students obtain a more reflective placement for their abilities. This evaluation focuses on student data to analyze the effects of placement preparation workshops and three-week placement review courses in helping students improve their college math placement, contribute towards students' cumulative math class success, and to overall college success for students of all ages and genders. While these programs attracted both students who desired to improve their mathematics placement, and those who desired information and practice resources prior to testing, these programs resulted in students who improved their mathematics placement, with some students testing completely out of their program of study's math requirement, and led to retention, math success, and overall college success rates for participating students that were comparable, and in most cases much higher, than the overall rates for all or developmental math students at this college. Finally, several recommendations are given that could assist all community colleges in preparing new incoming students for a placement test, and contribute to improved enrollment, retention, success, and graduation rates of community college students.

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CHAPTER ONE: INTRODUCTION

Approximately 40% of college enrollees choose to enroll in community colleges, many of whom recently graduated from high school (National Center for Education Statistics, 2005). Community colleges provide the opportunity for all types of students to obtain higher education: current high school students, those who have recently graduated from high school, those who have not been in an academic setting for a number of years, or those who are returning for additional education. No matter the age or educational attainment, students are allowed to enroll in college classes based upon their results on a college readiness test (such as the ACT or SAT), a high school exit exam, or a college placement test. Unfortunately, a large percentage of new incoming students, 60% to 98%, are placed into at least one developmental education course, and it is primarily due to students' results on a college placement test (Achieving the Dream, 2009; Collins, 2009). Certainly some students will place into developmental education courses as that is where their knowledge and skill levels reside; however, some will place into developmental mathematics courses or courses below their ability because they are not prepared for the placement test, and have not been alerted by the college in which they apply that they will be taking a placement test. In other words, it is up to individual community colleges to determine how to accurately place students, who choose to take or must take a college placement test, into a mathematics course that is aligned with their performance on a placement test.

Students' Present Mathematical Knowledge

Students place into mathematics courses beneath their skill level as a result of their present mathematical knowledge. Some students are placed into a particular class because the topics are all new to them, some because most or certain topics are new to them and others due to the attrition of knowledge. The students who are placed into a class as a result of the attrition of knowledge have already learned the topics in that math course, or a very large percentage of the topics, and could potentially be successful in a higher-level math course. This is the focus of this study, on students who placed lower than their skills and abilities, and how colleges can help them improve their mathematics placement.

Some students place into a lower level mathematics course because they have forgotten processes or topics due to a time range between their last mathematics class and the time they take a college placement test. This time difference could have contributed to students forgetting mathematical topics and processes, and hence their individual ability or knowledge may no longer be where it was previously. Similarly, the gap between the beginning testing level on the college placement test and the student's present knowledge level may be too large. For example, a student who has recently taken a math course in high school could have been at a level much higher than the level in which the college placement test begins testing. Consequently, due to wrong answers from forgotten topics and processes, these students were not able to reach questions that accurately align with their present ability level or capabilities.

Colleges Do Not Provide Placement Testing Preparation

Students can place into developmental mathematics courses or into courses beneath their ability because of a lack of communication between them and the colleges that accept them (Collins, 2009). First, high school students are not informed prior to graduation of the importance of college placement tests and of the time and money they could save by reviewing and placing into a higher-level mathematics course. Second, incoming students are herded to a testing center to take the college placement test immediately after gaining admissions or completing a new student orientation session rather than scheduling a date and time which would allow students to prepare, review, feel confident, and better focus on success (Robinson & Kubala, 1999). Third, new students are not informed after admission what or how to study, or where to go for placement testing assistance or information, but rather are told after taking the placement test or not told at all.

Reasons to Improve Student Placement

Certainly, there are numerous explanations for the placement of incoming college students into developmental education courses or into courses beneath their abilities; however, with careful consideration, many of these explanations could be remediated or improved by colleges, high schools, or both working together. Hence, the focus should be on what could be done to help educate students and help them improve their placement into community college courses, as well as what is most economical for students, colleges, and high schools. In addition to the previously stated reasons why students place into mathematics courses beneath their abilities, there are other factors that directly impact community colleges and should lead to the careful consideration of policies and procedures that govern placement testing.

National math placement. At the national level, there are large numbers of students placing within developmental education courses, and too few students graduating from community colleges. Recent research indicates that approximately 60% of incoming community college students place into or below developmental education courses (Collins, 2009). According to the "Field Guide for Improving Student Success," a publication by Achieving the Dream in partnership with the Lumina Foundation, some community colleges have seen as high as 98% of incoming students place into at least one developmental education course (Achieving the Dream, 2009). Furthermore, according to *The Chronicle of Higher Education* (n.d.), which published data from the Integrated Postsecondary Education Data System (IPEDS) website, the national average public two-year graduation rate is just over 20%. Due to the high number of students placing into developmental education and the low number of students graduating from community colleges nationally, it is important that all colleges look at student placement and the policies and procedures governing placement (Hughes & Scott-Clayton, 2011).

Ironically, incoming developmental placement percentages remain high and community college graduation rates remain low even though some states have implemented new mathematical standards. For example, effective with the graduating class of 2011, the State of Michigan requires that all high school students complete four years of mathematics while in high school and at least one mathematics class within the senior year (Michigan Depatment of Education, 2010). Furthermore, at least 11 other states require high school students to take four years, and at least 24 states require three years, of mathematics while in high school (Reys, Dingman, Nevels, & Teuscher, 2007). Nevertheless, thousands of students are misplaced in college mathematics courses, most within remedial courses, and could be successful within a higher, even college-level, mathematics course (Lewin, 2012). With college completion demands rising at the national level, community colleges will need to have better ways of placing students into courses in which they can be successful and graduate in a timely manner (Burdman, 2012).

The misplacement of students. There are many factors, stemming from students and colleges, which contribute to the misplacement of community college students. First, colleges do not stress the importance of placement testing. Many colleges contain one-stop shops or attempt to enroll as many students as possible at one time. Students are herded without warning or prior preparation to take a placement test immediately after attending an orientation session or after waiting in long lines (Robinson & Kubala, 1999). Although these so called one-stop-shops might be convenient, they may be facilitating the misplacement of students.

Second, placement tests that students are given may not be well aligned to previously learned, or recently learned material and hence do a poor job of analyzing where students lack knowledge. For example, very few colleges use diagnostic features (such as on the COMPASS diagnostic test) to drill down and determine the topics students do or do not understand. Consequently, the specific mathematical topics students already know are not considered and are not used to place students. Likewise, the topics students don’t know, or could learn through quick remediation or review, are not used to help students obtain a higher course placement. In turn, students are placed at a level dependent on the score they received and the interval in which this score falls rather than being evaluated for higher placement based on the topics they understand or could acquire through a brief review or within a higher-level course (Jaggars & Hodara, 2011).

Third, additional measures of student knowledge, other than a college placement test, are not regularly used when placing students. For example, students may have recently completed a higher mathematics level within high school; however, due to the level in which the placement test begins testing, students could have forgotten the topics and processes and, consequently, answered these questions incorrectly, thus contributing to the placement into a course below the level in which they could be successful (Lewin, 2012). And factors such as perseverance, family support, past success, past education, or determination, are not considered.

Fourth, perhaps being misplaced is due to the decisions students make. For example, students who apply to college shortly before the start of the semester, or decide not to prepare prior to testing, or merely lack a sense of responsibility, may be solely at fault for placing in a course beneath their capabilities. Unfortunately, it is common for community colleges to see large numbers of students apply and attempt to enroll a few days before the start of the semester (Dean Dad, 2012). This occurrence makes accurate placement, thorough advising and counseling, and placement preparation difficult to nearly impossible. Furthermore, many new incoming students lack motivation, and their sense of urgency seems absent as many students do not take placement tests seriously (Ingalls, 2011; James, 2006). Students may misinterpret open access and take for granted that they will get into college level courses.

Improving Placements

At this point what is certain is that too many students are placing below where they could start and be successful. Some students test, try hard and do well. Others test, try hard and don't do well, and some don't try or have personal issues preventing them from doing well. Unfortunately, some students are told that they do not need to worry about placement tests, and are not encouraged to prepare for them as they would for other college-entrance exams, such as the SAT or ACT (Lewin, 2012).

Colleges across the nation are starting to realize that students who take Algebra II, Geometry (or Integrated Mathematics II and III), Pre-Calculus, and even Calculus in high school, should not be placing into classes below their previous math class, or worse, in developmental mathematics. Community colleges could pursue several initiatives that could help educate students on the importance of the placement test, help students prepare for the placement test, and help students obtain a placement that will lead them to success within and beyond college. The following programs/practices are but a few that colleges have created to help students obtain their appropriate mathematics course placement:

- Placement testing in high schools
- Placement preparation workshops
- Diagnostic testing
- Boot camps
- Summer bridge programs
- Dual enrollment/Early Colleges
- Multiple considerations such as non-cognitive, affective measures, placement testing, and high school transcripts

Many of these programs have contributed not only to successful course placement, but have led to increased enrollment, retention and persistence.

Research, such as was completed by Sherer and Grunow (2010), shows that community college can improve students' persistence, retention, and graduation rates by focusing on the proper placement of students. Perhaps more importantly, focusing on proper placement of students may improve the education process as a whole, create a seamless transition from high school to the community college to the university or workforce, and grant students the ability to begin their lifelong careers sooner.

This dissertation will research and evaluate techniques that focus on factors that contribute to a greater awareness of the importance of the mathematics portion of the placement test, to greater participation in mathematics placement test preparation sessions, and to greater mathematics placement test success for community college students.

CHAPTER TWO: REVIEW OF LITERATURE

Over 64% of public two-year colleges use placement tests to place students into mathematics courses, and of that 64% approximately 92% of community colleges use placement tests such as COMPASS and ACCUPLACER to determine new incoming students' course placement (Parsad, Lewis, & Greene, 2003). Placement tests not only assist colleges in determining students' mathematical abilities, but also test students' reading and writing abilities for placement into college-level or developmental coursework.

Every college is unique in some way whether they are in a state system or an independently governed institution. Each institution has different application, advising, placement, and registration processes, and all of these processes affect how students perceive the institution upon entry and this ultimately affects students' futures. Some institutions have a seamless process where students apply, are admitted, attend an orientation, complete the college's placement test, go to advising and counseling, and finally register. Other institutions have similar processes, but focus more on advising, orientating, testing, or registering students. Considering only the placement of students into mathematics courses, the debate on whether the process or tests are broken seems to be increasing, especially considering the large percentage of students who are placed into developmental mathematics courses and the focus on college completions.

The debates vary from the testing process, to the test itself, to informing and assisting students in succeeding before testing or entering college. Many educators believe that students are unaware of and frustrated with placement tests as students are blindsided when they are informed of their need to take these tests upon entry (Behringer, 2008; Venezia, Bracco, & Nodine, 2010). Even so, students are told to take these tests, do so, are not aware of why they take them or the high-stakes that are involved; many earn a low placement, and although they are surprised by a low placement, they accept it (Safran & Visher, 2010). Some never meet with a counselor to discuss their options, and hence are forced into classes lower than their potential (Behringer, 2008; Venezia, et al., 2010, p. 10). For example, Venezia, et al. (2010) found in a study of California Community Colleges that, on average, 65% of students who took the placement test accepted their course placement and enrolled in courses based on their placement. The other students either disregarded their placement recommendation and registered in another class due to an absence of mandatory placement policies, or did not need to enroll in that class for their program of study.

Placement test concerns have been growing among students, educators, and governmental officials. For example, even when students place into developmental-level courses, many often say that "they thought the tests were 'basic' or 'easy' but that they had learned the information such a long time ago that they no longer remembered it" (Venezia, et al., 2010, p. 9). Educators and college administrators wonder whether the placement tests facilitate student persistence and success or help students refocus their aspirations into something more representative of their abilities (Kingan & Alfred, 1993).

Some believe that the placement tests are biased and geared towards specific demographics (Kingan & Alfred, 1993).

Although there are many concerns and debates, much could be done to improve the placement of students into mathematics classes appropriate for their individual skill sets. This literature review will present information about the placement test process, the arguments regarding the use of placement tests, developmental education, and how community colleges are improving mathematics placement.

Placement Test Processes

Students typically do not start with a placement test but rather go through an entry procedure consisting of applying, being accepted, and then coming onto campus for orientation, placement, advising, and registration. When they begin testing, the mathematics portion starts students in the middle range of difficulty, with questions randomly selected from a large bank of questions related to various topics (Jaggars & Hodara, 2011). As students work through mathematics problems, the placement test adapts and either gives students more difficult topics or shifts to lower level mathematical questions depending on how students perform (Jaggars & Hodara, 2011). Finally, based on their performance, students receive a score, and depending on where this score falls, students receive their recommended placement into a particular mathematics class.

As noted above, most commonly used placement tests are adaptive, meaning they shift to easier or more difficult mathematics questions or from one topic or level to another depending on individual performance. Adaptive exams do not give students the exact same questions, topics, or completely cover every possible topic within a skill level; however, they provide a means to quickly test, score, and instantaneously determine a placement level for thousands of students before the start of classes (Jaggars & Hodara, 2011).

Placement tests are procedural and assess what students can do, not what they understand about a concept or topic (Stigler, Givvin, & Thompson, 2010, p. 5). In fact, Stigler, et al. (2010) found that it's common for students to just perform a procedure that they remember rather than trying to understand what the question is truly asking.

The ACT and SAT tests are the most common assessment tools used by community colleges before college entrance, and ACCUPLACER by the College Board and COMPASS by ACT are the most commonly used assessment tools used by colleges after college admissions (ACT, Inc., 2007; Boylan, 2009; Conley, 2010). Some state systems, such as Maryland for example, use the same placement test and have the same cutoff scores for every community college in the state (Prince, 2005). However, many states systems, as well as colleges not in state systems, have the opportunity to choose their preferred placement tests and have varying admission processes, testing procedures, cut-off scores, and policies (Prince, 2005).

There is a lot of freedom in choice, implementation, and process for student placement. As one example, Perin (2006) found in a case study of 15 community colleges within six states that institutions vary in their choice of placement procedures and tests, and out of these 15, eight used only one measure (the placement test) to place students into college courses. To obtain a better understanding of student placement, college administrators and decision makers need to consider how these tests are administered, what investments students must make, and the various policies community colleges have in place with regards to the placement of students.

Testing procedures. If students have not met minimum requirements on the ACT or SAT test, or another college readiness test or state exit exam, they will more than likely need to take a college placement test prior to enrolling in courses at a community college. The procedures for testing vary from institution to institution. For example, testing times and locations vary, the process for scheduling or taking the test varies, the order of the tests (reading, writing, and mathematics) varies, the number of times a student can retake the placement test (or an individual math, reading, or writing portion of the placement test) varies, and the overall student experience from admission to enrollment varies from one institution to another.

At most colleges, placement tests are taken by students after submitting their application packets to the admissions office, before or after orientation sessions, and prior to registering for courses (Robinson & Kubala, 1999; Safran & Visher, 2010). Depending on procedures at their respective college, it’s not uncommon for students to become frustrated, inattentive, and downright irritable after waiting in lines for hours to go through the college’s entrance processes prior to taking a placement test (Robinson & Kubala, 1999). Consequently, many students are not warned about placement tests, have no understanding why they are taking them, are not provided sample questions or a preview of test components, do not brush up on their skills prior to testing, and are basically blindsided with the demand to sit down and take a placement test that will determine how much time and money these students will spend in college (Safran & Visher, 2010). Through focus groups with students, Venezia, et al. (2010) found the following:

> Community college students describe assessment and placement as something they encounter for the first time upon arrival at the college. They describe an

> isolated event that happens one day with minimal to no advance information. They walk into a testing center and take a test that seems disconnected to any recent academic work they had in high school. They receive a printout of their results and then register for courses. Many do not meet with a counselor to discuss their test results, and believe they are on their own to determine course-taking options. (p. 2)

In conclusion, colleges are sending mixed messages on student success and students are feeling discouraged from the very start. This is leading colleges to second guess their testing and enrollment procedures and whether testing students immediately upon acceptance will assist students on the road to success (Safran & Visher, 2010).

Student investment. There are two types of investments that students have to make for the placement test. The largest is time; however, some have to invest money as well.

Depending on their success on the adaptive placement tests, the testing portion of the admission process consumes approximately 30 minutes per exam per student for the popular placement tests such the COMPASS or ACCUPLACER tests (College Board, 2007; Hughes & Scott-Clayton, 2011). As some students need to take all three portions (reading, writing, and mathematics) of the college's placement test, students could spend two hours or more just testing before receiving their course placements (Hughes & Scott-Clayton, 2011).

Upon receiving placement test scores, some institutions' procedures then route students to advising, counseling, or registration. No matter the route, after receiving placement scores students ultimately have the option to register for courses or, depending on that college's policies, may retake the placement test. Regardless of the process, the time commitment can be additional hours or days before a student finally completes the enrollment process.

In addition to the time commitment, students, their families, and their employers must juggle a monetary investment. According to various colleges' websites, some community colleges, such as one in Washington, directly charge students $25 for taking the placement test and another $25 to retest (College Placement Test, n.d.), whereas other community colleges, such as one in North Carolina, do not directly charge students for placement testing (Nash Community College, n.d.). Placement tests do cost institutions money, and for those that do not directly charge a fee for testing, student fees are generally imposed through course registration to help offset the cost. Regardless of where or when students pay, many face the challenges of taking time off from work, obtaining childcare, and securing the resources to ensure they are able to complete the process to enroll in classes.

Testing policies. After a student takes a placement test, his or her scores are interpreted, and he or she are placed into courses that would be appropriate to his or her ability level, preventing frustration and boredom and opening the door to new insights and challenges (Mattern & Packman, 2009). Overall, policies vary between institutions. When taking the mathematics placement test for example, some colleges allow students to use a calculator, which can vary from a basic calculator to a graphing calculator, but some do not allow the use of a calculator (Safran & Visher, 2010). Some community colleges, such as the Community College of Baltimore County (CCBC), give students assessment packets prior to testing, and encourage students to practice at home and return for a test or a retest when they feel more prepared (Safran & Visher, 2010). Overall, four areas of concern regarding college placement testing and their policies have emerged in higher education: the type of placement test, cutoff scores, the high-stakes with a one-shot placement test score versus the ability to retest, and the accuracy of placement tests.

Type of placement test. Approximately 92% of community colleges use placement tests to determine which developmental or college-level mathematics and English courses incoming students should be placed into (Parsad, Lewis, & Greene, 2003). Each institution, or state system, has the choice of which test they would like to use, and which type to administer – a diagnostic or non-diagnostic test. Ewell, Boeke, and Zis (2008) reported that 20 states had a statewide policy governing college course placements, and 18 states had, or were in the process of adopting, a common set of placement tests, with COMPASS and ACCUPLACER being the most commonly used tests.

Placement tests, such as COMPASS or ACCUPLACER, are generally not timed, but take approximately a half an hour per portion to complete, and each institution or state system chooses the test and procedures that they believe are best for their particular needs (Hughes & Scott-Clayton, 2011). The students who need to take all three portions of the placement test – reading, writing, and mathematics – can expect to spend at least an hour and a half testing. In a world full of distractions and obligations, if a student was unaware of this time commitment and the test's importance, it could be quite difficult for a student to complete the entire placement process (Hughes & Scott-Clayton, 2011).

COMPASS and ACCUPLACER. The types of mathematics questions asked on both the ACCUPLACER and COMPASS adaptive placement tests are similar in content and style. Both exams test students over similar topics, have numerous questions within each topic, start students with a question that is in the middle range of difficulty, and adapts to easier or more difficult questions and topics, as students answer questions, until a placement is determined (Jaggars & Hodara, 2011).

Less than half of community colleges use ACT's COMPASS placement test (Primary Research Group, Inc. , 2008). The COMPASS test consists of five main categories: Pre-Algebra – complete with questions from over 12 content areas, Algebra – complete with questions from over 20 content areas, College Algebra – complete with questions from over five content areas, Geometry – complete with questions from over six content areas, and Trigonometry – complete with questions from over five content areas (ACT, Inc.). Furthermore, more than half of community colleges use College Board's ACCUPLACER placement test (Parsad, et al., 2003). ACCUPLACER consists of three main categories: Arithmetic – complete with 17 types of questions, Elementary Algebra – complete with 12 types of questions, and College-level – complete with 20 types of questions (Hughes & Scott-Clayton, 2011).

Placement test cutoff score. A cutoff score is a number that is used to help place students into a particular course. In general, most colleges use an interval, with maximum and minimum cutoff scores. The minimum number in a particular math course's placement interval dictates the lowest score that could be scored for a student to place into that particular math course, and the maximum number in that particular math course's placement interval dictates which students would be prevented from placing into the next level math course.

Although the major testing companies may provide suggested intervals for mathematics course placement, every college or state system has the right and ability to create their own intervals and cutoff scores. Therefore, a student's mathematics placement is based upon an individual college's or state system's interpretation of how well its placement test matches up with its math courses and students' performance in these courses. This undoubtedly leads to numerous variations on mathematics placement rather than one unified national decision and ultimately means that a student could be placed into a developmental math course at one college and into a college level math course at another college, all based on the same test and test score. In fact, based on individual colleges' set cutoff scores, students could be placed into a developmental math course at some colleges, but college-level math course at other institutions (Jaggars & Hodara, 2011). Because of such variations in the placement of students, many experts believe that placement tests are not good predictors of student success for students near cutoff scores (Belfield & Crosta, 2012).

Colleges' placement score ranges vary from institution to institution, even for entrance into essentially the same math class. This difference basically means that some colleges require more or less incoming knowledge for their students in that math class than other colleges. Furthermore, since each math class has a placement range, there could be a large difference in student knowledge and skills within that one class. Consider a beginning algebra class, the student who earned the lowest cutoff score in that course's range would place into that course, but their current knowledge and potential skills could vary tremendously compared to the student who knows all of the topics from that course except for solving quadratic equations by factoring. Consequently, both students are placed within the same course, and instructors are faced with educating both so that they are engaged and obtain the knowledge needed to pass that course and be successful within the next. This implies that all scores within a range are equivalent, including those that are one point above a cutoff score or those that are one point below the next level's cutoff score (Belfield & Crosta, 2012). Hence, if student placement is based solely on a placement score, it is clear that prior knowledge, current skill levels, and capabilities within a particular topic of that placed course are not being considered.

Through their research, Bettinger and Long found ranges as large as 74.5 points between cutoff scores for institutions who are able to pick their own cutoff score (as cited in Jaggars & Hodara, 2011). Furthermore, Bettinger and Long state that ranges such as these contribute to varying ability levels for students within these classes, increase the count of students within these classes, and make it difficult for instructors to manage student learning (as cited by Jaggars & Hodara, 2011). The larger the range of students' knowledge and ability levels, the harder it will be for instructors to address everyone's needs, and the harder it will be for students to learn and stay engaged.

Retaking placement tests. Students tend to place lower than their abilities when under the pressure of a timed placement test (Latterell, 2007). Allowing students to retake a placement test is up to the discretion of individual institutions or state-systems and their policies. Some colleges allow students to retest and others do not. For the colleges that allow retesting, some allow students to retake the placement test once and others give multiple, even an unlimited number of opportunities to retest until they eventually pass or meet the institution's minimum cutoff score (Perin, 2006). Venezia, et al. (2010) found through student focus groups that students weren't sure if they could retake the placement test, how to obtain permission to retake the test, what to study before retesting or if studying would make a difference, and didn't know if they could challenge their placement with the consideration of multiple measures.

Colleges that allow students to retest don’t encourage students to turn around and test continuously until their desired score is achieved. Most colleges require at least permission from an academic advisor, counselor, dean or faculty member before retesting (Perin, 2006). Some institutions, such as one in Michigan (COMPASS, n.d.), require students to pay in order to retake a placement test, and other institutions restrict when students can retest. For example, the Community College of Baltimore County, allows students to retest if they fall within a few points of the cutoff score, and Houston Community College and Merced College make students wait a semester before retesting (Safran & Visher, 2010). Policies such as these prevent students from abusing the placement process, such as retesting until a desired placement level is obtained, and still allow institutions to have a streamlined placement process; however, these policies could force students to either enroll in a course (or courses) they don't need, or postpone college entrance due to low placement test scores or the inability to receive financial aid due to course enrollment restrictions (Safran & Visher, 2010).

Accuracy. Placement tests are intended to help colleges place students into classes that are appropriate for individual students’ ability level, which should prevent the occurrence of boredom or the feeling of being completely overwhelmed (Mattern & Packman, 2009). Unfortunately, placement tests are not perfect in placing students. These assessments rely upon the knowledge of the test taker at a particular moment, and consequently students can be inaccurately placed, based on as few as eight questions, into levels not representative of their skills (ACT, Inc., 2006). Theoretically, placement test results should be assessed yearly to ensure alignment between high school and college expectations; however, in reality these tests might not reflect content from high school or college classes and what a student was actually taught (Conley, 2005).

Many recent studies have reported on the accuracy of college placement tests. For example, Scott-Clayton (2012) found, in a study of a Large Urban Community College System (LUCCS), that students placed into mathematics courses using placement test results produced more student success than allowing all students to enroll directly into a college-level math class. Bailey, et al. (2010) found that students who bypassed their developmental mathematics course placements were much more successful in college-level mathematics compared to those who enrolled directly into developmental mathematics courses. Furthermore, the probability of these students enrolling in a developmental mathematics course and attempting a college-level course was much lower compared to students who actually bypassed their developmental mathematics courses (Bailey, et al., 2010). Complete College America (2012) published a report that found that students who skipped their developmental course placements were just as likely to be successful in gateway courses as the students who enrolled in the developmental courses first.

The LUCCS study also found that when placing students into mathematics courses based on placement test scores, approximately 58% of students were successful and hence accurately placed, and only 24% of students were severely misplaced two or more levels higher or lower than their abilities (Scott-Clayton, 2012). Scott-Clayton (2012) noted that using placement test scores served as a better predictor of which students would be successful if directly placed into college-level courses, compared to predicting which students were likely to fail, and reduced the occurrence of severely misplacing students.

In a study by Medhanie, Dupuis, LeBeau, Harwell, and Post (2012), of 28 colleges or universities using the ACCUPLACER placement test, and 6,471 students from approximately 300 high schools, it was found that the ACCUPLACER test provided only a small amount of additional information on the effectiveness of placing students beyond what the ACT mathematics test provided. The data they found were not significant; however, they concluded that the placement of students could simply be done by using ACT mathematics test scores (Medhanie, et al., 2012).

Furthermore, Mattern and Packman (2009) found in a meta-analysis of 47 studies (11,266 students) from 17 institutions (14 of which were community colleges), that 73% to 84% of students who took the ACCUPLACER test were placed into the correct math class (the student earned a C or better in that class) as well as a "moderate-to-strong relationship between test scores and subsequent course performance" (Mattern & Packman, 2009, p. 6). As they fleshed out the data further they found an 84% accuracy rate for students earning a C or better, and a 66% accuracy rate for students earning a B or better for 1,824 students at 13 institutions that placed into Pre-Algebra, and a 73% accuracy rate for students earning a C or better, and a 65% accuracy rate for students earning a B or better for 7,307 students at 34 institutions that placed into Elementary Algebra.

In 2006, a COMPASS meta-analysis found a 72% accuracy rate for students in Arithmetic from 26 institutions, a 63% accuracy rate for students in Elementary Algebra from 29 institutions, and a 67% accuracy rate for students in College Algebra from 23 institutions (ACT, Inc., 2006). The accuracy rates for students earning a B or better in their placed class was 70% in Arithmetic, 67% in Elementary Algebra, 71% in Intermediate Algebra, and 72% in College Algebra.

The Arguments

Due to variations between institutions and placement tests, much discussion has occurred regarding the accuracy, appropriateness, procedures, and policies that govern placement tests and their usage. The following are only a few of the major arguments, some of which will be discussed in more detail throughout this literature review:

- Students do not take placement tests seriously (Ingalls, 2011; James, 2006). Community colleges see students ranging from dual enrolled students to those who have been out of an educational setting for years and have demanding family and job obligations. Such obligations, if not accounted for prior to attending orientation or participating in the placement process, could indeed hinder students from focusing or performing up to their ability. In addition, if the process or importance of the test isn't explained, the student might not see the benefit of taking the placement test seriously (Bryant, 2001; Hughes & Scott-Clayton, 2011).

- Students are not informed about community college readiness or do not see its importance when information is provide to them (Venezia, et al., 2010). Estacion, et al. (2011) found that actually giving high school students the college's placement test, even as early as 9^{th} or 10^{th} grade, helped students become more aware of their current college level and their options for math classes, including dual enrollment.

- Students and colleges are not aware of student capabilities. Some students may have been out of the academic realm for a number of years, and hence may not have a good sense of what they are capable of accomplishing. Consequently, colleges may rely entirely on placement tests, rather than using multiple measures such as high school transcripts or non-cognitive measures, to assist in the placement of students (Bryant, 2001).

- College math classes may not match the content of the college's placement test or align with the math sequence at the college (Bryant, 2001).

- Students are not prepared or focused for initial success (Ingalls, 2011; Prince, 2005). Most placement tests and processes require students to take three distinct tests (reading, writing, and mathematics) back-to-back, on a single day (Hughes & Scott-Clayton, 2011). It can be relatively easy for students to lose their focus, become tired, frustrated, and potentially not perform up to their ability (Ingalls, 2011; Robinson & Kubala, 1999).

- Hundreds of thousands of potential community college students have been denied access to an education due to low or no college placement (Gonzalez, 2012).
  - The first type of denied access that should be considered is when students are unable to advance from developmental course work to college level course work (Bailey, Jeong, & Cho, 2010; Belfield & Crosta, 2012). Several reports have shown that students who start in developmental education courses have a very low probability of progressing through the developmental sequence and into college-level courses (Bailey T. , 2009; Bailey, et al., 2010; Belfield & Crosta, 2012; Jaggars & Hodara, 2011; Templin, 2011; Vandal, 2010).
  - The second type of access that should be considered is the traditional community college open-door. Historically, community colleges were institutions that served students desiring or needing anywhere from remediation, to workforce skills, to knowledge for transferring to a four-year college. However, due to a lack of funding and an effort to improve graduation rates, some colleges are denying access to students based on low placement scores (Gonzalez, 2012; Rhoades, 2012; Rhoades & Madaus, 2003). Certainly, this is an issue for students who recently graduated from high school and were required to take four years of high school mathematics (Hughes & Scott-Clayton, 2011). Additionally, this could be an issue for students who have been out of academia for a number of years and either had a strong foundation a number of years ago, or were unable to obtain remediation through adult basic education centers. Finally, this is an issue for poor and minority students whose families or communities have few, if any, individuals who have attended college (Rosenbaum, Stephan, & Rosenbaum, 2010).
- The test is broken or biased. It is recommended by the test makers that colleges check their placement test results with students' course placements regularly for validity, course placement effectiveness and placement score ranges (ACT, Inc., 2006; Mattern & Packman, 2009; Saxon, Levine-Brown, & Boylan, 2008). Others believe that the placement tests are biased, not appropriate for specific students based on their race or location, could contain or yield errors due to where students live or are from, or may not match the content found in high school or college math classes (Kingan & Alfred, 1993; Rhoades & Madaus, 2003; Bryant, 2001).
- Perhaps the process that is used in preparing students, testing students, and then placing students is broken and not the test (Hughes & Scott-Clayton, 2011). This argument is heightened as many states require four years of high school mathematics, which should imply that fewer students place into developmental mathematics courses (Hughes & Scott-Clayton, 2011). For example, Reys, et al.

found in 2007 that 11 states required high school students to take four years of high school math (followed by 24 states which require three years, and seven states that require two years of high school math).

- Additionally, more colleges are using data to make decisions, and one fact that is constant is that students who are successful within their first mathematics course are more likely to take additional mathematics courses (Steen, 1992). Therefore, in an effort to improve processes, student placement, and student success, discussions regarding uniform policies and cutoff scores have increased (Collins, 2009; Morgan & Michaelides, 2005; Prince, 2005).

Perhaps the problem with student placement at a community college is not any one of the above arguments, but a combination of several. This dissertation will touch on all of the above, but will focus in particular on placement preparation, testing, and processes that reduce students from feeling inhibited, but rather welcome them through a door that directs them towards college success even before heading to classes.

Developmental Education

All community colleges offer developmental education courses (Parsad, et al., 2003). Developmental education courses, also called remedial education, are courses that a student must take to learn the mathematical, reading and writing foundational skills for college and lifelong success.

The numbers of students who are not college ready are staggering, and at times unfathomable. Some states and institutions see over 90% of first-time community college students who are deemed insufficiently prepared for college level mathematics, and thus must take developmental or remedial education courses (Achieving the Dream, 2009; Carnegie Foundation, 2011). ACT (2011) reported that of the 1.5 million students in 2011 who took the ACT test, only 45% met the mathematics benchmark and were ready to enroll in college level math courses; the other 55% were not ready for college-level mathematics. Furthermore, when disaggregated, Collins (2009) reported that 97% of African Americans and 90% of Hispanics are not college ready after graduating from high school. Likewise, one-third of Caucasian students and one-fourth of Asian students are not college ready upon graduating from high school (Bettinger & Long, 2007).

Breneman, Costrell, Harlow, Ponitz and Steinberg (1998) state that remedial students enroll in an average of two remedial courses, and that 70% of remedial students are in community colleges, while 30% attend four-year colleges, including the most exclusive colleges. In general, students either choose to take developmental education courses or are placed within developmental education courses. For the students who are placed within developmental education courses, they either belong in developmental education courses because that is their current or past knowledge level, or have placed into developmental education courses for a variety of reasons, but belong in, or could be successful in, a college level course. Regardless, students are not even aware of college placement tests, may not have understood their importance upon testing, or their consequences until after admissions (Scott-Clayton, 2012; Venezia, et al., 2010).

High placement rate. A very large percentage, 60% upwards to 98% at some colleges, of new incoming community college students place into at least one developmental education course upon college entrance (Achieving the Dream, 2009; Collins, 2009). More recently, a study across 57 community colleges found that 59% of incoming students placed into a developmental mathematics course (Bailey, et al., 2010). It was also found in Texas that less than 50% of students met the state’s math and verbal skills college readiness standards (Smith, 2012).

Demographically, it seems that minority groups are in need of more remediation, with approximately 68% of African Americans, 58% of Hispanics, 49% of other ethnic students, and 46.8% of whites needing remediation upon college entry (Complete College America, 2012). In addition, almost 657% of low-income students were also in need of remediation upon college entrance (Complete College America, 2012).

Low enrollment rate. Although many students may need remediation, there is no guarantee that they will obtain remediation. With the expectation that all students, including those in developmental mathematics courses, will work to complete the course or sequence, Jaggars & Hodara (2011) reported that this occurrence is not often the case for students placing into developmental courses. In fact, Complete College America (2012) reported that thousands of students become frustrated about their placement into developmental education and that 30% decide not to attend their first course or subsequent remedial courses.

Bailey, et al. (2010) report that many students who place into developmental education never enrolled in developmental education or skip it completely. If mandatory placement policies are not set in place, some students will avoid taking developmental education courses, and rather try to bypass them by enrolling in college-level courses that do not contain prerequisites (Bailey, Jaggars, & Cho, 2010; Jenkins, Jaggars, Roksa, Zeidenberg, & Cho, 2009). These students are then more likely to enroll in college-level math or English and skip developmental work altogether, whereas others just disappear from college completely (Bailey, et al., 2010; Jenkins, et al., 2009).

For the students who do just disappear, Bailey, et al. (2010) analyzed data from Achieving the Dream and found that students who were referred to developmental mathematics courses and chose not to enroll in a math class, 39% actually did not enroll in any college courses. Altogether, Complete College America (2012) reported that approximately 51.7% of community college students actually enroll in developmental education courses.

Low completion rate. Being assigned to a lower or higher-level class can lead to negative effects, such as student frustration, reduced retention and persistence rates, and delayed or reduced college completion rates (Boatman & Long, 2011). Similarly, students that are placed into developmental education courses have a low probability of taking college-level courses (Belfield & Crosta, 2012).

The main reason why students who place into developmental education courses cannot take college-level courses is that they don't complete the sequence. For example, Achieving the Dream data on 250,000 students showed that 31% of the students who were placed into a developmental math course actually completed the developmental math sequence to become college-level eligible (Bailey, 2009). Similarly, Bailey, et al. (2010) reported that up to two-thirds of students placing into developmental education do not complete the developmental sequence, and only 10% of those that place into the lowest level of the developmental math sequence actually finish the sequence and move on to college level mathematics courses. And of those that placed into developmental math courses, 11% never failed a math course but still did not complete the developmental sequence, and 29% did fail a course and did not complete the sequence (Bailey, et al., 2010). In addition, Templin (2011) and Vandal (2010) found that of the percentage of students who place into developmental education courses, less than 20% actually make it to graduation.

Basically, the majority of students who place into developmental education courses and actually enroll in these courses become hindered in some way through the sequence and never reach college-level courses or degree completion (Bailey, et al., 2010; Jenkins, et al., 2009). Attewell, Lavin, Domina and Levey (2006) found that of recent high school graduates who took at least one developmental course in a community college, only about a quarter of them earned a degree within eight years.

Unfortunately, student results on a placement test do not help predict the grades students will earn in their courses after being placed (Belfield & Crosta, 2012). Coupling this with the case that baseline data is often ignored or not published when an institution claims improved developmental completion rates, and other colleges are reluctant to make improvements to their placement process, placement test, developmental courses, or developmental sequences (Sherer & Grunow, 2010).

Nevertheless, with such high developmental placement and attrition rates, several questions emerge:

- Are colleges accurately placing students?
- Can students afford the time and money associated with completing repetitive math courses? Will they persist in college? Or will they be discouraged?
- Can colleges save money by developing processes that improve placement, improve student learning, and improve retention and persistence?
- Will the government continue to fund education that is repetitive when there is very little success in college completion?
- What are colleges doing to improve student placement?

Cost of developmental education. College placement tests regularly place students into courses beneath their ability level, which forces them to spend more time and money to obtain their desired credentials (Latterell, 2007).

Institutional cost. The cost to attend college isn't decreasing, and hence neither is student debt. With colleges receiving less local, state, and federal funding, the cost of attending college is shifting onto the students. Students may rely on their parents for financial support, pay out of pocket, obtain student loans or scholarships, or qualify to receive grants, such as the Pell grant, to pay for their education, but no matter how they get their money, their costs are not dropping. Considering rising tuition costs, increases in student fees, the price of textbooks, computer software, and other course necessities, attending college can be extremely costly or impossible for some students. With the economy of the 21st century thus far, and the cost of living, nontraditional students may find it difficult to sustain their (or their family's) lifestyle.

In earlier studies, it was estimated that the cost of remedial instruction was around one billion dollars, which accounted for approximately 1% of all public expenditures for post-secondary education – upwards of three or more times this amount (Breneman, et al., 1998; Phipps, 1998). A few years later, Saxon and Boylan (2001) compared the cost of remediation in post-secondary education within statewide systems and found that it did not exceed 10% of the cost of education as a whole, with no reports of institutions or states exceeding this amount.

Needless to say, from 1998 to 2001, the cost of developmental remediation could have increased as did the number of students actually placing into developmental education courses. Progressing in time, Noble, Schiel, and Sawyer (2004) estimated that the cost for providing remedial education was $1 billion or more, and finally, the Alliance for Excellence Education (2011) reported that for the 2007-2008 cohort of students who placed into developmental education, over $3.6 billion was spent on remediation for their time in college.

Overall, a considerable amount of funding has been spent on remediation. Certainly, community colleges need to offer remedial classes as they serve students with a variety of skills, abilities, and knowledge levels. However, with the demand for college completions growing, and funding possibly being tied to performance (which is the case in at least 12 states already), community colleges may look for ways to help reduce costs, boost developmental sequence completions, accelerate students through college, or even restrict their missions (Ewell et al, 2008; Scott-Clayton, 2012).

Student cost. First, community colleges offer a more affordable option for students, as tuition rates are lower than universities or private colleges. Second, only college level courses count towards degree programs and graduation. Third, students have to pay for developmental courses either with their own money, with student loans, or some other source of student aid. No matter how they pay for their education, money is being spent on courses that will not count towards their degree and consequently may eat up their financial resources for completion or advancement. And finally, with the high cost of textbooks, computer software, and student fees, students are paying hundreds of dollars, and months to years on each developmental education course they take.

Improving Community College Mathematics Placement

No matter which type of placement test or measures are taken to ensure proper student placement, there inevitably will be students who place higher than their abilities, just right for their abilities, and some that receive placement that is too low for their abilities. Hughes and Scott-Clayton (2011) add that just because a student scores low doesn’t necessarily mean that he or she should be placed into remedial math. It is this statement in which the remainder of this dissertation will focus – in particular, how community colleges can improve the placement of students into mathematics classes that will facilitate better student retention and persistence beyond developmental education courses.

Placing students can be challenging, costly, and time sensitive. For example, placing students too low could result in the students being bored, frustrated, or upset which could in turn lead to persistence or retention problems, discouragement, and lowering their standards and aspirations as well as changing classroom dynamics which could have otherwise been avoided. In addition, a low placement prolongs students’ attainment of their educational goals and ultimately their future, forces students to spend more money on tuition, books, fees, etc., and forces students to spend valuable time that could have been spent elsewhere.

Placing students too high has similar consequences. Being placed too high could cause students to feel inferior, discouraged, and lower their self-worth. Consequently, these feelings might not promote encouragement and success, but rather could force students down the road of failure, despair, and attrition unless they quickly recognize their situation and seek avenues to improve their lack of skills or receive some sort of intervention from a family member, friend, or college employee. On the other hand, depending on students’ capabilities, attitude, and grit, some students might see this as a challenge and ultimately do just fine. Needless to say, there will always be students who are satisfied, and others who are disappointed with their mathematics placement. For example, El Paso Community College (EPCC)’s Director of Student Success, Irma

Camacho, reported that approximately 70% of incoming students are not happy with their initial course placement (Sherer & Grunow, 2010).

Unfortunately, although hundreds of thousands of students take placement tests each year, and millions of dollars are spent on college readiness and placement assessments, the development of a large-scale test-preparation market has not yet occurred (Scott-Clayton, 2012). Individual institutions and state systems are forced to independently determine their own procedures for test preparation, testing, and improving student placement. Hence, it could be assumed that thousands of variations of the same initiatives, one at each college, and millions of dollars could be spent on repetitive initiatives as colleges seek to educate and prepare students for initial college placement success.

Multiple considerations. Perhaps the easiest method for accurately placing community college students into the mathematics level most appropriate for their abilities is through the use of multiple considerations. As academic preparation is dependent on skills such as personal attitudes, habits, and behaviors, it would be only natural for a college to utilize multiple considerations when placing students rather than a single high-stakes placement test score (Attinasi, 1989; Karp, 2011; Karp & Bork, 2012; Person, Rosenbaum, & Deil-Amen, 2006).

The use of multiple measures can significantly increase the accuracy of placing students (Gordon, 1999; Hughes & Scott-Clayton, 2011; Rouche & Rouche, 1999). In fact, both of the makers of the COMPASS and ACCUPLACER tests believe that placement test scores should be used in conjunction with other data on new incoming students (ACT, Inc., 1997; College Board, 2003). Unfortunately, there aren't many colleges that use multiple measures. Although four-year institutions commonly use multiple measures of college readiness, community colleges mostly rely on students' scores on standardized placement tests (Hughes & Scott-Clayton, 2011; Safran & Visher, 2010). Hughes & Scott-Clayton (2011) note that community colleges might rely primarily on placement test scores, as it may be difficult to collect student success data prior to course enrollments and to organize this information so that it can be used and interpreted efficiently.

If colleges had additional student information, and it was of potential value for course placement, they might not have the personnel, time, space, or other resources necessary to make decisions based on the additional information (Hughes & Scott-Clayton, 2011). For example, colleges that admit tens of thousands of students often do not have the staff to look at multiple considerations, and hence are forced to side with efficiency and a one-time placement test score for placing students (Jaggars & Hodara, 2011; Robinson & Kubala, 1999). According to Safran & Visher (2010), California counselors are required, by a matriculation policy, to use a checklist consisting of multiple items such as high school transcripts, writing samples, and a counselor's assessment when placing students; however, many counselors have voiced concerns regarding time constraints, and unfortunately, at times are forced to rely only on placement test scores. However, if more students are retained, more resources will be available.

In addition to the time and resource constraints that community colleges must face, debate has increased recently on the effectiveness and validity of college placement tests, especially the commonly used COMPASS and ACCUPLACER placement tests.

From evidence found looking at the predictive validity of college placement tests, Hughes and Scott-Clayton (2011) reported that in order to improve the placement of students and their future success, colleges will have to effectively use multiple measures, including non-cognitive or broader measures of prior academic achievement, and consider being more flexible in the placement of students based on these measures.

In a case study consisting of 15 community colleges in six states, it was found that utilizing subjective measures, multiple considerations, re-administering placement tests, ignoring placement scores and giving waivers for remedial courses, giving separate tests for non-native English students, allowing students to appeal their placement test score, or ultimately choose their own placement instead of utilizing a single objective test score, decreased the number of students in developmental education courses (Perin, 2006). Scott-Clayton (2012) complements this by reporting that if colleges would change current practices to consider multiple measures before making students' placement, misplacements could be reduced by approximately 15%, developmental placement rates could be reduced by 8%-12%, and overall college-level placement and success rates would increase.

Basically, colleges can improve their placement process and help students increase their chances of future success by working with students individually to analyze a comprehensive set of information before placing them into any classes (Jaggars & Hodara, 2011, p. 7). The following few sections discuss the multiple considerations a college could employ to help them better place a student into a mathematics course.

More testing. One of many actions colleges are implementing to improve placement is additional testing. A more accurate mathematics course placement may be determined by interpreting current tests differently, using new tests, using additional supplemental tests, or giving students the opportunity to retake the college placement test (Belfield & Crosta, 2012).

According to Illich and McCallister (2004), "students who successfully complete their remedial courses perform as well as non-developmental students enrolled in college-level courses" and hence using one "placement test to determine a student's academic preparedness is not sufficient for some students" (p. 452). However, before utilizing additional testing of students, there are a few factors that colleges should be aware of. First, current placement test procedures can take several hours to complete. Adding additional assessments will yield additional time for both students and colleges (Boylan, 2009). Second, utilizing additional tests will yield additional costs. Either colleges will have to absorb these costs, or find a way to charge students. Third, colleges will have to devote personnel to initiate additional tests, proctor these tests, and interpret these tests, which will either require new staff or additional responsibilities for already existing staff.

Several colleges have used additional testing to supplement their college placement test. For example, Portland Community College uses an in-house placement test to retest students who feel that their course placement from the college's placement test placed them lower than the level in which they expected to be placed (Hughes, 2010). Additionally, a small university, which placed students into math courses based on their ACT mathematics score, gave students the ability to take up to three additional, in-house created, placement tests to improve their course placement (Ingalls, 2011). However, after the dean of mathematics double-checked the course placements as they related to students' high school transcripts, it was found that the results from the additional tests were not as effective in determining successful course placement (Ingalls, 2011). However, a connection was found between students' ACT mathematics score of 26 or higher and success at the university within college algebra or finite math classes (Ingalls, 2011). Due to these results, the university reached out to students who scored 26 or higher on the ACT mathematics test, invited them to take the third in-house math placement test, and the students who passed with an 80% or higher received free credit for college algebra or finite math (Ingalls, 2011).

Diagnostic features. Placement tests do not diagnose students' knowledge gaps or needs, but rather place students into classes that could extend their academic path (Belfield & Crosta, 2012). One method for diagnosing students' knowledge gaps or needs and improving students' mathematics placement, especially within modular mathematics courses, is to use diagnostic features. Diagnostic features or a diagnostic test is similar to a traditional placement test but generally consists of additional questions on the major topics covered on the placement test, and gives a breakdown of students' scores relative to mathematical topics.

Students won't necessarily know the difference between a diagnostic and traditional placement test, outside of the additional time required to complete the test – which commonly take students longer (Burdman, 2012). For example, the newly adopted PERT placement test used in Florida takes students about twice the time it took students to take the ACCUPLACER test (Burdman, 2012). Similar to Florida, Texas is scrapping the traditional placement test, and will use a diagnostic placement test that will give postsecondary students a better idea of what they are missing (Smith, 2012).

Determining course placements of remedial students can be very difficult, and consequently, if they are not well selected, could lead to attrition due to a lack of progression (Smith, 2012). Using the diagnostic feature would allow counselors or advisors the ability to really see what topics the students may lack, and a more accurate course placement could occur based on these interpretations and the topics found within their colleges' mathematics courses. For example, rather than seeing an overall score earned with the Pre-Algebra portion of a placement test, a student's score within topics such as percentages, ratios and proportions, or averages is listed (ACT, Inc.). Once individual students' strengths and weaknesses are identified, advisors, counselors, or even mathematics faculty members could use these results to better place students and help them succeed within their respective mathematics course. Unfortunately, many colleges that use diagnostic features "provide finer-grained placements of students based on their skills, but they don't provide information to instructors" or use it for alternative course placement (Burdman, 2012, p. 15). Furthermore, it is not uncommon for some math instructors to use the first day of class to retest students with the placement test to identify students who were incorrectly placed (Jaggars & Hodara, 2011). Unfortunately, Jaggars and Hodara (2011) note that very few students obtain a new placement after retesting, and their individual results are not always used within their classes after testing for instruction (Jaggars & Hodara, 2011).

In conclusion, using diagnostic features could help better place students and determine where students are lacking in their mathematical knowledge; however, improving students' mathematical knowledge can only be capitalized on if the results can be obtained, accurately interpreted, and used. Unfortunately, obtaining diagnostic information is difficult to obtain and conflicts with the efficiency most colleges strive to have with their admissions and registration processes as these exams require more time of students, computer labs, and other college resources (Jaggars & Hodara, 2011).

High school transcripts. Perhaps the most common method for placing students into mathematics courses in addition to the college's placement test is using high school transcripts and the mathematics courses students took in high school.

Recent and past data show that using high school transcripts in addition to college placement test scores can better help to place community college students. For example, Belfield and Crosta (2012) found through the evaluation of a statewide community college system that when using placement test results, a third of students were severely misplaced, and they believed that those errors rates could have been reduced by 50% by using students' high school grades instead of placement test scores. However, it is easier for colleges to process course placements based on a placement test score rather than slowing down the process through the evaluation of high school transcripts (Belfield & Crosta, 2012). Perhaps smaller colleges with the right resources might have the ability to analyze high school transcripts, or turn unprepared students away; however, larger institutions or colleges that have high numbers of students who apply days before the semester starts more than likely won't have the staffing to consider high school grades (Dean Dad, 2012). These students and these institutions are then bound to using placement test scores unless they change their enrollment period to end weeks prior to the start of the semester.

Assuming that students have their transcripts, viewing them might be preferred for some counselors or advisors; however, there seems to be a huge shortage of counselors (and advisors) as the average counselor to student ratio in high schools is 1:284 (Parsad, Alexander, Farris, Hudson, & Greene, 2003), with some high schools seeing ratios exceeding 1:700 (McDonough, 2004), and some community colleges seeing ratios of 1:1,000 (MDRC, 2010). Using high school transcripts and recognizing the number of English, math, honors, or difficult classes a student has taken in high school may help predict college success, but if one-on-one counseling or advising cannot be utilized, college placement test scores will be more heavily weighted, or it will be up to the individual students to interpret their placement score and judge if their placement is accurate based on their prior math knowledge.

Finally, few states have data systems that allow colleges to analyze high school records, or if they do, they often experience time delays or cannot find information on a non-traditional returning student to influence course placement (Burdman, 2012). Furthermore, these systems are generally not readily accessible by advisors or faculty members thus making placement decisions slow, difficult, and at times no better than a quick interpretation of a single placement test score (Burdman, 2012).

High school grade point averages. Scott-Clayton (2012) found that using high school grade point averages (GPAs) rather than placement test scores served as a better predictor for student success than using only placement test scores, and that when combing the two together there was little improvement in course placement. Scott-Clayton (2012) added that, through the analysis of placement simulations, students could have opted out of developmental courses based on placement test scores or high school results, and that college’s developmental placement rates could be decreased substantially without compromising college-level success.

In a study of 216 institutions, Nobel and Sawyer (2004) found that high school GPAs were not good predictors of high levels of academic achievement within the first year of college; however, for high school GPAs of 3.0 or lower, using high school GPAs was a better predictor of a student's first-year college GPA than using their ACT score for GPAs of 3.0 or lower. Similarly, Belfield and Crosta (2012) reported on the evaluation of a statewide community college system and found that using placement test cutoff scores resulted in a high misplacement of students into classes below what they could have successfully completed with a C or higher, whereas using high school GPAs in addition to the college's placement test scores reduced these misplacement rates in half. They also analyzed correlations between developmental education grades with college placement test results and high school GPAs and found no correlation between placement test results and college GPAs when controlling for high school GPAs, but a moderately weak positive correlation (r = 0.36) between high school and college GPAs (Belfield & Crosta, 2012).

Lastly, community colleges by name are institutions that intend to serve their community. Using high school GPAs might be relevant to the student who just graduated from high school, but using them or even obtaining them for nontraditional students who have been out of school anywhere from one to 30 or more years might not be possible or useful.

Classes taken while in high school. Drilling deeper than high school GPAs, some colleges are viewing students' transcripts to analyze past classes taken and students' successes within them. Similar to the findings of Noble & McNabb (1989), Roth, Crans, Carter, Ariet, and Resnick (2000) analyzed data on 19,457 Florida high school students and found that the mathematics courses students took in high school had a dramatic effect on college placement. In fact, taking more difficult mathematics courses while in high school was found to be a stronger predictor of placing out of developmental education courses at a community college than GPAs or the score students earned on the state's standardized tenth-grade test (Roth, et al., 2000).

Although not a community college, but valuable in terms of their findings, a university used standardized ACT-Mathematics test scores to place students, but after years of using this process determined that students weren't performing well due to their course placement (Ingalls, 2011). In an effort to improve student success and placement, the university created a series of placement tests for students' placement, and before placing students the department chair cross-checked students' placement with the classes these students took in high school (Ingalls, 2011). The chair then allowed some students to enroll in the course in which the in-house tests placed them, moved some students up, and moved some students down (Ingalls, 2011). The students who enrolled in the course in which they were placed by the tests had a pass rate of 28%, those who obtained a new placement by the department chair had a pass rate of 70%, and those who were moved up by the department chair had a pass rate of 93% (Ingalls, 2011). Ingalls (2011) added that even though students were informed well ahead of time of the university's placement tests, 70% of those that were tested said that they were not informed of the tests. Finally, the conclusion was drawn that the courses taken in high school were a much stronger predictor to student success than was the placement from the university's in-house placement test (Ingalls, 2011).

Arguing against the use of high school transcripts for student placement is the debate on how high school and college math, chemistry, and biology courses align. Some educators, even though curriculum may be aligned, may believe the courses and content are not equivalent. With regards to math, high schools have either an integrated math sequence, or teach the traditional Algebra 1, Algebra 2, Geometry, and Pre-Calculus sequence. The majority of community colleges teach at least Pre-Algebra, Beginning (also called Elementary or Introductory) Algebra, Intermediate Algebra, College Algebra, and Pre-Calculus. Although both the high school and college mathematics sequences cover a great deal of mathematics from basic operations through Pre-Calculus, the topics covered in one course at one institution isn't necessarily what is being taught in the associative high school course, or even at another college, as specific topics could be in a previous or subsequent math class. For example, in a 1984 study, a university found that nearly 70% of Intermediate Algebra students took three to four years of math in high school and 42% of Elementary Algebra students took two to three years of college prep math (Lappan & Phillips, 1984). This doesn't necessarily mean that these students were repeating topics when they reached college; however, it could be the fact that the high school and college math courses were not perfectly aligned. Willett, Hayward, and Dahlstrom (2008) attest that due to these differences, colleges need to be cautious when placing students based on their high school completions.

Others. The opportunities to help better place students could be limitless. In addition to those already mentioned, the following have been used and found success within certain institutions:

- More counseling: Venezia, et al. (2012) found that students really want more time with counselors. This intervention is costly, and seems impossible with student to counselor ratios as high as 1,000:1, as reported by some community colleges (MDRC, 2010; Venezia, et al., 2012).

- Place all students in a college-level course: The argument here is to do away with developmental education, and provide students needing remediation with the assistance and resources they will need to become remediated in their college-level math class while learning the college-level math. Doing just this, a community college studied 304 students who performed relatively the same as students who were placed into college-level math (Marwick, 2004).

- Use multiple measures: Outreaching to potential community college students with early testing, remediation interventions, placement preparation workshops, diagnostic placement tests, measuring non-cognitive factors and providing a road map to success could yield a more holistic means for college readiness and begin students on the right road towards success and completion (Hughes & Scott-Clayton, 2011).

- Let students choose: If all else fails, colleges could let students select their classes (Dean Dad, 2012). Unfortunately many students will then "badly overestimate their own abilities and quickly wash out of college-level classes" (Dean Dad, 2012).

- Testing guide and practice test: The Complete College America (2012) report recommends that in addition to considering high school transcripts along with placement test results, that colleges give future students a testing guide and a practice test before students test so that they can review prior to testing with the hopes of being better prepared.

Less testing. Colleges across the nation are faced each year with high numbers of incoming students placing into developmental education courses (Achieving the Dream, 2009; Collins, 2009). Many of these incoming students who are placing beneath college level are recent high school graduates, and some of them were required to take four years of math in high school yet still place as low as two or three levels below College Algebra into Basic Math or Pre-Algebra courses (Michigan Depatment of Education, 2010). One method for improving the placement of these recently graduated high schools students is to scrap the placement test and use other measures.

Some institutions are finding that accurate mathematics course placements can be obtained by merely looking at high school transcripts. For example, Belfield and Crosta

(2012) found through the evaluation of data from a large statewide community college system that college placement tests and developmental education for recent high school graduates who had an average high school grade point average over C+ could be waived. Additionally, some states such as Florida have policies that allow students to be placed into mathematics courses based on prior course grades rather than reliance on the state test (Perin, 2006).

Other institutions are finding accurate mathematics course placements through ACT scores, SAT scores, or other various state tests that high school students are required to take. For example, a 2006 study using data from 3,743 California 11th-graders who received a community college math grade by the end of fall 2006, found statistically significant findings between grades earned on the California Assessment Test given to 11th-graders and community college math class grades (Willett, et al., 2008). These findings were statistically significant, and the correlation coefficient was positive, but it was not a strong correlation, hence institutions that find merit in placing students based on performance on an ACT, SAT, or other high school standardized test should take caution and view additional measures before placing students (Willett, et al., 2008).

As a result of low correlations between placement test scores and subsequent remedial math course grades, some colleges have abandoned the use of commercial placement tests and rather give students the option to choose their class placement (Perin, 2006). Felder, Finney, and Kirst (2007) reported that by informing students about the content of developmental and college-level mathematics courses, colleges are able to use informed or directed self-placement where students can actually decide which course seems best for their skills and academic preparation.

In addition, some institutions have decided to place students directly into college level mathematics courses. These students are then directed to sources that will assist them in their success, or are engaged in interventions that are intended to help them improve their knowledge and have a greater chance of success. For example, an Achieving the Dream data analysis found that students who skipped developmental mathematics courses and enrolled directly into gatekeeper math courses passed “at a slightly lower rate than those students who enrolled in a gatekeeper course after they completed their” developmental math course(s) (Bailey, et al., p. 261).

In conclusion, many experts are concerned with the number of students who are placing into developmental education courses. Students are being placed into classes two or three levels beneath their prior mathematics class, and experts such as Bailey, et al. (2010) believe that the benefits of additional learning outweigh the learning that would occur within the developmental education course. Finally, Conley (2005) believes that the best option for students preparing for college is not to prepare for college placement tests, but to avoid them through earning high enough scores on a college readiness exam or through a high enough high school GPA that would grant them college-level placement.

Policies. Although placement tests such as ACCUPLACER and COMPASS are standardized and ACT and College Board provide suggested score ranges for course placement, the process for test administration varies between colleges (Hughes & Scott-Clayton, 2011). In other words, types of calculators that can be used, testing times and locations, processes for scheduling or taking the test, the type of test (diagnostic vs. non-diagnostic), the order of the tests (reading, writing, and mathematics), and the number of times a student can retake a test (reading, writing, or mathematics) can vary from college to college. In light of improving students' placement, the following sections will specifically address two of the various policies community colleges have considered: cutoff scores and retaking the placement test.

Cutoff Scores. Cutoff scores on college placement tests are being viewed by many decision makers within higher education. Numerous reports and suggestions have been written on college placement test scores and have received national attention (such as Collins, 2009; Morgan & Michaelides, 2005; Prince, 2005). Overall, there seems to be a huge lack of uniform standards as cutoff scores between colleges vary, cutoff scores between state systems vary and cutoff scores between community colleges and universities vary (Safran & Visher, 2010). Certainly, institutions or state-systems have the choice to set their own cutoff scores, but these differences raise several points of concern.

Variations in cutoff scores, and hence course placements, could invoke institutions to question matriculation agreements, transferring of credits and courses, high school to college alignment, and might spur the discussion of quality and equality of courses that contain the same content. For example, "in states with large numbers of community colleges, campuses within a few miles of each other can have different cut scores, allowing students who test into developmental education at one college to effectively game the system by enrolling in a second college where their score qualifies them as college-ready" (Collins, 2008, p. 4). Bettinger and Long (2009) confirmed this by using an instrumental-variable approach to view data on 28,000 students and noticed that these students' test scores would lead to different course placements depending on which institution they selected.

Although having cutoff scores won't improve placements, as colleges already have ranges for placing students, perhaps re-evaluating these ranges, especially with respect to nearby colleges or transfer institutions, may help colleges place students into classes that would be best attuned for their abilities and future success. According to Shults (2000), 77% of institutions determine their mathematics cutoff scores. Furthermore, at least 16 states reported that the entire state has mandated the usage of the same placement test and the same cutoff scores for all community colleges in the state (Ewell, et al., 2008; Prince, 2005). In other words, these 16 states have eliminated inconsistencies with placing students among community colleges in their respective states, but more could be done in aligning their placement scores with universities in their respective states, or with colleges within neighboring states.

In addition to eliminating alignment issues, community colleges are utilizing standardized cutoff scores to improve students' placement statewide. Although Prince (2005) predicts that standardizing cutoff scores will likely increase the placement of students into developmental courses, he believes that it could in time decrease the percentage of high school graduates who are underprepared for college. Boylan (2009) adds that even with cutoff scores, colleges can still use multiple considerations to analyze student placements to determine which students might be successful being placed into a college-level course rather than a developmental course.

Retesting. Allowing students to retake the college placement test can assist students in placing into mathematics courses best suited for their abilities. As noted earlier, there are varying policies on retaking placement tests as some institutions simply allow students to retest, and others require students to pay an additional fee or complete an intervention prior to retesting (Jaggars & Hodara, 2011). CUNY, for example, is an institution that allows students to retake the placement test; however, students must first complete the 20-hour University Summer Immersion Program (Jaggars & Hodara, 2011). Although very few students took advantage of CUNY's intervention, institutions are attempting to accelerate students' knowledge through self-paced tutoring, intensive test preparation workshops, etc. to assist students in placing into a higher-level mathematics course (Jaggars & Hodara, 2011, p. 16). Additional information on accelerating student knowledge and current examples from various colleges can be found within the accelerating initiatives section of this dissertation.

Educating potential community college students. New incoming students are not well informed on how to be successful in college, let alone on the college's placement test (Howell, Kurlaender, & Grodsky, 2010; Person, et al., 2006; Rosenbaum, 2001; Venezia, Kirst, & Antonio, 2003). All new incoming students could be informed of placement testing processes and college's placement tests upon walking through the front door, which could help them and the colleges they enroll in obtain course placements that are more reflective of students' true knowledge and abilities.

Certainly, many people know that colleges have placement tests; unfortunately, not many people see them as a concern to be addressed in the college enrollment process (Conley, 2005). Collins (2008) recommends that colleges reach out to all incoming students to communicate standards necessary for college-level admittance. Furthermore, communicating these standards and informing students before enrolling in courses or taking the placement test would be a first defense against students who believe that placement test results are fatalistic, and could serve as a launching pad to educate students on their options and how they might improve their results (Conley, 2005).

Understanding placement tests and performing up to one's potential is critical for students and their success within their first years of college (Conley, 2005). Before a college or high school can begin assisting students in becoming college ready, the students must be aware of the demands of being college-ready, the placement test process, where they currently stand and then must be open to obtaining assistance if necessary. Although educating potential students could come through a variety of methods, two popular methods arise to the surface: high school outreach and new-student orientations. With the creation and advancement of the Achieving the Dream initiative, colleges across the country are creating and enhancing both high school outreach programs and orientation programs. More and more students are being educated on the importance of college-readiness and the expectations in which they will be held in colleges, and some students are shown examples or allowed to practice meeting these expectations through interventions such as college orientations, placement preparation workshops, and high school outreach programs (Karp & Bork, 2012, p. 36). High school outreach will be discussed in the next section, but presenters at orientation sessions or academic advisors could educate students on their options prior to taking the college's placement test and enrolling in classes that might be well below their capabilities.

In conclusion, reaching out to potential community college students could be difficult. Depending on the surrounding area, colleges are faced with serving varying demographics, poor and financially secure students and families, prepared and underprepared students, and students who come from a variety of cultural and language speaking communities (Kindle, 2012). Hence, Collins (2008) recommends developing a robust strategy to communicate to entering students the standards necessary for college-level entrance and graduation. Furthermore, it might be optimal for colleges to reach out to their communities through local high schools and test students on the college's placement test to determine students' current levels and begin planning a strategy for initial college success (Collins, 2008).

High School Outreach. Recent high school graduates make up a significant portion of the incoming community college student body each academic year. According to a report to the U.S. Department of Education, it was found that 26.7% in 2010, 27.7% in 2009, and less than this in every prior year since 1975, of recent high school graduates actually enrolled in a two-year college the fall after graduating from high school (Aud, et al., 2012). Unfortunately, just a few months after passing high school competency or exit exams, many recent high school graduates fail college placement tests (Rosenbaum, et al., 2010).

According to Rosenbaum, et al. (2010), "high school students are rarely given good information about what college requires, how prepared they are, and what steps would prepare them" (p. 7). This happens even more in school systems or high schools that are under resourced, are located in poor communities, or in communities that have very few individuals who have attended a college (Rosenbaum, et al., 2010). Without anyone to accurately inform students on their standings, low achieving students are rarely warned prior to college admissions that they may not be able to enroll in college-level classes or enter into certain programs of study, but rather are kept optimistic about their future to the point that less than adequate information is given to them to make valuable decisions that could impact their futures (Rosenbaum, et al., 2010).

One way that colleges and high schools can better assist students in making sound decisions is to offer college placement testing to students who are still in high school and allow or assist them in taking courses that would prepare them for college (Rosenbaum, et al., 2010). With the varying number of college placement tests and strategies, high schools cannot adequately prepare students; however, they can either research on their own and share information to students, or partner with colleges to use their resources for student readiness (Conley, 2005). Counselors and high schools that opt to research on their own will need to obtain admission, placement testing, and enrollment policies for every college in which students desire to enroll or would need a database of online sites that they could give to students listing college information and placement test preparation (Conley, 2005). High schools and colleges that partner together could work together to educate students on testing procedures, test students, and if needed, work together to remediate students prior to graduating from high school (Conley, 2005).

Reaching out and testing high school students prior to graduation is a recommendation several experts believe will assist students in becoming college-ready and help them place into the mathematics course best suited for their abilities (Brown & Niemi, 2007; Conley, 2005; Jenkins, 2011). Brown and Niemi (2007) suggest that high schools and colleges partner to inform students, as early as middle school, what colleges will expect of them. Helping high school students realize expectations and assisting them in remediation through placement testing as early as 10^{th} grade can help students and high schools recognize deficiencies (Complete College America, 2012). Through testing and advising, students, teachers, and parents would better understand from colleges what college-readiness means (Complete College America, 2012).

Other ways to help educate and prepare high school or middle school students for college success would be to create continuity of English and mathematics curricula across high schools, community colleges, and four-year colleges, provide college orientations (both two-year and four-year), develop practice placement tests or offer practice sessions, and finally provide assistance to help students and their parents complete financial aid packets (Brown & Niemi, 2007; Jenkins, 2011).

Testing high school students has benefits for colleges and high schools, but also has challenges. Testing high school students on the college placement test within high schools or bringing students into the colleges to test would decrease the demands on the students and the colleges within the first few weeks of the semester (Noble, et al., 2004). On the other hand, not every high school student will enroll in classes at the college thus causing colleges to utilize resources on students who will have a very little connection to the college. However, testing students and establishing a personal connection or attaching a face (particularly students' faces) might assist a college in obtaining additional in-district enrollments that on average could be increased (Aud, et al., 2012). To benefit high schools, colleges could invite high school students to take the college placement test on the college campus, and high schools could use students' test results to show college readiness, which would ultimately help alleviate the stress of "testing large numbers of high school students who may not even attend college" (Noble, et al., 2004, p. 303). Additionally, students and their parents would become more aware of colleges and their requirements, and students might seek remediation within high school to improve their high school performances and high school graduation rates (Collins, 2009; Kirst, 2007; Rutschow & Schneider, 2011). On the other hand, as Kindle (2012) found from interviewing AtD Leader Colleges, it could be difficult reaching out to high schools due to factors such as arrogance, costs, and the sharing of time and resources.

Consequently, it might be in the best interest to attempt to educate high school students on the placement test due to alignment differences in high school and college curriculum. For example, K-12 schools must occasionally change their curriculum to align with state standards; however, college placement tests do not change and remain traditional (Bryant, 2001). Although colleges and high schools may have curriculum that is fairly similar and aligned, traditional placement tests could lead to a disconnection between K-12 mathematics education and the college courses in which students are being placed (Bryant, 2001). Thus, if a college is unable to change its placement test, or better align the curriculum to local high schools, perhaps the only way to encourage proper placement of students would be to educate students beforehand.

In general, if students were made aware of the placement testing process, encouraged to practice, or even to take the test while in high school, then they could have the opportunity to reflect on their placement level and problem solving skills related to their past academics to possibly prepare and become a more successful college student (Karp & Bork, 2012). Several high schools and colleges are currently testing students within high schools; the following sections highlight a few programs:

California's Early Assessment Program. The California State University (CSU) system incorporated an Early Assessment Program (EAP) that included questions into the state's 11th grade exam to help inform students on whether or not they were on track to being college ready in the CSU system (Complete College America, 2012).

Howell, Kurlaender, and Grodsky (2010) reported that as a result of the EAP from 2003–2006, statistically significant results were obtained showing that the program reduced the probability of a high school student needing English remediation at CSU by 6.1 percentage points. With a significance level of 0.10, they also found that the EAP reduced the probability a high school student would need mathematics remediation at CSU by 4.1 percentage points (Howell, et al., 2010). To further students' initial college success and smooth their transitions, CSU is also working with high school teachers to develop a transitional program for 12th graders who are underprepared (Complete College America, 2012).

El Paso Community College. El Paso Community College (EPCC), in El Paso, Texas, offers placement testing to high school students to help them determine if they are college ready (Smith, 2012). All high school juniors take the placement test and then are able to, with the help of the college and high school, determine their senior year course work that would best prepare them for college entrance (Smith, 2012). This initiative allows EPCC and the universities they partnered with to intervene and help students improve their chances at success prior to college (Smith, 2012). After testing and receiving their scores, the high school students can see where they stand and choose to work in their senior year to improve their skills before retesting and possibly bypass remedial work in college (Smith, 2012).

Palo Alto College. Similar to EPCC, many other Texas schools offer three-week review classes before the start of the fall semester. According to Gonzalez (2012), Palo

Alto College, in San Antonio, Texas, requires students to take a free, two-week placement preparation course prior to taking the placement test. Through committed participation in these start-of-the-semester, two-three-week review courses, students can bypass a semester or a full year of introductory math reviews (Smith, 2012).

Santa Monica College. Santa Monica College, in Santa Monica, California, brings in high school students via bus (the cost is split by the high schools and college); students go through an orientation, take the placement test, meet with a college counselor, take a tour, and then are allowed to mingle around campus (Venezia, et al., 2010). Students' results on the placement test are then shared with the high school counselors, data are aggregated and shared with the high schools, and students are invited to come back after a couple of weeks to retake the placement test (Venezia, et al., 2010).

High school alignment. Another method that community colleges are employing to better place students into college math classes is through strengthened alignment with high schools. Students coming from the K-12 system could quickly and easily transition to a community college if high schools and colleges would align their content, develop strategies to link students between the two systems, and develop services to support students in their transition (Venezia, et al., 2010).

High school and college alignments could occur in three ways. First, curriculum could be aligned so that the same topics that were covered in high school math classes are relatively the same topics that are covered in community college math classes. The second way is similar to the previous section, and that is to reach out to high school students through testing and special curriculum/courses. And finally, the third way to align high schools and community colleges is to make high school exit exams and standards the same as the entrance tests and standards at a community college, or vice versa.

Aligning curriculum. Aligning curriculum can be challenging. As previously discussed, most high schools offer an Algebra 1, Geometry, and Algebra 2 sequence, or an Integrated Mathematics I, II, and III sequence, which is relatively the same content as a community college's Pre-Algebra, Beginning (also called Elementary or Introductory) Algebra, Intermediate Algebra sequence, and for some, College Algebra, with the exception of the order in which the topics are presented. Thus, if a community college were to align its mathematics curriculum to that of the high schools, it would first have to align itself with every major feeder schools' curriculum. This in itself could be impossible as, depending on the state and the policies governing the K-12 mathematics curriculum, various high schools may have varying curricula, and hence, a community college would have to choose which curriculum with which it would align.

Furthermore, aligning curricula could be difficult in that high schools must regularly change their curricula to meet state standards (Bryant, 2001). Unfortunately, curriculum changes within a community college may not be as simple or quick as they can be within a high school. Depending on the individuals who govern mathematics curriculum, and the processes for proposing, reviewing, approving and adopting changes, it could take longer or be more difficult for community colleges. Venezia, et al. (2010) believe that perhaps this is the largest barrier to aligning high schools' mathematics curriculum with community colleges', due to the fact that most community colleges and community college systems are decentralized structures that operate as autonomous entities than an organized unit. Additionally, high school tests and community college placement test alignment may be necessary; however, just because they are aligned does not ensure that students will be adequately prepared to transition from high school to college (Brown & Niemi, 2007). On the other hand, Willett, et al. (2008) believe that by aligning high school and post-secondary curricula, that K-12 standardized tests will improve and become better predictors of college placement and success.

Collaboratively reach out. Reaching out to high school students with collaborative efforts among high schools and community colleges might be the most effective of the three methods for aligning high school mathematics with college mathematics (Hoyt & Sorensen, 2001). According to Hughes & Scott-Clayton (2011), more colleges and high schools are giving students college readiness assessments, such as placement tests, earlier. Allowing high school students to take college placement tests lessens the high-stakes context, and rather identifies students' skills deficiencies prior to college entrance so that the student and high school can assume responsibility for college preparation and remediation (Hughes & Scott-Clayton, 2011).

If high schools and community colleges realize where student deficiencies are, they could work together to create an intervention or course that would help remediate students. The content for remediating students could either be repeating the topics that these students have already learned in the high school's curriculum, or colleges and high schools could create a course or content that would bridge the gap between high school classes and the knowledge needed for subsequent college level course work (Hoyt & Sorensen, 2001).

The largest challenge high schools and colleges may have in reaching out to high school students and preventing senioritis is that many high schools do not require their students to take a mathematics course within their senior year (Rosenbaum, et al., 2010). Furthermore, some students "don't have to take difficult courses in their senior year, they don't have to work hard in class, they don't have to think about college in advance, and their senior year can be a time to 'rest' before seriously thinking about college" (Rosenbaum, et al., 2010, p. 7). To combat this occurrence, some colleges and state systems, such as those found in Virginia, Texas, Florida, and Kentucky, have created transitional courses to help high school seniors become college-ready (Complete College America, 2012). Through these transitional courses, high schools and colleges have solidified alignments, allowing students who take the end-of-course test and score high enough to proceed directly into college courses without needing to take the placement test (Complete College America, 2012).

Exit and entrance testing. The final way to align high schools and community colleges mathematically is to standardize exit and entrance testing between the two systems. For example, through their work within the American Diploma Project, some colleges are aligning high school exit and college entrance standards (Collins, 2008). This can be done by utilizing ACT or SAT test scores, using statewide exit exams as a community college placement test, using a community college placement test as an exit test for high school classes or graduation, or through the creation of a unified standardized test to accomplish both high school exit requirements and college entrance requirements. Regardless of the types of tests that are used, a very large amount of significance will be placed upon the results of these test(s), and high schools and colleges will still have to gauge whether or not these tests are accurate representations of students' knowledge.

To ensure students are prepared in advance and knowledgeable of the tests, students will need to be provided information on the test, actual practice tests that could be done at home or on high school campuses, and colleges will need to have online resources for placement testing so that students can regularly obtain information on the placement test and the types of questions it could contain (Venezia, et al., 2010).

In conclusion, aligning high school and community college mathematics may help students improve their community college placement. However, although students "may be instructed in and tested on subject matter content that aligns well with the expectations at community colleges, alignment alone is insufficient to stem the rising need for remediation" (Brown & Niemi, 2007, p. 27). Thus, high schools and colleges will need to accept that fact that some students will still place into developmental education courses. And regardless of where students do place, curriculum alignment and placement testing measures can only be effectively assessed if the K-12 and community college systems combine their data systems regularly, analyze their results, and work together to make improvements (Kirst, 2007).

Dual enrollment. Another option for improving the mathematics placement of community college students is to increase the number of dual-credit courses through dual enrollment or the creation of early-college high schools (Smith, 2012).

Dual enrollment allows high school students to enroll in classes at a community college and allows them to focus on and actually pursue their future goals rather than becoming disengaged in education and potentially preventing an information loss (Andrews, 2000; Boswell, 2000; Bryant, 2001). According to Bailey, Hughes, and Karp (2003), dual enrollment provides "an early warning mechanism to signal whether students are prepared for college," and can assist colleges in acclimating "high school students to a college environment" (p. 2). Additionally, dual enrollment programs are free or relatively low cost for students and can help high school students earn college credit in an inexpensive way (Bailey & Karp, 2003).

Dual enrollment helps to increase high school students' engagement through access to more courses, helps them to reduce their time and cost within college, and helps to bridge the gap and strengthen the alignment between colleges and high schools (Bailey & Karp, 2003). Dual enrollment also helps high school students earn college credits prior to graduating from high school, increases the likelihood that they will earn a college degree, and reduces the time it will take students to earn a college degree (Adelman, 2006; Swanson, 2008). Even with these results, policymakers and legislators will, and should, continue to question high school and college enrollments and whether expenditures on dual enrollment and developmental education are the most effective use of state and federal dollars (Bailey, et al., 2003).

Several studies have published findings supporting the need for dual enrollment. For example, Swanson (2008) found statistically significant data that dual enrolled students were 11% more likely to persist through the second year of college and were 12% more likely to enter college within seven months of high school graduation than the students who did not dual enroll while in high school. Likewise, it was found in Florida, through the analysis of longitudinal data, that dual-enrolled students, including minority students, ended up enrolling in postsecondary education (community colleges and universities) at a higher rate than the students who did not participate in dual enrollment (Florida Department of Education, 2004; Florida Department of Education, 2006). In addition, of the students who had high school grade point averages of 3.0 or higher, the students who enrolled in dual enrollment while in high school had greater community college graduation rates than the students who did not participate in dual enrollment (Florida Department of Education, 2006; Florida Department of Education, 2004).

Early colleges. A special type of dual enrollment program, actually a special type of high school, that is emerging is early college: "Early college high schools blend high school and college in a rigorous yet supportive program, compressing the time it takes to complete a high school diploma and the first two years of college" (Early College High School Initiative, n.d.). Basically, students within high school are able to take college-level courses and potentially graduate with a two-year degree and a high school diploma upon high school graduation (Early College High School Initiative, n.d.).

American Institute for Research and SRI International (2009) reported that students enrolled in early colleges within the Early College High School Initiative scored seven percentage points higher in mathematics and English proficiency than non-early college students within their districts, had attendance rates of 94%, had high school GPAs averaging 3.0, had college GPAs averaging 3.1, earned on average 23 college credits prior to graduating from high school, and 88% of early college students enrolled in college upon high school graduation with at least 47% enrolling in a two-year institution or in a certification program.

According to Bailey, et al. (2003), enrolling in an early college, or merely dual enrolling in a community college can assist students who aren't sure how they would pay for college, how to apply for college, or who are academically underprepared. As an example, California has created 23 early colleges in addition to their Early Assessment

Program, where high school students enroll in college courses while in high school and earn an associate's degree along with their high school diploma (Venezia, et al., 2010). In support of dual enrollment and Early Colleges, and since the college cost of developmental education is more than $1 billion a year, high schools and colleges could partner together and allow high school students to obtain their basic mathematics knowledge within college rather than repeating it in college after high school graduation (Noble, et al., 2004).

Accelerating initiatives. Various colleges across the nation have developed initiatives to improve the mathematics placement for community college students or help students quickly advance through lower level mathematics courses. The basic assumption is that if students are educated about the placement test prior to testing, especially in high school or through a few days of practice, they could save up to a full year of time in college and tuition spent, and radically alter their approach before they even begin at a community college (Rosenbaum, et al., 2010). Therefore, to better place students into mathematics classes, boost completion numbers and decrease developmental placement numbers, colleges are providing practice sessions, workshops, boot camps, and accelerated courses to help improve a student's placement and hence graduation time.

Boot camps. Boot camps and summer bridge programs are similar. According to Sherer and Grunow (2010), boot camps are one to three weeks in length and help students review math skills so that they don't have to take a particular developmental math course or the entire sequence. The logistics of college boot camps vary in how they are instructed, where they are held, who instructs them, how many tutors are involved, and the materials or computer systems that are used (Sherer & Grunow, 2010).

Although boot camps vary from institution to institution, they are intended to be relatively short, ranging from an hour long to three weeks long, where students receive quick instruction and are reassessed for advancement into a higher level. Assessment into a higher level varies as well, where higher placement could be dictated from the performance within the boot camp course, to a course-specific exam or the results (or reassessment) of the college's placement test (Sherer & Grunow, 2010).

There are several benefits for offering boot camps. They are short, can assist large numbers of students with varying mathematical abilities, intend to help students place into a higher-level mathematics course more appropriate to their abilities, decrease the number of students who place into a developmental math course, teach study skills, connect students with valuable student services, and help build relationships with peers, mentors, and faculty (Sherer & Grunow, 2010). On the other hand, one major drawback could occur for students who participate in boot camps – these students could increase the number of underprepared students in college-level courses, which could have a negative effect on academic standards within those college-level courses (Jaggars & Hodara, 2011).

Ultimately, it would be best to educate students prior to taking the placement test; however, boot camps could help to serve students who have already taken the placement tests and believe their placement score was not representative of their capabilities. The following are a few examples of colleges that have utilized boot camps to improve students' mathematics placement:

Montgomery County Community College. The Fast Track program at Montgomery County Community College (MCCC), in Blue Bell, Pennsylvania, is an intensive two-week, five-days-per-week, two-hour-per-day review of developmental mathematics courses that consists of traditional lecture, with time for students to practice topics (Sherer & Grunow, 2010). The program targets all new incoming students, and is conducted in January, June, and August prior to the start of a semester (Sherer & Grunow, 2010).

According to Sherer & Grunow (2010), program completers saw success rates in college-level math that were higher for program completers: 45.8% went up one mathematics level, 20.8% went up two levels, and program completers did better in their recommended courses the following semester compared to non-Fast Track students.

Palo Alto College. Palo Alto College, in San Antonio, Texas, requires students to enroll in a free two-week test-preparation course before taking the college's placement test (Gonzalez, 2012). Similar to what Palo Alto College is doing, many other Texas schools offer three-week review courses instead of yearlong introductory math reviews or developmental mathematics courses (Smith, 2012).

Pasadena City College – Math Jam: "Summer Math Jam is a two-week, intensive, voluntary math review and college orientation for new students assessed at all three levels of basic skills math" (Weissman, et al., 2009, p. 59). Math Jam involves one to four developmental math faculty members, at times as many as 15 peer tutors/mentors, and has counseling access readily available for any Math Jam student (Weissman, et al., 2009). Within the sessions, the instruction focuses on math, but they try to put a fun twist on it.

As a result of the Math Jam program, Pasadena City College (PCC), in Pasadena, California, was able to help students improve their course placement. In fact, 56% of students who participated in Math Jam retook the college's placement test, after participating in the Math Jam program, and tested into a higher-level math class (Weissman, et al., 2009). On the other hand, during the summer of 2006 only 28%, and during the summer of 2007 only 31%, of Math Jam participants passed the math course they attempted after Math Jam compared to 49% after the summer of 2006 and 46% after the summer of 2007 of all students who attempted the same courses (Weissman, et al., 2009).

In terms of persistence, Math Jam students seemed to persist more than non-Math Jam students in that 87% from fall 2006 persisted to spring 2007, 79% from fall 2006 persisted to fall 2007, and 62% from fall 2007 persisted to spring 2008, compared to 79%, 71%, and 78% respectively for non-Math Jam students (Weissman, et al., 2009).

University of Maryland at College Park. The University of Maryland at College Park requires the top 60% of students who are underprepared to enroll in a five-day-per-week, five-week, co-requisite math course where they receive accelerated remediation and are retested on the college's placement test (Complete College America, 2012). Due to this boot camp-style intervention, 80% of these students placed and were enrolled directly into the next higher-level math course for the remaining ten weeks of the semester (Complete College America, 2012).

Summer bridge programs. Summer bridge programs are math intensive programs that focus support and instruction of study skills toward targeted populations, such as recent high school graduates, students who have earned their GEDs, or high-risk populations, which are mainly identified and contacted while in high school (Sherer & Grunow, 2010).

In contrast to boot camps, most summer bridge programs are grant funded and require a larger time commitment on behalf of students, faculty, and the college as a whole (Sherer & Grunow, 2010). Typical programs run for five-ten weeks and focus on broader content as well as social acclimation and study skills (Sherer & Grunow, 2010).

Overall, the data have been mixed, where some colleges have found good supportive data, and other colleges have limited data. For example, the results of the summer bridge programs that were created at eight Texas colleges were analyzed. At all eight colleges, students received instruction in math, reading, and/or writing for a span of three to six hours a day, for a total of four or five weeks (Barnett, et al., 2012). Although there was evidence that the programs impacted college-level course completion in math and writing for the first-year-program completers, during the same time span it was found that there was no impact for those who participated in the programs in the year and a half after the program's initial year (Barnett, et al., 2012). Through their experimental design, it was found that students in the program passed their college-level math course at higher rates than students in the control group; however, after two years, the differences were no longer statistically significant (Barnett, et al., 2012).

Furthermore, the summer bridge program within these Texas colleges did not find any evidence that students within the program had increased persistence or attempted or earned a higher number of credits (Barnett, et al., 2012). On the other hand, the summer bridge programs effectively reduced the need for developmental education within the fall 2009, spring 2010, and fall 2010 semesters; however, these results diminished in later years as the same outcomes were not found through the same measures (Barnett, et al., 2012). Certainly, there could be several reasons why these results diminished. Sherer and

Grunow (2010) believe that the most difficult part about summer bridge programs and getting the students who could benefit the most from them is that these students do not find out about the programs until the programs are well under way or already over.

In contrast to the limited success mentioned above, Sherer and Grunow (2010) found promising data from a variety of colleges. The DREAM program at EPCC saw 87% of the students who were in the summer bridge program enroll in EPCC prior to completing the program. Likewise, the Community College of Denver (CCD) saw 78% of students enroll in classes prior to completing their bridge program. Also, it was found that 54% of EPCC's DREAM program completers moved up one to three levels of mathematics, and CCD's College Connection program saw 25% of program completers advance one level and 42% advance two or more mathematics levels (Sherer & Grunow, 2010).

In addition to EPCC and CCD, Sherer, & Grunow (2010) analyzed data from the Math Intensive program at LaGuardia Community College, in Long Island City, New York, and found that 38% of their program completers passed their Introduction to Algebra COMPASS cutoff score and 40% passed their Elementary Algebra COMPASS cutoff score. MCCC's Fast Track program saw 45.8% of program completers advance one mathematics level and 20.8% advance two levels, and 56% of PCC's 2006 Math Jam program participants advanced up a level. Although all of the above programs reported between 25-67% of program participants increasing their placement, unfortunately none of them reported any information on a comparison or control group (Sherer & Grunow, 2010).

Accelerated semester courses. Accelerated semester courses are similar to boot camps, except that these programs fall within the academic year, rather than just before the start of a semester. These courses or programs could last a week to several weeks long, but have the intention of improving community college developmental education and either improving students' placement within the sequence or entirely out of the sequence (Sherer & Grunow, 2010).

Of the colleges that offer accelerated semester courses, many either teach a core set of topics to help improve students' placement out of a single course or have courses that are self-paced and module-based and allow students to practice and retest to improve course placement (Sherer & Grunow, 2010). Additionally, some colleges include computer remediation, study skills, or involve counseling and advising (Sherer & Grunow, 2010).

Through their study of math intensives at various colleges, Sherer & Grunow (2010) found the following accelerated semester course programs that allowed students to obtain remediation and then test out of a class or complete more than one math course within a single term:

Math My Way. Math My Way, at Foothill College, in Los Altos Hills, CA, is a highly structured, student-centered program intended for all developmental mathematics courses (Sherer & Grunow, 2010). This program runs five days-per-week, two hours-per-day for a quarter of a semester and takes a modular approach to the topics within the developmental sequence. Math My Way Pre-Algebra students had subsequent Beginning Algebra pass rates from 85-90%, which was considerably higher than their control group's 55-60% pass rate (Sherer & Grunow, 2010).

FastStart. The FastStart program at CCD, in Denver, Colorado, is a semester-long, two days-per-week, three hours-per-day program that gives students the opportunity to complete two developmental math courses in one semester (Sherer & Grunow, 2010). Through mastery learning within MyMathLab, FastStart students' success rates were found to be higher in college-level math, and they had higher pass rates in their developmental courses, earned more credits, passed the math gatekeeper course at a higher rate, had a statistically higher first semester GPA, and had a higher two-year GPA than the comparison group (Sherer & Grunow, 2010). Students in the program also had higher persistence, retention, and graduation rates, and completed the developmental sequence at a higher rate compared to students not in the program (Sherer & Grunow, 2010).

Cool at School. The Cool at School program at Daytona State College, in Daytona Beach, Florida, was similar to Foothill's Math My Way program in that they took a modular approach lasting eight weeks, four days per week, one and a half hours per day (Sherer & Grunow, 2010). Within the Cool at School program, students had the opportunity to complete two classes within one semester (Sherer & Grunow, 2010). Overall, Sherer & Grunow (2010) reported that the Cool at School program helped students decrease the number of semesters to complete the math sequence compared to the comparison group, students' attendance was greatly improved, and their course success rates were 75% for Pre-Algebra, 59% for Introductory Algebra, 56% for Intermediate Algebra, and 62% for College Algebra.

Math Path. Pasadena City College's Math Path focuses on students who desire to spend extra time to finish more quickly; hence, students in this program enroll in a semester-long, five days-per-week, two hours-per-day class with a half to one hour support class four days per week (Sherer & Grunow, 2010). Math Path classes are traditional classes with a focus on student engagement and group work (Sherer & Grunow, 2010). Overall, students have the opportunity to complete two math classes in one semester, from developmental classes up to Linear Algebra (Sherer & Grunow, 2010). Sherer & Grunow (2010) reported that the Math Path program had pass rates that were 20% higher than traditional courses and that 48% of Math Path students who were in Beginning Algebra could transfer to college-level math after 2.5 years compared to only 27% of the comparison group.

Placement workshops. Placement workshops are generally short, one day sessions where students work on questions similar to the college's placement test. These workshops, if marketed well prior to enrollment, can assist the students who were placed into a remedial mathematics course, but could perform successfully in a college-level course if they were encouraged to participate in the workshops and merely brushed up on their basic mathematics skills (Illich & McCallister, 2004).

Perhaps because it is a relatively new concept, or the fact that data are not being published, there isn't as much information on placement workshops as there is on boot camps and summer bridge programs. Perhaps this is due to the fact that when students are admitted, they traditionally go through a series of events in a single day and receive their placement. As Kindle (2012) found through interviewing AtD Leader Colleges that had placement workshops for students, it was basically found that some colleges and their employees saw the workshops or student preparation techniques in general as an interruption of the college's one-stop enrollment process, and that some students did not see it as valuable or important to prepare for the placement test (Kindle, 2012).

On the other hand, for the AtD Leader Colleges that did have placement workshops, many consisted of a face-to-face workshop (some with counseling and advising), practice or guided help, and a post-test with the college's placement test (Kindle, 2012). According to Kindle (2012), one college found a significant improvement in student placement scores after participating in a COMPASS review workshop, and led the college to develop an online version with video instruction.

EPCC is one college that encourages students to improve their mathematics placement through workshops. EPCC's PREP program is a supportive placement workshop where students attend a 1.5 hour information session that introduces the ACCUPLACER test, gives test-taking strategies, and helps students recognize the importance of the placement test (Sherer & Grunow, 2010). After the session, if students are dissatisfied with their course placement, they meet with a case manager, take a diagnostic placement test, receive an individualized study plan within Plato, and then use the computer lab to practice their areas of weakness online (Sherer & Grunow, 2010). Students practice as much as they desire within the lab, obtain free tutoring when necessary, and when they feel better prepared they retake the placement test (Sherer & Grunow, 2010). And finally, if students are still displeased with their placement, they meet with their counselor and repeat this process (Sherer & Grunow, 2010).

Overall, due to these workshops and the case management nature of the counseling sessions, EPCC has had 60% in 2003-2004, 54% in 2004-2005, 52% in 2005-

2006, 54% in 2006-2007, and 66% of PREP students in 2007-2008 move up one to three math levels after completing the intervention program (Sherer & Grunow, 2010).

In summary, community colleges could employ many strategies to help place students into the mathematics level appropriate for students' skills and abilities. Strategies that may be more difficult to employ are aligning curriculum between high schools and colleges, starting college prep as early as middle school, and conducting boot camps or summer bridge programs (Bryant, 2001; Kirst, 2007; Sherer & Grunow, 2010; Venezia, et al., 2010). The most probable strategies include educating new and potential students prior to testing, requiring preparation before testing, using multiple measures of student knowledge to place students, and enforcing that students who apply just before the start of the semester begin the semester with preparation and take late-start courses (Hoyt & Sorensen, 2001; Hughes & Scott-Clayton, 2011; Sherer & Grunow, 2010). A very important step to college entrance is educating and preparing students before they take a college placement test.

CHAPTER THREE: METHODOLOGY

This chapter describes the methodology that was utilized to examine and analyze the effectiveness of two programs MathCC created to assist students in preparing for the COMPASS math placement test: placement preparation workshops (workshops) and a Pre-Algebra and Beginning Algebra three-week placement review course (review course). The chapter begins with the description of these programs, followed by the research questions guiding this study, the definitions of the terms used in this study, the research design, and how placement improvement programs (workshops and review courses) and baseline MathCC data were collected and analyzed. The chapter concludes with the generalizability of the data and limitations and delimitations of the data and study.

Workshops

Workshops at MathCC were free, 1.5 hour long preparation sessions, in an on-campus computer classroom, for students who desired to prepare for MathCC's placement test. These workshops started in the fall 2011 semester by a volunteer mathematics faculty member, and grew to include additional volunteer mathematics faculty members and student tutors in subsequent semesters.

Each workshop was relatively the same: the instructor would arrive to the classroom early, turn computers on, organize handouts, prepare the PowerPoint presentation, and then sign in students as they arrived. When the time came to begin, the instructor welcomed students, gave them a brief 10-15 minute presentation on the COMPASS math test: why it is important, the level in which the test starts, how it progresses up, down, or places students, and how to practice and prepare to take or retake the COMPASS math test. After the presentation, the instructor guided the students to an online resource that they could use to practice, and the students practiced math problems similar to topics represented on the COMPASS math test. As these students practiced, the instructor and peer tutors walked around to answer students' questions related to the math problems they were working on, and answered general advising questions. Upon completion of the workshop, the instructor gave final concluding remarks, such as to continue to practice before testing or retesting, and showed other practice resources. For more information, see Appendix D.

Review Courses

Review courses at MathCC were one credit hour, two days per week, 2.25 hours per class, courses intended to help students who placed into Pre-Algebra or Beginning Algebra improve their mathematics placement by at least one level. Students self-selected to register for one of the review courses (Pre-Algebra or Beginning Algebra) and had to co-enroll in a late start 12-week Pre-Algebra or Beginning Algebra course. Both courses, and the late start 12-week classes, were on the same day of the week, at the same time of the day.

Both of MathCC's winter 2013 review courses, Pre-Algebra and Beginning Algebra, were taught by a full-time math instructor. The structure of these courses was similar with each class given daily handouts that consisted of topics from Pre-Algebra and Beginning Algebra, respectively. The instructor would briefly introduce the topic, showed examples, had the students work in class on similar questions, and walked around to answer questions and keep students engaged. On the last day of the three-week period, both classes met at MathCC's placement testing center, took the COMPASS math test and received their placement. For the students who improved their math placement, and wanted (or needed) to take that math class, they were automatically dropped from their previously enrolled late start 12-week math class and enrolled in the higher-level late start 12-week math class by the Associate Dean of Mathematics. Students who did not improve their math placement kept their late start 12-week Pre-Algebra or Beginning Algebra co-enrollment math course. And students who improved their placement level beyond what their program of study required, and consequently did not need to take any more math classes, were instructed to drop their co-enrolled math course, and either enroll in a higher-level late start 12-week math course, if they so desired, or not to take any more math classes at MathCC but rather a course required by their program of study. For more information, see Appendix E.

Research Questions

The questions guiding this study:

1. Does attending a placement preparation workshop improve college math placement, success in math classes, and overall college success for students of all ages and genders?
2. Does enrolling in a three-week placement review course improve college math placement, success in math classes, and overall college success for students of all ages and genders?

Definitions

The following terms are words and abbreviations used in this study:

- Basic Math: Topics in this course include whole numbers, fractions and decimals.

- Beginning Algebra: Topics in this course include solving and graphing linear equations, linear inequalities, solving quadratic equations by factoring, performing operations and factoring polynomials, and integer exponents.

- Calculus I: Topics in this course include limits, continuity, derivatives, differentiation, applications of derivatives, anti-differentiation, and the definite integral.

- College Algebra: Topics in this course include geometry, functions and their graphs, solutions of equations and inequalities, polynomial graphs and zeros, conic sections, linear and polynomial modeling, systems of equations and inequalities, sequences and series, and the Binomial Theorem.

- Drop: A grade a student receives if they withdraw from the course, or a grade an instructor can give a student if it is requested of the instructor by the student and falls within the boundaries of that instructor's course policies. A drop grade does not affect a student's GPA if the course is repeated for an A – E letter grade, and is counted as a 0.0 if it is not repeated.

- FTIAC: Stands for first time in any college. These are the students who enrolled in their first ever college classes at MathCC.

- GPAs: Student grade point averages. MathCC does not differentiate between plus and minus grades for calculated GPAs. Hence, the grade of C includes students who received a C-, C, and C+; the same is true for A, B, and D grades.

- Highest level tested into: The highest math level in which a student placed into after retaking the COMPASS math test upwards of three times.

- Initial placement level: The level in which a student placed into after taking the COMPASS math test for the first time.

- Intermediate Algebra: Topics in this course include solving linear, quadratic, rational, and square root equations, linear and compound inequalities, systems of linear equations, and an introduction to functions, graphs of linear and quadratic functions, rational expressions, exponents, and radicals.

- Never Attended: Students who register for a class but do not attend that class are given a Never Attended grade. This grade is counted as a 0.0 GPA.

- Pre-Algebra: Topics in this course include fractions, percentages, measurement, dimensional analysis, geometry, signed numbers, linear equations, and proportions.

- Pre-Calculus: Topics in this course include functions, composition and inverse of functions, rational, exponential, logarithmic, and trigonometric functions, solutions of triangles, and polar coordinates and vectors.

- Program: The term "program," within Chapter 4: Results, is the declared area of study in which a student is in to earn an associate degree.

- Semesters: MathCC's semesters are fall (FA), winter (WI), spring (SP), and summer (SU). For this study, SP/SU will represent the combined spring and summer semester. In addition, abbreviations followed by two numbers stand for the semester and year. For example, FA09 means the fall semester of 2009.

- Technical Math I: Topics in this course include arithmetic, approximate numbers, dimensional analysis, beginning algebra, geometry, trigonometry and statistics.

- Transfer-in students: Students who enrolled in another college prior to taking classes at MathCC, and then transferred from that college to MathCC.

Research Design

MathCC's workshops were intended to assist students in their preparations for taking or retaking the COMPASS math placement test. This study analyzes placement test scores, program of study and course enrollment information, and demographic information for students who attended a workshop, within the fall 2011 through fall 2013 timeframe, to see if students who attended a workshop had success in improving his or her math placement levels, in his or her enrolled math courses, in his or her other enrolled college courses, and in persisting from one semester to another (retention).

Similarly, MathCC's review courses were intended to help students enrolled in a winter 2013 semester, three-week placement improvement course, improve their mathematics placement from either Pre-Algebra or Beginning Algebra into a higher level. This program enabled students to enroll in the next math class if they improved their math placement level for the remaining 12 weeks of the winter 2013 semester.

Data Collection

All data were obtained from MathCC's Institutional Research that extracted student data from MathCC's data system and exported it into a Microsoft Excel file.

Variables. The following data were obtained for students who attended a workshop and enrolled in a review course (see Table 1).

Table 1: Variables

Independent Variables	Data Supporting Dependent Variables
Dates of workshops attended	Second and third COMPASS math scores and dates taken
Gender	Math classes enrolled[a]
Birth date	Grades earned in enrolled math classes
Declared program of study	Semesters enrolled[a]
First COMPASS math score and date taken	Cumulative GPA after each semester enrolled[a]

Notes: [a] Math classes enrolled, and semesters enrolled, for workshop students were winter 2012 through fall 2013, or eight semesters. Math classes enrolled, and semesters enrolled, for review course students were winter 2013 through fall 2013, or four semesters.

Some of the data were used, as given from MathCC's Institutional Research, for variables in the study; however, some data were recoded for all students to enable calculations (see Table 2).

Table 2: Additional Derived Workshop Variables

Independent Variables	Data Supporting Dependent Variables
Number of workshops attended Student age based on birth date relative to January 1, 2014 Program of study's math requirement(s) based on MathCC's 2011 to 2012 catalog	Whether or not a student improved his or her COMPASS math score after retesting[a] Whether or not a student improved his or her mathematics level based on MathCC's placement interpretation for COMPASS math scores Whether or not a student satisfied his or her declared program of study's math requirement based on his or her COMPASS math score and MathCC's 2011-2012 catalog Whether or not a student completed all required math classes necessary for his or her program of study The number of math courses taken beyond those required by a student's declared program of study Students' calculated math GPA based on the courses taken, credit hours, and earned grade[b] Number of semesters enrolled in classes[c] First semester enrolled in classes[d]

Notes: [a] A student was classified as improving his or her score if he or she increased his or her score on a test, or received a score on a higher-level test (such as Algebra compared to Pre-Algebra).
[b] Grades, including developmental classes, were coded as: A = 4.0, B = 3.0, C = 2.0, D = 1.0, Fail (E or unsatisfactory) = Drop = Never Attended = Incomplete = 0.0. Highest grade earned was used in calculations for classes that were repeated.
[c] Semesters enrolled for workshop students were winter 2012 through fall 2013, or eight semesters. Semester enrolled for review course students were winter 2013 through fall 2013, or four semesters.
[d] First semester is the first semester a placement review program student enrolled in classes after participating in a placement review program.

Baseline data. Baseline data to compare placement, retention, pass, and completion rates between students in a placement improvement program and overall MathCC students were also obtained:

- Percent and number of all students who placed into Pre-Algebra and Beginning Algebra from the fall 2007 through the fall 2013 semester.

- Fall-to-fall and winter-to-winter retention rates for first time in any college students (FTIACs), from the fall 2007 through fall 2013 semester, who enrolled in a developmental math course (Basic Math, Pre-Algebra, or Beginning Algebra).

- The fall-to-winter and winter-to-fall retention rates for FTIACs, from the fall 2007 through fall 2013 semester, who enrolled in developmental math courses (Basic Math, Pre-Algebra, or Beginning Algebra).

- Overall pass, failure, drop, and never attended rates for all students who enrolled in developmental math courses between fall 2007 and fall 2013.

- Overall developmental mathematics completion rates for students beginning in Pre-Algebra from the fall 2007 through fall 2013 semester.

Data Analysis

The following sections describe the methodology used to calculate baseline data and analyze MathCC's workshop and review course data.

Baseline data. Baseline data included simple percentage calculations in Microsoft Excel.

Percent of students who placed into developmental mathematics. Students may take the placement test up to three times with signed written permission by a MathCC counselor, advisor, or the math associate dean. Student initial course placement results were drawn and recorded as "First Placement."

$$\text{First Placement rate} = \frac{\text{Number of students who placed into a specific course}}{\text{Total number of students who took the COMPASS math test}}$$

Students who took the placement test more than once were categorized as "Second Placement." Second placement is defined as students' most recent math placement test level according to their first enrolled semester at MathCC.

$$\text{Second Placement rate} = \frac{\begin{array}{c}\text{Number of students who placed}\\ \text{into a specific course after retesting}\end{array}}{\begin{array}{c}\text{Total number of students who}\\ \text{retook the COMPASS math test}\end{array}}$$

The second placement rate doesn't necessarily give students' highest test score, but an assumption was made that the student who retested wanted to improve their placement level. Students could still use their highest placement level when enrolling for courses. This definition was used for all students, regardless if they retook the placement test in the same day, after a few semesters, after their initial enrollment, or even years their initial enrollment.

For both first and second placement rates, a breakdown of the course into which students placed (Pre-Algebra, Beginning Algebra, Intermediate Algebra or higher) was obtained. These percentages were calculated in the same way as the first placement and second placement rates were calculated.

Retention rates: Overall MathCC and developmental math. There were a total of 28,682 new MathCC students who started in a fall or winter semester from the fall 2009 to fall 2012 semester (new MathCC student data from winter 2013 to fall 2013 could not be obtained). These students were tracked to measure semester-to-semester and year-to-year retention rates after enrolling in a MathCC class.

$$\text{Retention rate (including graduates)} = \frac{\text{all enrolled students from cohort}}{\text{all students from cohort}}$$

There were a total of 18,597 fall and winter FTIAC students who took a developmental course, regardless of whether or not they took a placement test in math, from the fall 2007 to fall 2013 semesters. The first semester in which a student enrolled in a developmental course was determined. There were 267 students who were excluded due to bad data interpretation (FTIAC students who were really FTIAC students in a prior term), or due to bad data (students were enrolled as dual enrolled students in a semester in which they took a developmental math class – which should not be possible). In addition, there were 389 students who took their first developmental math course in a spring or summer term. Excluding the 389 and 267 students, and there were 17,941 FTIAC students who took a developmental fall or winter math course sometime from the fall 2007 to fall 2013 timeframe. These 17,941 students were tracked to measure semester-to-semester and year-to-year retention rates after enrolling in a developmental math class at MathCC.

Retention was calculated in two ways, one to include the students who have graduated from MathCC (including graduates) and another to exclude students who have graduated from MathCC (no graduates):

1. Retention rate (including graduates) = $\frac{\text{all enrolled students from cohort}}{\text{all students from cohort}}$

2. Retention rate (no graduates) =

$$\frac{\left(\begin{array}{c}\text{all enrolled}\\ \text{students from cohort}\end{array}\right)-\left(\begin{array}{c}\text{students from cohort who enrolled in}\\ \text{this term but graduated in a prior term}\end{array}\right)}{\left(\text{all students from cohort}\right)-\left(\begin{array}{c}\text{all students from cohort}\\ \text{who graduated in a prior term}\end{array}\right)}$$

Notice that "all students from cohort who graduated in a prior term" is a cumulative count of all students from that cohort who graduated from subsequent terms. In other words, a student in the fall 2007 cohort, who earned his or her associate degree at the end of the fall 2012 semester, and enrolled in at least one class in the winter 2013 semester, would be excluded from this calculation.

Math success rates for students enrolled in a developmental math class. Two measurements were taken to determine the success rates for students enrolled in a developmental math course at MathCC:

1. Pass rates for all students enrolled in a math class =

$$\frac{\text{Number of students who earned a passing math grade}}{\text{Number of students enrolled in that math class}}$$

2. Pass rates for all FTIAC students enrolled in a math class =

$$\frac{\text{Number of FTIAC students who earned a passing math grade}}{\text{Number of FTIAC students enrolled in that math class}}$$

The definition of success for these calculations is the earning of a passing grade: A+, A, A-, B+, B, B-, C+, C, C-, or Satisfactory (Satisfactory is only possible for Basic Math students).

Overall developmental math completion. The developmental math classes students can place into at MathCC are Pre-Algebra or Beginning Algebra. Although MathCC has three developmental math classes, the third, and lowest level, math class (Basic Math) is taken by students who self-select to take this class. Thus, to measure overall developmental math completion, only students who began in Pre-Algebra were considered. Students who placed into Beginning Algebra can complete their developmental math sequence by successfully completing Beginning Algebra. Hence, since it isn't a sequence of two or more classes, such as in Pre-Algebra where both Pre-Algebra and Beginning Algebra must be successfully completed in order to complete the developmental sequence, Beginning Algebra is omitted from this section, as the success rate for Beginning Algebra students can be found in the developmental pass rates section within the MathCC baseline data section of Chapter 4: Results.

A limitation to this study is that the passing of Pre-Algebra at MathCC as a prerequisite for enrollment in Beginning Algebra is not enforced. In other words, students may enroll in Beginning Algebra even if they have not successfully completed Pre-

Algebra. For the sake of this section, the data do not include unsuccessful Pre-Algebra students who have enrolled in Beginning Algebra. The calculations for such students are measured in two ways, by distinct students and by total number of enrollments, as some students who passed Pre-Algebra (or Beginning Algebra) decided to retake the course even after passing it.

1. Developmental sequence completion rate (distinct number of students) =

$$\frac{\text{Distinct students who passed Beginning Algebra after passing Pre-Algebra}}{\text{Total number of distinct students who enrolled in Pre-Algebra}}$$

2. Developmental sequence completion rate (after repeating either Pre- or Beginning Algebra) =

$$\frac{\text{Number of successful Beginning Algebra completions after passing Pre-Algebra}}{\text{Total number of enrolments in Pre-Algebra}}$$

One additional measure calculated, slightly different than the developmental sequence completion rate for distinct students, was the developmental sequence completion rate for students who passed Pre-Algebra and then passed Beginning Algebra as a percentage of those who completed Pre-Algebra.

3. Developmental sequence completion rate for students who passed Pre-Algebra and then passed Beginning Algebra =

$$\frac{\text{Students who passed Beginning Algebra after passing Pre-Algebra}}{\text{Students who passed Pre-Algebra}}$$

Not every student who passes Pre-Algebra at MathCC is required to enroll in and pass Beginning Algebra. Although some students do, many programs of study do not require Beginning Algebra, or the completion of any math at MathCC.

Placement improvement programs. Raw data on students who attended a placement preparation workshop or enrolled in a three-week placement review course were received in a Microsoft Excel file, and imported into IBM SPSS Statistics 20 (SPSS), a statistical software package. The data were then coded as nominal, ordinal, or scale, or recoded to perform calculations, and SPSS was used to perform calculations. The data for each placement improvement program were kept separately, and a comparison of the two MathCC programs will be made in Chapter 5: Analysis, along with a comparison of MathCC's baseline data and data found in literature.

Variables, measurements, hypotheses. This section describes the underlying assumptions for the research questions, and the independent variables (IV), control variables (CV), dependent variables (DV), tools, definitions, or equations that were used to address each assumption.

Overall college success: There are three hypotheses pertaining to overall college success for students who participated in a placement improvement program (IV):

1. They enrolled in MathCC classes in subsequent semesters (DV) after participating in a placement improvement program. Cross tabulation frequency tables, chi-square significance tests, and symmetric measure testing within SPSS were used to measure simple percentages, frequencies, significance and effect.

2. They had greater cumulative retention rates (DV) than all students who placed into developmental mathematics courses and all MathCC students. Cross tabulation frequency tables, chi-square significance tests, and symmetric measure testing within SPSS were used to measure simple percentages, frequencies, significance and effect. Cumulative retention rates were calculated as follows:

$$\text{Cumulative retention rate} = \frac{\text{cumulative sum of students retained}}{\text{cumulative sum of possible students retained}}$$

3. They obtained overall GPA success at MathCC (DV), as measured by cumulative overall GPAs greater than 2.0. Cross tabulation frequency tables, chi-square significance tests, and symmetric measure testing within SPSS were used to measure simple percentages, frequencies, significance and effect. Descriptive

statistics tables within SPSS were used to measure GPA means and standard deviations.

$$\text{Overall GPA} = \frac{\sum\left(\left(\text{earned GPA}\right)\times\left(\text{credits of class}\right)\right)}{\sum\left(\text{credits attempted}\right)}$$

College math placement: There are three hypotheses pertaining to college math placement for students who participated in a placement improvement program (IV):

1. They took the COMPASS math test prior to participating (DV) in a placement improvement program and took the COMPASS math test after participating (DV) in a placement improvement program. Cross tabulation frequency tables, chi-square significance tests, and symmetric measure testing within SPSS were used to measure simple percentages, frequencies, significance and effect.

2. They improved their COMPASS math score (DV), math placement level (DV), and satisfied their program's math requirements (DV). Cross tabulation frequency tables, chi-square significance tests, and symmetric measure testing within SPSS were used to measure simple percentages, frequencies, significance and effect.

3. They improved their placement at higher rates (DV) if they attended multiple workshops (CV). Cross tabulation frequency tables, chi-square significance tests, and symmetric measure testing within SPSS were used to measure simple percentages, frequencies, significance and effect. SPSS linear regression with the number of workshops attended (CV) and improving placement level (DV) were used to determine causality.

Success in math classes: Two hypotheses pertain to success in math classes for students who participated in a placement improvement program (IV), and enrolled in a math class after participating in a placement improvement program (CV):

1. They had calculated math GPA success (DV), as measured by calculated math GPAs greater than 2.0. Cross tabulation frequency tables, chi-square significance tests, and symmetric measure testing within SPSS were used to measure simple percentages, frequencies, significance and effect. Descriptive statistics tables within SPSS were used to measure GPA means and standard deviations.

$$\text{Calculated math GPA} = \frac{\sum\left(\left(\text{earned GPA}\right)\times\left(\text{credits of math class}\right)\right)}{\sum\left(\text{math credits attempted}\right)}$$

2. They had overall GPA success (DV), as measured by GPAs greater than 2.0. Cross tabulation frequency tables, chi-square significance tests, and symmetric measure testing within SPSS were used to measure simple percentages,

frequencies, significance and effect. Descriptive statistics tables within SPSS were used to measure GPA means and standard deviations.

Age and gender: There is one hypothesis pertaining to age and gender for students who participated in a placement improvement program (CV) and are within certain age or gender groups (IV):

1. They are more likely to improve their math placement test score (DV) after participating in a placement preparation program. Cross tabulation frequency tables, chi-square significance tests, and symmetric measure testing within SPSS were used to measure simple percentages, frequencies, significance and effect. SPSS linear regression with students' age and gender (IV) and an improved math placement score (DV) were used to determine causality.

Statistically significant and effect size. Chi-Square exact significance and Phi and Cramer's *V* options were selected to measure statistical significance and effect size, respectively, from cross tabulation tables within SPSS and reported as $\chi^2(\text{d.f.}, N)$ = value, *p-value,* Cramer's *V*. Asymptotic significance values were not used as they don't always produce reliable results when data sets are small (Mehta & Patel, 2011). Hence, since many of the cross tabulation tables contained small sample sizes, or had multiple cells with low actual count values, the Chi-Square exact significance *p*-value was reported. However, some data sets were too large for a complete enumeration, and hence the Monte Carlo (2-sided) significance *p*-value was reported. The Monte Carlo method typically produces an unbiased approximation of the *p*-value, based on 10,000 sample tables that are derived from the same dimensions as the reported observed table, and is 99% accurate (Mehta & Patel, 2011). Fisher's exact significance (2-sided) test was used to determine significance for 2×2 cross tabulation tables.

Results were statistically significance if $p \leq 0.05$ (Cohen, 1988). Cramer's *V* and Phi, nominal-by-nominal symmetric measures, were calculated to determine effect size when there was a statistically significant association between two variables. According to Cohen (1988), the effect size estimates the effect or impact of the association between two variables - the larger the effect size, the greater the impact; thus, if *V* or Phi, φ, ranges from:

- 0.10 to 0.29, then the association's effect size is small
- 0.30 to 0.49, then the association's effect size is medium
- 0.50 to 1.0, then the association's effect size is large

Generalizability

There were a total of 53 workshops and 266 unduplicated students who attended at least one workshop over the course of two full years. There were two three-week placement review courses and 35 unduplicated students who registered to enroll. These programs will be analyzed separately, and a comparison will be made in CHAPTER 5.

One student participated in both a workshop and a review course. This student attended a workshop before taking the COMPASS math test for the first time, took the COMPASS math test, enrolled in a three-week placement review course, and at the end of the three-week course retook the COMPASS math test for his or her second math placement score. Since this student did not have a pre-workshop COMPASS math score, tested for the first time after a workshop, and did not retest again until after taking a review course, this student was not excluded from this study. In the workshop and review course data, this student was placed into the appropriate data category, and the results were analyzed with other students in that category.

Since this study is an evaluation of two programs at MathCC, all information was obtained from MathCC's Institutional Research on the students who participated in one of MathCC's placement improvement program, and hence the information in this study can only be generalized to those who participated in a placement improvement program. The data in this study do not represent data from a random sample, but a subset of data from MathCC's population. This study is intended to contribute educational knowledge and data to the field of college course placement and developmental mathematics.

Limitations of Evaluation

Many limitations impact the evaluation of this study in terms of assisting students with improving their mathematics placement, such as:

- Not all students who participated in a workshop decided to enroll in classes at MathCC. Reasons for attrition are unknown as student intent was not captured.
- Not all students who attended a workshop or enrolled in a review course had a pre-COMPASS math score. Although having more pre- and post-COMPASS test scores would add to the validity of the program's effectiveness, students may have participated to prepare for their first (or only) COMPASS math attempt.
- MathCC does not require all students to take a placement test; hence, not every student who registered for, or attended, a workshop could be analyzed for improving their COMPASS score or level.
- Students are not required to take the COMPASS math test at MathCC. It is required of most math classes, some non-mathematics courses, and some MathCC associate degree programs.
- Students can easily change their desired program of study, or merely select one to become eligible for financial aid. Hence, the accuracy of fulfilling a program of study's math requirement isn't always reflective of students' educational goals.
- Students who attended a workshop or enrolled in a placement review course may not have received advising on the requirements of their program of study prior to attending or registration.
- Some students attended a workshop to prepare for the COMPASS test, and did not want to take the COMPASS math test before attending a workshop.
- MathCC had data contradictions found in the baseline data for a few students. The data from these students were excluded from the baseline data, although it would not be enough to make a large difference in the baseline data.

- The amount of time, or the specific topics, a student practiced prior to taking or retaking the COMPASS math test could not be determined.

Delimitations

Several areas of delimitations impact this evaluation:

- Demographics for this study were limited to age and gender, and students' corresponding course success and retention rates.
- Time for the study of MathCC's workshops was limited to two years, fall 2011 – fall 2013, and was less than a year for review courses, winter 2013 – fall 2013. Historical data, as early as fall 2007, were obtained for additional comparisons.
- Baseline data on students who did not attend a workshop or enroll in a three-week placement review course were not separated out of the entire population.
- Some students who attended a workshop had a secondary major on file. This was ignored, and only the primary major was utilized in this study.
- Some students had more than three placement test scores. Only the three most recent placement test scores, with respective dates, were utilized. A limitation to this study is the second placement rate, which isn't necessarily students' highest placement level.
- Retesting: Students who participated in a placement improvement program were not separated out of the entire MathCC population's baseline data. Hence, a comparison was not made between students who retook the COMPASS math test for those who participated in a placement improvement program versus those who did not.

Reliability and Validity

All data were obtained first hand from MathCC's Institutional Research department, which helps improve reliability (Merriam, 2009). The variables in the data all measured different items, thus checking reliability within SPSS does not make sense. However, MathCC has been holding workshops since the fall of 2011, and the process (see Appendix D) was not significantly altered. From fall 2011- fall 2013, MathCC held a total of 53 workshops, which improves the reliability and validity of the workshops program and the measurement of its collected data (Merriam, 2009). Although this study is the first time an analysis of MathCC's data has been conducted, the same data for all students regardless of when they registered or what workshop they attended were drawn.

External validity is how generalizable results of a study are (Merriam, 2009). The results of this study are only generalizable to the population within this study. Random sampling and generalization to larger populations were not a focus within this study.

Internal validity addresses how close the study's findings match reality (Merriam, 2009). All data from MathCC's Institutional Research, for students that participated in a placement improvement program, were obtained and imported into SPSS. Data were recoded, as described in the Data Collection section of this chapter, and reflected the reality for students who participated in a placement improvement program. In addition, there are several sources that could be threats to internal validity, such as selection bias, selection-maturation interaction, mortality, history, maturation, instrumentation, statistical regression, and testing (Campbell & Stanley, 1963). The following describes how these threats were mitigated:

- Selection bias: this source is not a threat, as students who participated in a workshop or review course were not randomly assigned, but rather self-selected to participate in one of these programs.
- Selection-maturation interaction: this source is not a threat as past data for students who participated in a placement improvement program were obtained and studied. Students were not aware that their data, including demographics, were going to be analyzed.
- Mortality: There were students who participated in a placement improvement program, but then decided not to enroll in math classes, and some decided not to enroll in any classes at MathCC. Hence, there is attrition within program participants. Attrition rates will be included in enrollment rates for dependent variables, but could not be minimized or impacted as a result of this study as it only measures the data to a program that occurred in the past.
- History: Electronic resources were switched for all workshops, beginning in the fall 2012 and continuing through the fall 2013, from online math practice tests to

online math practice resources that included math problems and related instructional videos (see Appendix D). No other events occurred over the time period that would significantly impact the results.

- Maturation: Only a small set of individuals attended multiple workshops, and only one participated in both programs. Hence, maturation effects were not considered within this study, as they should not pose a large threat, if any at all. However, data pertaining to the general population at MathCC is used, as relevant, to serve as a comparison with students in a placement improvement program.

- Instrumentation: The procedures and treatment of program participants were consistent between all workshops, and all faculty members conducting workshops or teaching review courses. Six different faculty members administered the 53 workshops. The faculty member who started the workshops in the fall 2011 trained one faculty member in the winter 2012 semester. This new faculty member then trained four other faculty members from the spring 2012 through the summer 2013 semester. All six faculty members followed the same process (see Appendix D), and used the same online resources. The two review courses were taught by two faculty members who followed the same processes. Both review courses were on the same days, at the same times, for the same length of time.

- Statistical Regression: this source is not a threat as past data for all students who participated in a placement improvement program was obtained and studied.

- Testing: this source is not a threat as past data for students who participated in a placement improvement program was obtained and studied. Furthermore, students participating in a placement improvement program were not aware that their data were going to being studied.

CHAPTER FOUR: RESULTS

This chapter presents the baseline MathCC data for comparison purposes, and the data relevant to students who attended or enrolled in a placement preparation workshop (workshop) or a three-week placement review course (review course).

MathCC Baseline Data

Placing into developmental mathematics. There were a total of 27,642 FTIAC students who enrolled in a fall or winter semester MathCC class from the fall 2009 semester to the fall 2013 semester. A total of 23,718 students, 86%, took the math portion of the COMPASS placement test. Of those taking the test, 93% placed into developmental mathematics courses with over half, 55%, placing into Pre-Algebra, 38% into Beginning Algebra, and only 7% into Intermediate Algebra or above. Table 3 gives a breakdown per semester for MathCC's placement rates. Overall, since the fall 2009 semester, the majority of students at MathCC placed into developmental level mathematics, with the majority into Pre-Algebra — two levels below college level.

A total of 3,840 students retook the math COMPASS test at least once. MathCC students may take the math COMPASS test up to three times with permission. Table 4 gives a breakdown per semester of the percentage of students who retook the placement test and the level in which they placed. Both tables show that historically, between 89% and 95% of students place into developmental mathematics courses after taking the COMPASS math test for the first time, and of those that retest, between 72% and 86%

place into developmental mathematics courses. In other words, MathCC sees a very large proportion of incoming students who test into developmental math classes.

Table 3: First COMPASS Math Course Placement Rates by Semester

Semester	Students who Tested	Placed into Pre-Algebra	Placed into Beginning Algebra	Placed into or Above Intermediate Algebra
		(percentages)		
FA09	3,424	52.5	39.4	8.1
WI10	1,832	61.3	33.7	5.0
FA10	3,730	55.9	37.6	6.5
WI11	1,782	60.1	34.0	5.9
FA11	3,556	50.7	40.8	8.4
WI12	1,949	64.8	30.1	5.1
FA12	3,384	52.6	39.9	7.6
WI13	1,726	63.0	31.3	5.7
FA13	2,335	44.8	44.4	10.8
Total	23,718	55.0	37.7	7.3

Table 4: Second COMPASS Math Course Placement Rates by Semester

Semester	Students who Retested	Placed into Pre-Algebra	Placed into Beginning Algebra	Placed into or Above Intermediate Algebra
		(percentages)		
FA09	561	30.8	49.6	19.6
WI10	211	36.5	49.8	13.7
FA10	553	37.4	46.1	16.5
WI11	230	43.9	37.4	18.7
FA11	591	27.7	46.0	26.2
WI12	216	43.5	37.5	19.0
FA12	670	24.3	47.9	27.8
WI13	192	42.7	37.5	19.8
FA13	616	22.2	53.1	24.7
Total	4,957	32.1	47.1	20.8

As can be seen in Table 4, the majority of students who retook the placement test at MathCC placed one level below college level, into Beginning Algebra. With about 47% of students who retested placed into Beginning Algebra and 32% placed into Pre-Algebra, overall, 79% of students who retook the COMPASS placement test placed into a developmental math course. Comparatively, students' second COMPASS math scores are higher, with the majority of students placed into Beginning Algebra. Furthermore, looking at students' first and second COMPASS math score, a higher proportion of students placed into Pre-Algebra in a winter semester than a fall semester. And for most years the opposite is true for Beginning Algebra, where students had higher proportions placed into Beginning Algebra in a fall semester. MathCC's overall developmental placement rate for students' second COMPASS math score was lower than it was for students' first COMPASS math score, but both are still higher than the national average of 60% (Collins, 2009).

There are two limitations with this data: first, it is not known what percentage of the students who retested initially tested into developmental mathematics, and second, the way the data for Second COMPASS Math Course Placement Rates by Semester were coded prevented the analysis of students' highest test score. The assumption made for a student retaking the COMPASS math test is that they wanted to improve their score. Hence, a student's second placement score may not be their highest; however, the overall placement rates for students who retook the COMPASS math test had lower developmental math placement rates.

Retention rates. The retention rates for all new transfer-in and FTIAC MathCC students starting in a fall or winter semester are shown in Table 5. Since the fall 2009 semester, fall-to-winter retention rates for students' initial semester, to the subsequent winter semester, were between 70% and 77%, winter-to-fall retention rates were between 29% and 42%, fall-to-fall retention rates were between 36% and 46%, and winter-to-winter retention rates were between 27% and 39%. Overall, semester-to-semester and year-to-year retention rates at MathCC declined from the fall 2009 to fall 2012.

Table 5: FTIAC and Transfer-In Students' Semester-to-Semester Retention Rates

	Subsequent Semesters												
Initial Sem.	WI 10	SP 10	SU 10	FA 10	WI 11	SP 11	SU 11	FA 11	WI 12	SP 12	SU 12	FA 12	WI 13
	(percentages)												
FA09	77.0	23.3	11.0	46.0	41.3	15.0	8.1	27.8	23.9	7.0	4.6	15.9	15.0
WI10		35.0	11.0	42.3	38.2	16.5	9.6	23.7	25.4	7.5	3.8	14.0	14.1
FA10					74.0	20.5	11.9	41.2	34.7	9.6	5.9	23.6	21.5
WI11						36.4	21.3	38.2	39.4	10.9	6.6	20.3	18.3
FA11									71.9	14.6	9.3	35.5	32.1
WI12										35.2	21.0	29.2	26.6
FA12													69.7

Finally, since the majority of students at MathCC place into developmental mathematics, Table 6 shows retention rates for the 7,493 students who first enrolled in a developmental math course in either a fall or winter semester from the fall 2011 to fall 2013. This data includes 24 students who graduated sometime within those given semesters, and five students were excluded as they had conflicting graduation information within MathCC's data system. In summary, fall-to-winter retention rates were between 74% and 76%, fall-to-fall retention rates were between 34% and 38%, winter-to-fall retention rates were between 27% and 32%, and winter 2012 to winter 2013 retention rates were 29%.

Lastly, out of the 18,597 student retention records that were drawn from fall 2007 to fall 2013, 267 data inconsistencies existed and there were 389 students who took their first developmental math course in the spring or summer term. These results were excluded by MathCC's Institutional Research; however, these results would not have made a substantial change in the retention data presented above as it only represented 3.5% of the total 18,597 total possible students.

Table 6: Retention Rates After the First Semester Enrolled in Developmental Math

Initial Semester	Subsequent Enrollment (percentages)			
	WI12	FA12	WI13	FA13
FA11	76.2	38.2	34.3	23.2
WI12		31.5	29.0	18.0
FA12			73.7	33.6
WI13				27.2

Excluding graduates, the retention rates are nearly identical, with a maximum difference of 0.2% compared to the data in Table 6. In summary, the retention rates for students taking a developmental math course were within the retention ranges for all MathCC students with the exception of fall-to-fall and winter-to-fall rates, which were a few percentage points lower.

Developmental pass rates. The average historical pass rates for Pre-Algebra and Beginning Algebra students, from fall 2007 through fall 2013, were approximately 42% and 47%, respectively. Altogether, the developmental pass rate for all students enrolled in a Pre-Algebra or Beginning Algebra course was 42%, which is nearly the same as the pass rates for all FTIAC student (see Table 7).

Looking at the Pre-Algebra and Beginning Algebra classes individually from fall 2011 through fall 2013 (see Table 8) Pre-Algebra students had pass rates between 30% and 52% and Beginning Algebra students had pass rates between 40% and 59%. The average pass rates, from fall 2011 through fall 2013, were approximately 39% for all Pre-

Algebra students (which was lower than the fall 2007 to fall 2013 pass rate) and 47% for all Beginning Algebra students (which was nearly the same as the fall 2007 to fall 2013 pass rate). In summary, historical Pre-Algebra pass rates were 42%, and the rates from 2011 through 2013 were slightly lower. The historical pass rates for Beginning Algebra were 47%, and stayed relatively the same from 2011 through 2013.

Table 7: Developmental Math Pass Rates (Pre-Algebra and Beginning Algebra Combined)

Semester	All MathCC Students	All MathCC Students Pass Rates (%)	FTIAC Students	FTIAC Pass Rates (%)
WI12	1,042	37.6	757	36.9
SP12	167	37.4	62	35.8
SU12	130	39.0	31	29.5
FA12	1,300	44.2	1,000	44.7
WI13	904	36.7	633	34.4
SP13	134	41.6	47	39.8
SU13	118	45.0	34	35.8
FA13	1,026	56.1	800	58.1
Total	4,821	42.4%	4,821	42.1%

Table 8: Pass Rates by Developmental Math Course (percentages)

Semester	Pre-Algebra Pass Rate	Beginning Algebra Pass Rate
FA11	42.0	47.9
WI12	35.2	39.9
SP12	29.8	44.0
SU12	32.6	46.0
FA12	37.1	51.7
WI13	34.3	39.6
SP13	38.4	44.3
SU13	33.0	54.4
FA13	52.1	59.3

Developmental sequence completion rates. There were a total of 18,201 distinct, unduplicated students who enrolled in a Pre-Algebra course from winter 2007 to fall 2013 (see Table 9). Of these students, 8,785 passed Pre-Algebra, and 2,747 went on to take and pass Beginning Algebra. Less than half (48%) of the initial 18,201 students passed Pre-Algebra, and 15% took and passed Beginning Algebra to complete MathCC's developmental sequence.

Table 9: Enrollments and Pass Rates for Developmental Mathematics Courses

Developmental Math	Distinct Students		Enrollments	
	n	Percent	n	Percent
Enrolled in Pre-Algebra	18,201		21,192	
Passed Pre-Algebra	8,785	48.3	8,846	41.7
Passed Beginning Algebra	2,747	15.1	2,766	13.1
Pass Beginning Algebra (of those who passed Pre-Algebra)	2,747	31.3	2,766	31.3

Overall, the 18,201 students enrolled in Pre-Algebra a total of 21,192 times and had a pass rate of approximately 42%. Notice that the number of enrollments that passed Pre-Algebra is higher than the number of distinct students that passed Pre-Algebra – in other words, there were students who passed Pre-Algebra that decided to re-enroll in Pre-Algebra, some of which passed Pre-Algebra for a second time. Looking at the enrollments that passed Beginning Algebra, approximately one in eight enrollments that started in Pre-Algebra passed Beginning Algebra. In addition, nearly a third of the students who started and passed Pre-Algebra went on to take and pass Beginning Algebra. Lastly, the pass rates for Beginning Algebra for students who started in, and passed, Pre-Algebra is the same when looking at distinct students and the total number of enrollments.

Workshops & College Success

Does attending a placement preparation workshop (workshop) improve overall college success?

Enrollment. A total of 266 students attended a workshop between the fall 2011 and fall 2013 semester. Two hundred fourteen students, 81%, attended a workshop and enrolled in at least one class at MathCC sometime after attending a workshop. Table 10 gives the breakdown per semester for all students who attended a workshop, the percentage of them that enrolled in MathCC classes beyond the fall 2011 semester, the enrollment rate in the subsequent semester following attendance at a workshop (using spring and summer as subsequent semester to winter, and fall as the subsequent semester to spring or summer), and the enrollment rate in the subsequent 15-week semester following attendance at a workshop (counting fall as the subsequent 15-week semester to winter, spring, and summer).

For all workshop attendees, the rate in which they enrolled in a MathCC class after attending a workshop is 35%. This rate counts spring and summer semesters as the subsequent semester to winter semesters, and the fall as the subsequent semester to either the spring or summer semester. On the other hand, if the fall semester is considered the subsequent 15-week semester to winter, spring, or summer semesters, nearly two out of every five students enrolled in a MathCC class after attending a workshop. For each semester, except workshops that occurred in the fall 2011, fall 2012, or the subsequent semester, enrollment rates were less than half the overall MathCC semester-to-semester retention rate (70% to 77%) for students who started in a fall semester. The subsequent semester enrollment rate for workshop students, 35% and 39%, was within the winter-to-fall retention rate for all MathCC students (29% to 42%). These percentages, subsequent workshop enrollments and semester-to-semester retention rates, are measuring similar but different things. Workshop enrollment rates are primarily for students who have not yet taken a class at MathCC and are enrolling in their first MathCC class, whereas the overall semester-to-semester retention rates are for all MathCC students who have already taken at least one class at MathCC.

Table 10: MathCC Enrollment Rates After Attending a Workshop

Semester Attended Workshop	n	Enrolled in MathCC Classes	Subsequent Semester Enrolled[a]	Subsequent 15-Week Semester Enrolled[b]
		(percentages)		
FA11	19	78.9	68.4	68.4
WI12	29	82.8	10.3	41.4
SP/SU12	43	65.1	30.2	30.2
FA12	29	75.9	41.4	41.4
WI13	50	78.0	22.0	24.0
SP/SU13	96	89.6	43.8	43.8
Total	266	80.5%	35.0%	39.1%

Notes: [a] Counting spring and summer as subsequent to winter, and fall as subsequent to spring and summer.
[b] Counting fall as subsequent to winter spring/summer.

Semester-to-semester retention rates, for students who enrolled in classes after attending a workshop, were close between subsequent full-length 15-week semesters. With the exception of the students who attended a fall 2012 semester (and enrolled in winter 2013 or fall 2013 classes), every semester a student attended a workshop there was a percentage difference of 22 percentage points or less in subsequent full-length 15-week retention rates (see Table 11). Basically, once students enrolled in classes at MathCC after attending a workshop, they were likely to re-enroll in subsequent full-length 15-week semesters at a rate close to their original enrollment rates into MathCC classes after attending a workshop.

Expanding from the semester subsequent to attending a workshop, to all semesters after a workshop, and students' enrollment rates were higher in many semesters following the immediate subsequent semester to a workshop (see Table 11). Table 10 is based on the semester in which students first enrolled in classes at MathCC, beyond the winter 2012 semester, whereas Table 11 is overall enrollment rates by semesters. Overall, Table 10's subsequent semester enrollment rates were lower than those in Table 11, as not every student who attended a workshop took their first MathCC class in the subsequent semester of a workshop – some students took classes in previous semesters, or even in that same semester. As a point of comparison, Table 10 shows that approximately 79% of fall 2011 workshop attendees enrolled in MathCC classes beyond the fall 2011 semester, and 68% enrolled in their first MathCC class in the winter 2012 semester. Table 11 gives the same 68% of fall 2011 workshop attendees enrolling in winter 2012 MathCC classes because all 13 of the students who attended a fall 2012 workshop enrolled in classes at MathCC for the first time in the winter 2012 semester. However, winter 2012 workshop attendees and spring/summer 2012 enrollment rates are different between Tables 10 and 11 because in Table 11 there are students who attended a winter 2012 workshop that took their first MathCC class in the winter 2012 semester rather than in the spring or summer 2012 semesters. Furthermore, Table 11 shows the enrollment rates for semesters beyond that which a student attended a workshop; for example, 68% of the 19 students enrolled in winter 2012 classes, 47% enrolled in spring or summer 2012, 58% enrolled in fall 2012, 58% enrolled in the winter 2013 semesters, and so on.

Two additional observations can be seen within this data: enrollments in spring or summer are lower than fall or winter, and students are almost equally likely to enroll in fall and winter classes after attending a workshop; for example, the fall 2011 workshop student enrollment rates in the fall 2012 and winter 2013 semesters were equal, at approximately 58%. The results for winter 2012 workshops and fall 2012 and winter 2013 enrollments, as well as spring/summer 2012 workshops and fall 2012 and winter 2013 enrollments are close. In summary, 80% of students who attended a workshop enrolled in a MathCC class, 35% did so the semester after a workshop, almost 40% did so the subsequent 15-week semester, and once they did enroll, they re-enrolled in MathCC classes the semesters following with approximately similar enrollment rates.

Table 11: MathCC Enrollment Rates after Attending a Workshop

Semester Attended Workshop	n	Semester Enrollment Rates (percentages)					
		WI12	SP/SU12	FA12	WI13	SP/SU13	FA13
FA11	19	68.4	47.4	57.9	57.9	26.3	42.1
WI12	29		24.1	62.1	65.5	34.5	58.6
SP/SU12	43			53.5	51.2	25.6	32.6
FA12	29				72.4	48.3	41.4
WI13	50					40.0	62.0
SP/SU13	96						82.3

Retention. Retention rates for students who attended a workshop can be viewed in two ways: by the semester in which they participated in a workshop or by the first semester they enrolled in classes at MathCC after the fall 2011 semester. Some students were already current students at MathCC prior to the fall 2011 semester. Data for these students, prior to the winter 2012 semester, were not pulled or analyzed. Hence, the first semester enrolled means the first semester after the fall 2011 semester in which a student has earned a grade at MathCC (including drop and withdrawal grades) for taking at least one class at MathCC.

Retention based on semester enrolled. A total of 214 students who attended a workshop enrolled in classes at MathCC between the winter 2011 and fall 2013 semester. Fifty-five of these students enrolled in the fall 2013 semester, and hence are excluded from semester-to-semester retention calculations; however, 159 students enrolled in a semester where at least one semester-to-semester retention rate could be measured (see Table 12).

Table 12: Retention Rates Based on First Semester Enrolled

Initial Semester	n	Semester Enrollment Rates (percentages)				
		SP/SU12	FA12	WI13	SP/SU13	FA13
WI12	54	55.6	81.5	79.6	42.6	57.4
SP/SU12	13		53.8	61.5	38.5	61.5
FA12	51			88.2	35.3	72.5
WI13	22				45.5	68.2
SP/SU13	19					78.9
Total	159					

Note: 55 students first enrolled in classes in fall 2013 have been excluded

Fifty-four students attended a workshop sometime between the fall 2011 and fall 2013 semesters and enrolled in winter 2012 classes. Of these 54 students, more than half, 56%, were retained to the next subsequent semester (spring/summer 2012), greater than four out of every five students (82%) were retained to the subsequent 15-week fall 2012 semester, and almost 80% were retained one year later to the winter 2013 semester. These rates are higher than MathCC's overall winter-to-fall and winter-to-winter retention rates of 29% to 42% and 27% to 39%, respectively.

For the 13 students who first enrolled in the spring or summer 2012 semester, more than half (54%) were retained one semester to enroll in the fall 2012 semester, approximately 62% were retained to the winter 2013 semester, and 39% were retained one year later to spring or summer 2013. Of the 51 students who first enrolled in MathCC classes in the fall 2012 semester, over 88% were retained one semester to take winter 2013 classes (fall-to-winter retention), and almost three out of every four students (73%) were retained a year later to take fall 2013 classes. These rates are also higher than MathCC's overall fall-to-winter and fall-to-fall retention rates of 70% to 77% and 36% to 46%, respectively. For the 22 students who started in the winter 2013 semester, over 68% were retained to the subsequent 15-week fall 2013 semester. Again, this rate was higher than the overall MathCC winter-to-fall range of 29% to 42%.

Combining the number of students who enrolled in the first two possible subsequent semesters, with spring and summer as one subsequent semester to winter, the cumulative first-to-second semester retention rate was 67% for these 159 students (30 from winter 2012, seven from spring/summer 2012, 45 from fall 2012, ten from winter 2013, and 15 from spring/summer 2013). On the other hand, counting fall semesters as subsequent to winter and spring/summer semesters, the overall cumulative first-to-second semester retention rate was over 79% (44 from winter 2012, seven from spring/summer 2012, 45 from fall 2012, 15 from winter 2013, and 15 from spring/summer 2013). The percentage, using fall as subsequent to winter, is higher than the 70% to 77% fall-to-winter and 29% to 42% winter-to-fall retention ranges for all MathCC students.

Measuring year-to-year retention rates, based on the first semester a student enrolled in a class at MathCC after the fall 2011 semester, and regardless of when he or she attended a workshop, the overall year-to-year cumulative retention rate was 72%. In other words, 72% (85 students) of the possible 118 students who first enrolled in a winter 2012, spring/summer 2012, or fall 2012 semester class (43 from winter 2012, five from spring/summer 2012, and 37 from fall 2012) were retained to take at least one class at MathCC one year later. This includes spring and summer semesters as a combined semester. This is considerably higher than the 36% to 46% fall-to-fall and 27% to 39% winter-to-winter retention ranges for all MathCC students.

In summary, semester-to-semester retention rates, for students who attended a workshop, based on their first enrolled semester, were eleven to 52 percentage points greater (comparatively by a semester-to-semester basis, such as a fall-to-winter comparison), and year-to-year retention rates were 26 to 46 percentage points greater (comparing fall-to-fall and winter-to-winter rates) than the retention rates for all MathCC students.

Retention based on workshop attended and semester enrolled. There were 84 students who attended a workshop and enrolled in a MathCC class the semester following their attended workshop (counting spring/summer as subsequent to winter) (see Table 13). First-to-second semester retention rates ranged from approximately 57% to 91%. The cumulative first-to-second semester retention rate after attending a workshop was just under 74%. This is within the overall 70% to 77% fall-to-winter retention rate range for all MathCC students and much higher than the 29% to 42% winter-to-fall retention rate range.

On the other hand, counting fall semesters as the semester subsequent to winter (see Table 13), the overall cumulative first semester-to-second semester retention rate for students who attended a workshop was greater than four students out of every five, 81%. First-to-second semester retention rates ranged from approximately 57% to 95%. Using fall as subsequent to winter yields higher retention rates than using spring/summer as subsequent to winter, and hence, students who attend a workshop and enroll in the subsequent semester are more likely to enroll in the next semester compared to all MathCC students.

Table 13: First-to-Second Semester Retention Rates for Workshop Attendees, including Spring and Summer

	Workshop Attended				
	FA11	WI12	SP/SU12	FA12	WI13
Semesters Enrolled	WI12-to-SP/SU12	SP/SU12-to-FA12	FA12-to-WI13	WI13-to-SP/SU13	SP/SU13-to-FA13
Retained	9	4	21	14	14
Possible	13	7	23	21	20
Retention Rates	69.2%	57.1%	91.3%	66.7%	70.0%
Cumulative First-to-Second Semester Retention Rate	69.2%	65.0%	79.1%	75.0%	73.8%

	Workshop Attended			
	FA11	WI12	SP/SU12	FA12
Semesters Enrolled	WI12-to-FA12	FA12-to-WI13	FA12-to-WI13	WI13-to-FA13
Retained	11	17	21	12
Possible	13	18	23	21
Retention Rates	84.6%	94.4%	91.3%	57.1%
Cumulative First-to-Second Semester Retention Rate	84.6%	90.3%	90.7%	81.3%

Measuring year-to-year retention rates, based on the first semester a student enrolled in a class at MathCC after attending a workshop, the overall year-to-year cumulative retention rate was 58%. This includes spring and summer semesters as a combined semester (see Table 14). On the other hand, counting fall semesters as the subsequent 15-week semester to winter and spring/summer semesters, then the overall cumulative year-to-year retention rate for students who attended a workshop was 69%. Both year-to-year retention rates are much higher than the fall-to-fall and winter-to-winter retention rates for all MathCC students (36% to 46% and 27% to 39%, respectively). In summary, workshop students who enrolled in classes the semester after attending a workshop had retention rates that were within the overall MathCC student retention rate ranges or were greater.

Table 14: Year-to-Year Retention Rates for Workshop Attendees

	Workshop Attended		
	FA11	WI12	SP/SU12
Semesters Enrolled	WI12-to-WI13	SP/SU12-to-SP/SU13	FA12-to-FA13
Retained	9	2	14
Possible	13	7	23
Cumulative Year-to-Year Retention Rate	69.2%	55.0%	58.1%

	Workshop Attended		
	FA11	WI12	SP/SU12
Semesters Enrolled	WI12 to WI13	FA12 to FA13	FA12 to FA13
Retained	9	14	14
Possible	13	18	23
Cumulative Year-to-Year Retention Rate	69.2%	74.2%	68.5%

Retention based on math class taken. A total of 146 students attended a workshop and enrolled in a math class sometime at MathCC, 86 of whom took a math class before the fall 2013 semester. Fourteen took a winter 2012 math class and all of them were retained to the following fall 2012 semester, and approximately 93% were retained to the winter 2013 semester. Spring and summer 2012 did not have as high of a retention rate, where only one third of the students enrolled in a fall 2012 class, less than half (44%) in winter 2013 classes, and one third one year later in a spring or summer 2013 class. However, almost 94% of the 32 students who enrolled in a fall 2012 math class enrolled in a MathCC class in the winter 2013 semester and 75% a year later in a fall 2013 class. Lastly, 16 students took a math class in the winter 2013 semester, over 81% of them enrolled in spring or summer classes and almost 63% enrolled in a fall 2013 class (see Table 15).

In summary, the cumulative semester-to-semester retention rate for students who took a math class, including spring and summer as a semester, is nearly 80%, which is the same as the semester-to-semester retention rate when using fall as the subsequent semester for a winter and spring/summer semester. In addition, the cumulative year-to-year retention rate for students who took a math class in winter 2012, spring or summer 2012, or fall 2012 is nearly 73%. Both the semester-to-semester and year-to-year retention rates for workshop students who enrolled in a math class were higher than MathCC's overall retention rates and the retention rates for all MathCC students after their first semester enrolled in a developmental math course. In fact, the year-to-year retention rate is double in some semesters for students who attended a workshop.

Table 15: Retention Rate by Semester for Workshop Attendees That Took a Math Class

Semester of Math Class	n	Subsequent Enrollment (percentages)				
		SP/SU12	FA12	WI13	SP/SU13	FA13
WI12	14	78.6	100.0	92.9	64.3	57.1
SP/SU12*	9		33.3	44.4	33.3	55.6
FA12	32			93.8	46.9	75.0
WI13	16				81.3	62.5
SP/SU13*	15					73.3

Note: * No students from SP/SU12 or SP/SU13 took both a spring and summer math class.

Overall MathCC success. Out of the 266 students who attended a MathCC workshop, 80% (214 students) enrolled in at least one class at MathCC between the fall 2011 and fall 2013 semesters (see Table 16). In addition, 88% of the 266 students (234 students) attended one workshop, 9% (24 students) attended two workshops, 3% (seven students) attended three workshops, and less than 1% (one student) attended six workshops.

Overall, 62% of all workshop attendees had a cumulative MathCC GPA greater than 2.0 by the end of the fall 2013 semester. The attrition rate was high, approximately 20%, and the remaining 18% earned GPAs of 2.0 or less. The largest percentage, when looking at GPA ranges, was greater than a 3.0 grade (36%). Removing the students who did not enroll, 78% of the 214 earned a GPA greater than 2.0.

Furthermore, 65% of the students who attended one workshop enrolled in MathCC classes and had earned a cumulative MathCC GPA greater than 2.0, whereas about 38% of those who attended two workshops, 72% of the seven students who attended three workshops, and the one student that attended six workshop earned a cumulative MathCC GPA greater than 2.0. In addition, 42% of students who attended two workshops (10 students) did not enroll in any classes between the fall 2011 and fall 2013 semester. The percentage of cumulative MathCC GPA ranges did not differ statistically as a result of the number of workshops a student attended, $\chi^2(15, N = 266) = 22.92, p = .12$.

Breaking this data into success and failures, excluding the students who did not enroll, and including 2.0 GPA as successes, the percentage of cumulative MathCC GPAs greater than or equal to 2.0 did not differ statistically as a result of the number of workshops a student attended, $\chi^2(6, N = 177) = 4.82, p = .47$, and the percentage of cumulative MathCC GPAs less than 2.0 did not differ statistically as a result of the number of workshops a student attended, $\chi^2(4, N = 37) = 6.32, p = .15$. Hence, the number of workshops a student attends is a not a predictor of success or non-success.

Finally, the average MathCC cumulative GPA was 2.7, with standard deviation of 1.0 for the 214 students who enrolled in at least one MathCC class between the fall 2011 and fall 2013 semesters. Although overall baseline FTIAC or all student MathCC GPA statistics were not obtained, this average GPA shows that students are overall more successful than they are in developmental math as the average pass rate for developmental math courses was just over 42% (see Table 7). Furthermore, a GPA of 2.0 is considered a success; hence, the students who attended a workshop are considerably above this success threshold.

Table 16: MathCC GPA Ranges Based on the Number of Workshops a Student Attended

Workshops Attended	n	Cumulative MathCC GPAs (percentages)					
		0.0	0.0<GPA≤1.0	1.0<GPA≤2.0	2.0<GPA≤3.0	3.0<GPA≤4.0	Did Not Enroll
One	234	4.3	2.1	11.5	27.8	36.8	17.5
Two	24	12.5	4.2	4.2	8.3	29.2	41.7
Three	7	0.0	14.3	0.0	42.9	28.6	14.3
Six	1	0.0	0.0	0.0	100.0	0.0	0.0
Total	266	4.9%	2.6%	10.5%	26.7%	35.7%	19.5%

Workshops & Placement

Does attending a placement preparation workshop (workshop) improve college math placement?

Pre- and post-COMPASS scores. Two hundred sixty-six students attended a placement preparation workshop, nearly one in four (24%, 65 students) attended a workshop before taking the math portion of the COMPASS test, one in five (21%, 55 students) did not have a COMPASS math test on file, and 55% (146 students) had already taken the COMPASS math test at least once.

Recoding students according to the dates in which they took or retook the COMPASS test (see Table 17), 47% (125 students) attended a workshop prior to taking or retaking the COMPASS math test. Removing the 65 students who attended a workshop before taking the COMPASS math test from the 125 students who attended a workshop before taking or retaking the COMPASS math test, overall almost 23% of the 266 students had taken the COMPASS math test prior to attending a workshop. Furthermore, an additional 32% (86 students) had a COMPASS math score on file before attending a workshop, but chose not to retake the COMPASS math test after attending a workshop

Table 17: Attended a Workshop Before Taking or Retaking the COMPASS Math Test

Attended Workshop	Frequency	Percent
Before Testing or Retesting	125	47.0
After Testing	86	32.3
Never Took COMPASS	55	20.7

COMPASS retest results. Of the students who retook the COMPASS placement test, what percent tested into a college-level math course, increased their placement test score, increased their MathCC math course placement, or satisfied their program's math requirements?

College level. One in five workshop attendees (21%, 55 students) did not take the COMPASS math test. Excluding these students, 211 took the COMPASS math test, 87% (184 students) of them had an initial developmental math course placement and 13% (27 students) placed into Intermediate Algebra or above (see Table 18). In addition, 57%

(120 students) retook the COMPASS placement test at least once. Some of them retook the placement test immediately following their first attempt, waited a few weeks, a semester, or a few years. Some students retook the COMPASS test after attending a workshop. The column labeled highest placement shows the results of all 266 students and their highest earned placement level.

Using students' highest placed level, 21% placed into Pre-Algebra (45 of the 211), more than half placed into Beginning Algebra (107 students), and more than one in four (28%) placed into Intermediate Algebra or above (59 students). In other words, the number of students placing into Pre-Algebra and Beginning Algebra decreased, and the number of students placing into Intermediate Algebra or higher increased. In summary, after students retook the COMPASS test, almost three out of every four students (72%) had a highest math COMPASS placement score that placed them into a developmental math course compared to the initial developmental placement rate of 87%.

Table 18: Initial and Highest Placement Levels for Students Who Attended a Workshop

Placement Level	Placement Percentages	
	Initial	Highest
Pre-Algebra	34.1	21.3
Beginning Algebra	53.1	50.7
Intermediate Algebra	11.0	18.5
College Algebra	0.5	4.3
Pre-Calculus	1.4	4.7
Calculus I	0.0	0.5

Improved score or level. Of the 266 students who attended a placement preparation workshop, 37% (98 students) had a pre-COMPASS math score on file, and retook the COMPASS math test after attending a workshop (see Table 19). Of those that had a pre-COMPASS math score on file, 80% (29% of the 266) retested and improved their score; the remaining students did not improve their score. In addition, 41 students attended a workshop before taking the COMPASS math test, 72 attended a workshop and chose not to retake the COMPASS math test, and 55 students chose not to take the COMPASS math test at all during the time of this study.

Improving a COMPASS math score doesn't always translate to a higher-level math placement. For example, a student could earn a higher score on the Algebra COMPASS math test section and still end up placed in the same math class. Of the 78 students who improved their COMPASS math score, two thirds of them (52 students) improved their mathematics placement level by at least one level, with 47% (37 of the 78 students) that improved one level, 13% (ten students) that improved two levels, 5% (four students) that improved three levels, and 1% (one student) that improved four levels.

Considering these students as a percentage, of the 98 who had an initial COMPASS math test and retested, almost 38% improved one level, 10% improved two levels, 4% improved three levels, and 1% improved four levels – in other words over half (53%) of the 98 students who retook the COMPASS math test placed at least one level higher.

Table 19: COMPASS Results and Levels Improved After Attending a Workshop

Post Workshop COMPASS Results	n	Math Levels Improved (percentages)						
		One	Two	Three	Four	Zero	Did Not Retest	No Test On File
Improved Score	78	47.4	12.8	5.1	1.3	33.3	0.0	0.0
Did Not Improve	20	0.0	5.0	0.0	0.0	95.0	0.0	0.0
Attended Workshop Before Testing	41	0.0	0.0	0.0	0.0	0.0	97.6	2.4
Did Not Retest After Workshop	72	12.5	0.0	0.0	0.0	18.1	69.4	0.0
No COMPASS on File	55	0.0	0.0	0.0	0.0	0.0	1.8	98.2
Total	266	17.3	4.1	1.5	0.4	21.8	34.2	20.7

Using the 266 students who attended a workshop as a baseline, just under 20% (62 students) attended a workshop, retook the COMPASS math test, and placed at least one level higher than their initial math placement. The other 9% (25 students) who improved their COMPASS score did not improve it enough to increase their mathematics placement level.

Notice in Table 19 that there were students in the Did Not Improve and Did Not Retest After Workshop categories that had improved their math placement levels. These students retested prior to attending a workshop, and improved their placement levels. The students in Did Not Retest After Workshop, did not retest after the workshop, and the students in Did Not Improve, improved their placement prior to the workshop, attended the workshop, retested again, but did not improve their level any more. The percentage of students who improved their math placement level statistically differed, with a large effect size, based on students' post workshop COMPASS math results, $\chi^2(24, N = 266) = 496.71$, $p < .001$, $V = .68$

On the other hand, there was no correlation between improving math levels and attending more workshops. Linear regression models for the number of workshops students attended as the independent variable, and the number of levels these students improved as the dependent variable, for the 120 students who retook the COMPASS math test and the 13 students who attended more than one workshop, showed no correlation (for all 120 students, $r = 0.048$, $r^2 = 0.002$, adjusted $r^2 = -0.006$, standard error = 0.8; for the 13 students, $r = 0.083$, $r^2 = 0.007$, adjusted $r^2 = -0.083$, standard error = 0.8).

Satisfied math requirement. MathCC has programs of study that have two different types of math requirements: those that require students to be at a specific level in order to be in the program of study, and those that require students to take at least one math class, regardless of the level in which they place on the COMPASS math test. This section considers satisfying a program of study's math requirement by testing high enough not to have to enroll in any math classes, or testing out of prerequisite math classes that would need to be taken before a required math course could be taken.

Overall, one out of every eight (12.4%) workshop attendee (33 students) satisfied their program's math requirement after taking the COMPASS test (see Table 20). Removing the students who did not have a program on file (30 students), who had a program with no math requirement or prerequisite (63 students), who did not test and had a program with no math requirement (six students), and who did not test and did not have a program on file (39 students), there were a total of 128 students who needed to take the COMPASS math test as a result of their program of study. In other words, 48% of students who attended a workshop needed to take the COMPASS math test for their program of study. Thus, more reflective of the students who needed a COMPASS math score, 26% of students who attended a workshop (33 of the 128 students) satisfied their program's math requirement. Looking back at the *Improved score or level* section of this study, 16% (16 of 98 students) who attended a workshop and retook the COMPASS math test improved their score enough to satisfy their program's math requirement.

Table 20: Post Workshop COMPASS Results and Satisfying Program's Math Requirement (DV)

Post Workshop COMPASS Math Results	n	Satisfied Program's Math Requirement After Taking COMPASS (percentages)						
		Yes	No	Program Requires No Math	No Program on File	Did Not Test	Did Not Test & No Math Required	Did Not Test & No Program on File
Improved Score	78	20.5	43.6	30.8	5.1	0.0	0.0	0.0
Did Not Improve	20	5.0	35.0	45.0	15.0	0.0	0.0	0.0
Attended Workshop Before Testing	41	19.5	36.6	17.1	26.8	0.0	0.0	0.0
Did Not Retest After Workshop	72	11.1	40.3	31.9	16.7	0.0	0.0	0.0
No COMPASS on File	55	0.0	0.0	0.0	0.0	18.2	10.9	70.9
Total	266	12.4	32.0	23.7	11.3	3.8	2.3	14.7

Also, in Table 20 is every possible category for students and their program of study. For example, approximately 24% of students who attended a workshop (63 students) had a program of study that did not require any math, and 11% of students who attended a workshop (30 students) did not have a program of study on file at MathCC. Pertaining to the students who improved their COMPASS math score after attending a workshop, more than one student out of five satisfied their program's math requirement, more than two out of every five students (44%) still needed to take at least one math class, over 30% had a declared program on file that did not require any math level, and 5% did not have a program on file. Of the 20 students who did not improve their COMPASS math score, 45% of them had a program on file that required no math, and 15% did not have a program of study on file.

Pertaining to the 41 students who attended a workshop before taking the COMPASS math test, about 20% tested high enough to satisfy their program's math requirement, 37% still needed to complete at least one more math class, 17% had a program of study that required no math, and 27% did not have a program of study on file. For the 72 students who did not retest after attending a workshop, approximately 11% had already satisfied their program's math requirement, 40% still needed to take at least one math class, 32% had a program that required no math, and 17% did not have a program of study recorded on file.

For the 55 students who did not take the COMPASS test, the majority of them (70.9%) did not have a program of study on file, and only 18% had a program of study on file that required math, but they did not take the COMPASS math test by the end of this study. The percentage of students who satisfied their program's math requirement after taking the COMPASS math test statistically differed, with a large effect size, based on students' post workshop COMPASS math results, $\chi^2(24, N = 266) = 288.44$, $p < .001$, $V = .52$. Hence, post workshop COMPASS math results are good predictors for satisfying program's math requirements after taking the COMPASS math test. In summary, the majority of students who attended a workshop did not need to take the COMPASS math test for their program of study. However, of those that did need to take the COMPASS math test for their program of study, more than one in four took the COMPASS math test and satisfied their program's math requirement. These students did not have to enroll in any math courses at MathCC, unless they wanted to.

Workshops & Math Success

Does attending a placement preparation workshop (workshop) improve success in math classes?

Math enrollment and success. Of the 266 students who attended a workshop, 146 took a math class at some point. A total of 53% (141 of the 266 students) took a math class at MathCC after attending a workshop. The majority of these students, 49% (131 students), took a math class the semester after the workshop, including the fall semester as the subsequent semester to a student who attended a winter, spring, or summer workshop. Just over 1% (three students) attended a spring or summer workshop and skipped the fall semester to take a math course in the following winter semester. Fewer than 2% (five students) waited a full year before enrolling in a math class, and 47% (125 students) chose not to take any math classes after attending a workshop (see Table 21). Approximately 3% (four students), of the 125 students who did not take any math classes after attending a workshop, took at least one math class before attending a workshop.

Of the 141 students who attended a workshop, 56% enrolled in at least one math class and were successful in their math classes, earning a calculated math GPA greater than 2.0. A larger percentage of students who enrolled in a math class the semester after attending a workshop earned a cumulative math GPA greater than 2.0 compared to students who waited longer than one semester: approximately 57% of the 131 students who took a math class the next semester (including fall as the subsequent semester to winter, spring, and summer), a third of the students who attended a spring or summer workshop and skipped the fall, 40% of the students who waited exactly one year, and half of the students who waited longer than one year.

Although not reflected, but incorporated into the 1.0 range, are 19 students who enrolled in a math class the semester after attending a workshop, and two students who waited one year to enroll in a math class that earned a 2.0 cumulative math GPA. Combining these students with the students in the greater than 2.0 range gives 72% (94 students) of those who enrolled in a math class the semester after a workshop, and 80% (four students) of those who enrolled in a math class one year after attending a workshop, that earned a cumulative math GPA of 2.0 or higher.

In addition, more than one in five (21%) who took a math class the very next semester earned a cumulative math GPA in the 1.0 range, compared to three in five who waited one year to take a math class. And lastly, nearly one student out of every four (23%) who took a math class the semester after a workshop earned a cumulative math GPA of 1.0 or less, as did two-thirds of students who skipped the fall after attending a spring or summer workshop, and 50% of students who waited longer than one year to take a math class. The percentage of students who earned particular calculated math GPA ranges for the math classes taken statistically differed, with a small effect size, based on the amount of time after attending a workshop a student enrolled in a math class, $\chi^2(12, N = 141) = 21.18$, $p = .04$, $V = .22$.

Looking at the overall MathCC cumulative GPAs for these students, and 77% of the 131 students (101 students) who took a math class the next semester (including fall as the subsequent semester to winter, spring, and summer), two-thirds of the three students (two students) who attended a spring or summer workshop and skipped enrolling in the fall semester, four out of the five students (80%) who waited exactly one year, and half of the two students who waited longer than one year that earned an overall MathCC GPA greater than 2.0 (see Table 22).

Although not reflected, but incorporated into the 1.0 range, are seven students who enrolled in a math class the semester after attending a workshop, one student who attended a spring or summer workshop and skipped the fall semester to enroll in a winter semester class, and one students who waited one year to enroll in a math class, that earned a 2.0 cumulative math GPA. Combining these students with the students in the greater than 2.0 ranges gives 79% (108 students) who enrolled in a math class the semester after a workshop, 100% (all three students) who attended a spring or summer workshop and skipped the fall semester to enroll in a winter semester class, and 100% (all five students) who waited one year to enroll in a math class, that earned a cumulative math GPA of 2.0 or higher.

In addition, nearly 15% of students who took a math class the very next semester earned a cumulative math GPA in the 1.0 range, compared to one-third of students who attended a spring or summer workshop and enrolled in winter classes, and one out of every five students who waited one year to take a math class. And lastly, less than 10% of students (8%) who took a math class the semester after a workshop earned a cumulative math GPA of 1.0 or less, compared to 0% for students who skipped the fall semester or waited a full year and half of the two students who waited longer than a year to take a math class. The percentage of students who earned particular overall MathCC cumulative GPA ranges did not differ statistically based on the amount of time after attending a workshop a student enrolled in a math class, $\chi^2(12, N = 141) = 15.88, p = .23$. Hence the semester a student enrolled in a math class is a good predictor for overall cumulative MathCC GPAs.

Also not reflected in Table 22 are the 125 students who attended a workshop and did not enroll in a math class at MathCC from winter 2012 through fall 2013 semester. Of them, 5% (six students) earned a 0.0 MathCC cumulative GPA, 2% (two students) earned a GPA within the 0.0 range, 6% (seven students) earned a GPA within the 1.0 range, 16% (20 students) earned a GPA within the 2.0 range, 30% (38 students) earned a GPA within the 3.0 range ($3.0 < \text{GPA} \leq 4.0$), and 42% (52 students) did not enroll in any MathCC classes. In summary, of the students who attended a workshop and enrolled in a math class, 71% earned a cumulative math GPA of 2.0 or higher, and 82% had an overall MathCC GPA of 2.0 or higher.

Table 21: Math Class GPAs (DV) Based on Time Waited to Take a Math Class After Attending a Workshop

When a Workshop Attendee Enrolled in a Math Class	n	GPAs Earned in Enrolled Math Classes (percentages)				
		0.0	0.0<GPA≤1.0	1.0<GPA≤2.0	2.0<GPA≤3.0	3.0<GPA≤4.0
The Next Semester	131	11.5	10.7	20.6	33.6	23.7
Skipped Fall, Enrolled Winter	3	66.7	0.0	0.0	0.0	33.3
One Year	5	0.0	0.0	60.0	0.0	40.0
Longer than One Year	2	0.0	50.0	0.0	0.0	50.0
Total	141	12.1	10.6	21.3	31.2	24.8

Table 22: Cumulative MathCC GPAs (DV) Based on Time Waited to Take a Math Class After Attending a Workshop

When a Workshop Attendee Enrolled in a Math Class	n	Overall Cumulative MathCC GPAs (percentages)				
		0.0	0.0<GPA≤1.0	1.0<GPA≤2.0	2.0<GPA≤3.0	3.0<GPA≤4.0
The Next Semester	131	5.3	3.1	14.5	37.4	39.7
Skipped Fall, Enrolled Winter	3	0.0	0.0	33.3	33.3	33.3
One Year	5	0.0	0.0	20.0	20.0	60.0
Longer than One Year	2	0.0	50.0	0.0	0.0	50.0
Total	141	5.0	3.5	14.9	36.2	40.4

Math enrollment and satisfying program's math requirements. Approximately, 14% of the 141 students satisfied their program's math requirements by the end of this study's timeframe (see Table 23). In addition, 33% (46 students) had a program of study on file that did not require math, 7% did not have a program of study on file, and the remaining 47% have not satisfied their program's math requirement. Thus, by the end of this study, over 46% of the 141 students no longer had to take another math class at MathCC, with 45% of the 141 students coming from the group that took a math class in the semester following attending a workshop. The percentage of students who satisfied their program's math requirement after taking the COMPASS math test did not statistically differ as a result of when a student enrolled in a math class after attending a workshop, $\chi^2(18, N = 141) = 9.18$, $p = .96$. Hence the semester a student enrolled in a math class is not a good predictor for satisfying his or her program's math requirement after taking the COMPASS math test.

Table 23: Time Waited to Take a Math Class After Attending a Workshop and Satisfying Program's Math Requirement (DV)

When a Workshop Attendee Enrolled in a Math Class	n	Satisfied Program's Math Requirement After Taking COMPASS? (percentages)						
		Yes	No	Program Requires No Math	No Program on File	Did Not Test	Did Not Test & No Math Required	Did Not Test & No Program on File
The Next Semester	131	13.0	43.5	32.1	3.8	3.1	0.8	3.8
Skipped Fall, Enrolled Winter	3	33.3	33.3	33.3	0.0	0.0	0.0	0.0
One Year	5	20.0	20.0	40.0	0.0	20.0	0.0	0.0
Longer than One Year	2	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Total	141	13.5	43.3	31.9	3.5	3.5	0.7	3.5

Math enrollment for workshop attendees. Depending on students' program of study, and their results on the COMPASS math test, students may have had to take at least one math class. In total 36% of all 266 students (95 students) who still needed to take at least one math class to fulfill their program's math requirement after attending a workshop and taking or retaking the COMPASS math test – 32% (85 students) who took the COMPASS math test and 4% (10 students) who did not. Furthermore, one in eight students (12%, 33 students) tested out of their program's math requirement, approximately one in four students (24%, 63 students) had a program on file that did not require any math, 11% (30 students) did not have a program of study on file, 15% (39 students) did not have a program of study on file and did not take the COMPASS test, and 2% (six students) did not need to take any math at MathCC based on their program of study and did not take the COMPASS test (see Table 24). Over 36% (96 students) either tested out of their program's math requirement (33 students) or had a program of study on file that did not require any math (63 students). Regardless of whether or not a student needed to take a math class, all students had to decide whether or not they would take a math class.

Table 24: Workshop Attendees That Satisfied Their Program's Math Requirement After COMPASS Testing

Satisfied Program's Math Requirement	Frequency	Percent
Yes	33	12.4
No	85	32.0
Program Requires No Math	63	23.7
No Program on File	30	11.3
Did Not Test & No Program on File	39	14.7
Did Not Test & No Math Required	6	2.3
Did Not Test	10	3.8

Students who did not need more math. Table 24 shows that one student in eight (12.4%, 33 students) took the COMPASS math test and initially tested out of having to take any math classes, 24% (63 students) had a program of study that did not have a math entrance or math course completion requirement, and six students did not take the COMPASS math test but had a program of study on file that did not have a math entrance or course completion requirement. Thus, a total of 38% (102 students) did not need to take any math classes after attending a workshop.

A total of 66% (67 of the 102 students) chose to take at least one math class at MathCC. Fewer than 14% (9 of the 67 students) took at least one math class prior to taking the COMPASS math test, took (or retook) the COMPASS math test, and tested out of their program's math requirement. In addition, more than half (55%, 37 students) took one math class beyond their program of study's math requirement, just under 20% (13 students) took two, 9% (six students) took three, and 3% (two students) took four math classes (see Table 25). For the 37 students who took one math class beyond their program's requirement, 54% (20 students) had a calculated GPA higher than 2.0. For the students who took two additional math classes, 62% (eight of the 13 students) had a calculated math GPA higher than 2.0, as did 67% (four of the six students) who took three math classes beyond their program's requirement. And finally, the two students who took four math classes beyond their math requirement had a GPA within the 1.0 range. The percentage of cumulative math GPA ranges students earned after taking math classes at MathCC statistically differed, with a medium effect size, based on the number of math classes taken beyond their program of study's math requirement, $\chi^2(16, N = 67) = 30.57$, $p = .01$, $V = .34$. In other words, the math classes taken beyond a program's math requirement is a good predictor for GPAs earned in enrolled math classes.

In addition to the math enrollments, 97% (99 of the 102 students) enrolled in any class at MathCC, and 82% of them (82 students) earned an overall cumulative MathCC GPA greater than 2.0 (see Table 26). Furthermore, 46% of them (45 of the 99 students) had an overall college GPA greater than 3.0 and more than two in five students (41%) did not take any math classes beyond their math requirement. However, 85% of the 99 students (35 students) had a successful GPA greater than 2.0, and 56% (23 students) had an overall college GPA greater than 3.0. The percentage of overall cumulative MathCC GPA ranges students earned after taking MathCC classes did not differ statistically as a result of the number of math classes taken beyond their program of study's math requirement, $\chi^2(16, N = 99) = 22.37$, $p = .17$. Hence, math classes taken beyond a program's math requirement is not a good predictor for overall cumulative GPAs.

Table 25: Math Class GPAs Based on Math Courses Taken for Students who Did Not Need More Math Classes

Courses Beyond Requirement	n	GPAs Earned in Enrolled Math Classes (percentages)				
		0.0	0.0<GPA≤1.0	1.0<GPA≤2.0	2.0<GPA≤3.0	3.0<GPA≤4.0
Zero	9	0.0	33.3	0.0	55.6	11.1
One	37	21.6	5.4	18.9	27.0	27.0
Two	13	0.0	30.8	7.7	46.2	15.4
Three	6	0.0	0.0	33.3	50.0	16.7
Four	2	0.0	0.0	100.0	0.0	0.0
Total	67	11.9	13.4	17.9	35.8	20.9

Table 26: MathCC GPAs Based on Math Courses Taken for Students Who Did Not Need More Math Classes

Courses Beyond Requirement	n	Overall Cumulative MathCC GPAs (percentages)				
		0.0	0.0<GPA≤1.0	1.0<GPA≤2.0	2.0<GPA≤3.0	3.0<GPA≤4.0
Zero	41	0.0	0.0	14.6	29.3	56.1
One	37	10.8	5.4	10.8	29.7	43.2
Two	13	0.0	7.7	0.0	61.5	30.8
Three	6	0.0	0.0	0.0	66.7	33.3
Four	2	0.0	0.0	0.0	100.0	0.0
Total	99	4.0	3.0	10.1	37.4	45.5

Lastly, as a side-by-side comparison, the average calculated math GPA for the 67 students who took a math class beyond their requirement (including the nine students who tested out of math after taking at least one math class beforehand) is approximately 2.3 whereas the overall cumulative MathCC GPA for all 99 students was approximately 2.9 (see Table 27). Hence, according to this data, students who took at least one math class beyond a program's requirement experienced a negative impact on their overall MathCC GPA.

Table 27: Overall GPA and Calculated Math GPAs for Students Enrolled in MathCC Classes Versus Enrolled in Math Classes

Statistics	Overall GPA	Math GPA calculated
n	99	67
Mean	2.85420	2.28724
Std. Error of Mean	.096259	.156855
Median	2.98400	2.57100
Std. Deviation	.957767	1.283916
Variance	.917	1.648

Students who needed more math classes. Table 24 showed that 36% of all workshop attendees (95 students) either took the COMPASS math test (85 students), or did not (10 students), and still needed to take at least one additional math class to satisfy their program's math requirement.

A total of 72% (68 students) of these students chose to take at least one math class at MathCC. Fewer than 9% (six students) took one math class beyond their program's math requirement, four of which did not successfully complete that one class, one earned a grade of 1.0 or lower, and one earned a grade greater than 3.0. Three more of these students took two math courses beyond their program's math requirement, and all three successfully completed their math courses with a cumulative math GPA greater than 2.0. And finally, of the other 59 students who took at least one math class at MathCC, but did not take any math classes beyond their program's requirement, 22% (13 students) did not successfully earn a GPA greater than 1.0, 27% (16 students) earned a cumulative math GPA within the 1.0 range, and over half (30 students) earned a cumulative math GPA greater than 2.0 (see Table 28). The percentage of cumulative math GPA ranges students earned after taking math classes at MathCC did not differ statistically as a result of the number of math classes these students enrolled in beyond their program's math requirement, $\chi^2(8, N = 68) = 10.90$, $p = .20$.

In addition to the math enrollments, 99% of the 95 students (94 students) enrolled in any classes at MathCC (see Table 29). Almost three out of four (72%) had an overall cumulative MathCC GPA greater than 2.0, and 42% (39 of the 94 students) had an overall college GPA greater than 3.0.

Table 28: Math Class GPAs Based on Math Courses Taken for Students Who Needed More Math Classes

Courses Beyond Requirement	n	GPAs Earned in Enrolled Math Classes (percentages)				
		0.0	0.0<GPA≤1.0	1.0<GPA≤2.0	2.0<GPA≤3.0	3.0<GPA≤4.0
Zero	59	11.9	10.2	27.1	30.5	20.3
One	6	33.3	33.3	16.7	0.0	16.7
Two	3	0.0	0.0	0.0	33.3	66.7
Total	68	13.2	11.8	25.0	27.9	22.1

Table 29: MathCC GPAs Based on Math Courses Taken for Students Who Needed More Math

Courses Beyond Requirement	n	Overall Cumulative MathCC GPAs (percentages)				
		0.0	0.0<GPA≤1.0	1.0<GPA≤2.0	2.0<GPA≤3.0	3.0<GPA≤4.0
Zero	85	9.4	2.4	15.3	32.9	40.0
One	6	0.0	16.7	33.3	0.0	50.0
Two	3	0.0	0.0	0.0	33.3	66.7
Total	94	8.5	3.2	16.0	30.9	41.5

Although 90% (85 students) did not take any math classes beyond their math requirement, 73% (62 of the 85) had a successful GPA greater than 2.0, and 40.0% (34 students) had an overall college GPA greater than 3.0. The percentage of overall cumulative MathCC GPA ranges students earned after taking classes at MathCC did not differ statistically as a result of the number of math classes these students enrolled in beyond their program's math requirement, $\chi^2(8, N = 94) = 8.77$, $p = .36$. In other words, math courses taken beyond a program's math requirement is not a good predictor for overall cumulative GPAs.

Lastly, see Table 30 as a side-by-side comparison; the average calculated math GPA for the 68 students who took a math class is approximately 2.3 whereas the overall cumulative MathCC GPA for all 94 students was approximately 2.6. Hence, according to this data, students who took at least one math class beyond a program's requirement experienced a negative impact on their overall MathCC GPA.

Table 30: Overall GPA and Calculated Math GPAs for Students Enrolled in MathCC Classes Versus Math Classes for Students Who Needed More Math Classes

Statistics	Overall GPA	Calculated Math GPA
n	94	68
Mean	2.60030	2.25603
Std. Error of Mean	.115164	.155676
Median	2.89900	2.14300
Std. Deviation	1.116555	1.283737
Variance	1.247	1.648

No program on file. Table 24 shows that 26% of all workshop attendees (69 students) did not have a program of study on file. Almost 16% (11students) of them took at least one math class at MathCC, 64% (seven students) earned a calculated math GPA greater than 3.0, 18% (two students) had a GPA within the 2.0 range, and 18% (two students) had a 2.0 math GPA or less (see Table 31). Furthermore, 30% (21 of the 69 students) enrolled in classes at MathCC sometime from fall 2011 to fall 2013. The majority earned a cumulative overall MathCC GPA greater than 2.0, over half (52%, 11 students) with a GPA greater than 3.0, and just under one quarter (24%, 5 students) with a GPA in the 2.0 to 3.0 range.

Lastly, Table 32 gives a side-by-side comparison; the average calculated math GPA for the 11 students who took a math class is approximately 3.3 whereas the overall cumulative MathCC GPA for all 21 students was approximately 2.9. Hence, according to this data, the students who did not have a program of study on file and that took at least one math class experienced a positive impact on their overall MathCC GPA.

Table 31: Math and Overall GPA Ranges for Students with No Program on File

	Math GPA		Overall GPA	
GPA Range	Frequency	Percent	Frequency	Percent
0.0	0	0.0	1	4.8
$0.0 < GPA \leq 1.0$	1	9.1	1	4.8
$1.0 < GPA \leq 2.0$	1	9.1	3	14.3
$2.0 < GPA \leq 3.0$	2	18.2	5	23.8
$3.0 < GPA \leq 4.0$	7	63.6	11	52.4
Total	11	100.0	21	100.0

Table 32: Overall GPA and Calculated Math GPAs for Students Enrolled in MathCC Classes Versus Math Classes for Students Who Needed More Math

Statistics	Calculated Math GPA	Overall GPA
n	11	21
Mean	3.30300	2.87019
Std. Error of Mean	.340708	.242758
Median	4.00000	3.29500
Std. Deviation	1.130000	1.112456
Variance	1.277	1.238

In summary, students who did not have a program of study on file had overall average calculated math GPAs and overall MathCC GPAs higher than students who did or did not need more math classes after taking the COMPASS math test. However, students who did not need more math classes after taking the COMPASS math test, and did take math classes, had higher calculated math GPAs and slightly higher overall GPAs than students who needed more math after taking the COMPASS math test.

Developmental math. Recall from Table 18 that of the 211 students who had a COMPASS math score on file, 87% initially tested into developmental mathematics (34% into Pre-Algebra and 53% into Beginning Algebra). After retesting and accepting students' highest COMPASS math score, 72% placed into developmental mathematics (21% into Pre-Algebra and 51% into Beginning Algebra). In other words, developmental math placement rates are lower when using students' highest COMPASS math scores, and both initial and highest COMPASS math scores have developmental placement rates lower than MathCC's 93% overall developmental math placement rate; however, both percentages are higher than the national average of 60% (Collins, 2009).

Pre-Algebra. Of the 21% who earned Pre-Algebra as their highest placement level (45 students), 53% (24 students) were required to pass that course, an equivalent level math course, or a higher-level math course (see Table 33). Furthermore, a total of 23 workshop students enrolled in Pre-Algebra during this study's timeframe. Eighteen of these students earned Pre-Algebra as their highest math placement, four earned a higher math placement level, and one did not have a COMPASS math score on file.

Table 33: Workshop Students Who Placed or Enrolled in Pre-Algebra

Must complete	Pre-Algebra Placement	Pre-Algebra Placement Percent	Enrolled in Pre-Algebra	Enrolled in Pre-Algebra Percent
Pre-Algebra or Equivalent	2	4.4	0	0.0
Higher than Pre-Algebra	22	48.9	16	69.6
No Math	9	20.0	5	21.7
No Program on File	12	26.7	2	8.7

Of the students who enrolled in Pre-Algebra, 70% (16 students) needed to pass Pre-Algebra and at least one more math course higher than Pre-Algebra based on their program of study. The remaining students who enrolled in Pre-Algebra either did not need to take a math class (22%) or did not have a program of study on file (9%). Overall, 61% passed Pre-Algebra with a C grade or better. This is much higher (22 percentage points) than MathCC's 39% average fall 2011 through fall 2013 pass rate. Of the remaining students, 13% earned a D grade, 13% earned an E grade, and 13% dropped.

Looking at the retention rates for these 23 students, two enrolled in Pre-Algebra in the winter 2012 semester, and both of them were retained to the next semester and a year later (FA12 and WI13) (see Table 34). Three students enrolled in Pre-Algebra in the fall 2012 semester, two-thirds of them were retained to the next semester (WI13), and none were retained a year later. Three students enrolled in Pre-Algebra in the winter 2013 semester and two-thirds of them were retained to the subsequent fall semester. Three students enrolled in Pre-Algebra in the spring 2013 semester and all of them were retained to the fall 2013 semester. Finally, one student took Pre-Algebra in the summer 2013 and enrolled in fall 2013 classes, and the remaining eleven students who took Pre-Algebra took it in the fall 2013 semester.

Table 34: Retention Rates for Pre-Algebra Enrolled Students

First Semester		Subsequent Semesters Enrolled at MathCC (percentages)						
	n	SP12	SU12	FA12	WI13	SP13	SU13	FA13
WI12	2	0.0	50.0	100	100	50.0	0.0	0.0
FA12	3				66.7	33.3	33.3	0.0
WI13	3					66.7	33.3	66.7
SP13	3						33.3	100
SU13	1							100

Of the 23 students who attempted Pre-Algebra, only 13% (three students) enrolled in Beginning Algebra in a following semester, one third of which earned a passing grade in Beginning Algebra and continued into Intermediate Algebra to earn an A grade. For the other two students, one earned an E grade and the other dropped their Beginning Algebra class. Every student in this sample, including the student who persisted to earn an A in Intermediate Algebra, still had at least one more math class at MathCC to successfully complete after fall 2013 based on their program of study. These numbers are too small to draw conclusions; however, 4% (one of 23 students) persisted from Pre-Algebra to successfully complete Beginning Algebra and the developmental sequence at MathCC. Similarly, 4% (one of 23 students) persisted from Pre-Algebra to enroll in and successfully complete a college level math class (Intermediate Algebra). And finally, of the 12 students who enrolled in a Pre-Algebra class, 83% of them (10 students) were retained to the next full length 15-week fall or winter semester. And although year-to-year retention rates can only be measured for the winter and fall 2012 semesters, a total of 40% out of the 5 students who took Pre-Algebra in these semesters were retained one full year later.

Beginning Algebra. Of the 51% who earned Beginning Algebra as their highest math placement level (107 students), 51% (55 students) were required to pass that course, an equivalent level math course, or a higher math course (see Table 35). Furthermore, a total of 59 workshop students enrolled in Beginning Algebra during this study's timeframe. Forty-nine of these students earned Beginning Algebra as their highest math placement, three earned a higher math placement level, six earned a Pre-Algebra placement level (only two of which enrolled in and passed Pre-Algebra) and one did not have a COMPASS math score on file.

Table 35: Required Math Courses for Students Placing into Beginning Algebra

Must complete	Beginning Algebra Placement	Beginning Algebra Placement Percent	Enrolled in Beginning Algebra	Enrolled in Beginning Algebra Percent
Beginning Algebra or Equivalent	12	11.2	9	15.3
Higher than Beginning Algebra	43	40.2	26	44.1
None	37	34.6	22	37.3
No Program on File	15	14.0	2	3.4

Of the students who enrolled in Beginning Algebra, 15.3% (9 students) actually needed to pass Beginning Algebra, and 44% (26 students) needed to pass Beginning Algebra and at least one more math course higher than Beginning Algebra based on their program of study. The remaining students who enrolled in Beginning Algebra either did not need to take a math class (37%) or did not have a program of study on file (3%). Of the 59 students who enrolled in Beginning Algebra, three out of every four (44 students) passed with a C or better. This is much higher (almost 28 percentage points) than MathCC's 47% average fall 2011 through fall 2013 pass rate. Of the remaining students, 9% earned a D grade, 5% earned an E grade, and 12% dropped.

Looking at the retention rates for these 59 students, two students enrolled in Beginning Algebra in the winter 2012 semester, and 100% were retained to the next semester, the fall semester, and a year later (FA12 and WI13) (see Table 36).

Table 36: Retention Rates for Beginning Algebra Enrolled Students

First Semester	n	Semesters Enrolled at MathCC (percentages)						
		SP12	SU12	FA12	WI13	SP13	SU13	FA13
WI12	2	50.0	0.0	100	100	50.0	50.0	100
SP12	3		0.0	66.7	66.7	33.3	0.0	66.7
FA12	14				100	50.0	21.4	85.7
WI13	7					57.1	14.3	57.1
SP13	3						66.7	33.3
SU13	2							100

Three students enrolled in Beginning Algebra in the spring 2012 semester, two-thirds were retained to the fall 2012 and winter 2013 semester, and two-thirds over a year later to the fall 2013 semester. Fourteen students enrolled in Beginning Algebra in the fall 2012 semester, all 100% were retained to the next semester (WI13), half were retained to the spring, and 86% were retained a year later. Seven students enrolled in Beginning Algebra in the winter 2013 semester and 57% of them were retained to the spring and fall 2013 semesters. Three students enrolled in Beginning Algebra in the spring 2013 semester and two-thirds were retained to the summer and one-third to the fall 2013 semesters. Finally, two students took Beginning Algebra in the summer 2013 and enrolled in fall 2013 classes, and the remaining 28 students took it in the fall 2013 semester. In summary, of the 31 students who enrolled in a Beginning Algebra class, 81% of them (25 students) were retained to the next full length 15-week fall or winter semester. And although year-to-year retention rates can only be measured for the winter, spring, and fall 2012 semesters, a total of 79% out of the 19 students who took Beginning Algebra in these semesters were retained one full year later.

Of the 59 students who attempted Beginning Algebra, 17% (ten students) enrolled in Intermediate Algebra in a following semester, 70% (seven students) of which earned a B or better grade in Intermediate Algebra (see Table 37). Furthermore, 43% of the seven students (three students) continued to take one additional college level math courses, one earned an A grade, one earned a B grade, and one earned a D grade.

Table 37: Beginning Algebra Enrolled Students' Subsequent Math Class Grades

Grades	Intermediate Algebra	Percent	Higher-level Math	Percent
A	4	40.0	1	33.3
B	3	30.0	1	33.3
D	3	30.0	1	33.3

Of the 59 students who enrolled in Beginning Algebra, 10% (six students) successfully completed Beginning Algebra and did not need to take any more math classes (six of the nine that needed Beginning Algebra or Equivalent). Of the 26 students who needed to take and pass a math class higher than Beginning Algebra, 31% (eight students) also needed to take and pass Intermediate Algebra. By the end of the fall 2013 semester, none had done so. Hence, all 26 students still needed to take and pass at least one more math class beyond the fall 2013 semester. In summary, three out of every four students (44 of the 59 students) passed Beginning Algebra with a C or better to advance on to be Intermediate Algebra eligible – college level eligible, 17% (ten students) persisted on to take Intermediate Algebra, and 70% of them (seven of the ten, or 12% of the 59) successfully completed Intermediate Algebra with a C or better. The Beginning Algebra pass rate for these students is much higher than the 47% pass rate for all Beginning Algebra students.

Workshops & Demographics

The average age for a student who attended a workshop was 26 years old; the median was 20 years old. In addition, approximately 3% of workshop attendees were younger than 17, 47% were from 17 to 20, 21% were from 21 to 30, 12% were from 31 to 40, 8% were from 41 to 50, and 6% were older than 50 years of age (see Table 38).

Table 38: Age Ranges for Students Who Attended a Workshop

Age Category	Frequency	Percent
<17	8	3.0
17-20	126	47.4
21-30	57	21.4
31-40	31	11.7
41-50	22	8.3
>50	15	5.6
Not Reported	7	2.6

Recall from Table 22 that 98 of these students had an initial COMPASS math score on file, and retook the COMPASS math test after attending a workshop. Nearly three out of every four (72%) were younger than 21 years of age. In addition, of those that improved their score, 73% were under the age of 21, as were 70% of those who did not improve their score. And of the 53 students that improved their mathematics level (52 of which did so after attending a workshop), 70% were under the age of 21 (including the one student who improved his or her placement level prior to attending a workshop), as were 76% of the 45 students who did not improve their placement level (see Table 39). The percentage of students who improved their mathematics placement by at least one level did not differ statistically as a result of their age group, $\chi^2(4, N = 98) = 4.76, p = .33$.

Table 39: Improved Placement Level After Attending a Workshop (DV) Based on Age

Improved At Least One Level	n	Age Group (percentages)				
		<17	17-20	21-30	31-40	41+
Yes	53	1.9	67.9	20.8	5.7	3.8
No	45	8.9	66.7	15.6	8.9	0.0
Total	98	5.1	67.3	18.4	7.1	2.0

Nearly double the number of females compared to males attended a placement preparation workshop – 62% compared to 38%, respectively (101 males and 165 females). Recall from Table 19 that 98 of these students had an initial COMPASS math score on file, and retook the COMPASS math test after attending a workshop. A total of 45% and 55% were males and females, respectively (see Table 40). Overall, 45% of the students who improved their placement math score were males and 55% were females. On the other hand, of the 53 students who improved their math placement by at least one level, 53% were males and 47% were females. In other words, a greater percentage of females improved their COMPASS math score, but males were more likely to improve their placement level. The percentage of students who improved their mathematics placement by at least one level did not differ statistically as a result of the gender of students, $\chi^2(1, N = 98) = 2.94, p = .33$.

Table 40: Improved Placement Level After Attending a Workshop (DV) Based on Gender

Improved At Least One Level	n	Gender (percentages)	
		Male	Female
Yes	53	52.8	47.2
No	45	35.6	64.4
Total	98	44.9%	55.1%

Finally, according to the linear regressions test with independent variables of gender and age, and dependent variable of an improved math placement level after attending a workshop (see Table 41), gender had a small, not significant, effect on improving placement levels after attending a workshop, $\beta = -.18$, $t(98) = -1.73$, $p = .25$. The effect was small, and does not explain a significant proportion of variance in improving placement levels, $R^2 = .034$, $F(2, 98) = 1.65$, $p = .20$.

Table 41: Linear Regression Test on an Improved Placement Level After Attending a Workshop Dependent on Gender and Age

	Unstandardized Coefficients		Standardized Correlation Coefficient		
Category	B	Std. Error	Beta	t	Sig.
(Constant)	.710	.234		3.040	.003
Gender	-.175	.101	-.175	-1.734	.086
AGE	.005	.008	.061	.063	.548

Review Courses & College Success

Does enrolling in a three-week placement review course (review course) improve overall college success?

Enrollment. A total of 35 students enrolled in one of MathCC's winter 2013 three-week review courses (review courses), less than half (49%, 17 students) enrolled in the Pre-Algebra and more than half (51%, 18 students) enrolled in the Beginning Algebra review course. Upon completion of the three-week placement review course, students had the option to keep their pre-registered 12-week math class, or drop their math class to either take a higher-level math class that they tested into, or not take any math for the remaining 12 weeks of the semester. Of the 35 students, 91% (32 students) took a 12-week winter 2013 math class – nearly one in three students (31%, ten students) of which took Pre-Algebra, two in three students (66%, 21 students) took Beginning Algebra, and the remaining 3% (one student) took Intermediate Algebra. The remaining three students, of the 35 total, dropped their 12-week math course – one because they tested out of their program of study's math requirement, and the other two because they dropped their review course.

Retention. Of the 35 students who initially enrolled in a review course, less than three in ten students (29%) enrolled in a spring 2013 class, one student in five enrolled in a summer (SU13) class, and less than half (46%, 16 students) enrolled in a fall (FA13) class (see Table 42). Of the 17 students who started in the Pre-Algebra review course, 41% enrolled in the spring and fall 2013 semester, and 35% enrolled in the summer 2013 semester. Of the 18 students who started in the Beginning Algebra review course, 17% enrolled in spring 2013 classes, 6% in summer 2013 classes and 50% in fall 2013 classes.

Table 42: Review Course Semester-to-Semester Retention Rates

Category	n	Semesters Enrolled (percentages)			
		WI13	SP13	SU13	FA13
Overall Three-Week Review Course	35	100.0	28.6	20.0	45.7
Pre-Algebra Review Course	17	100.0	41.2	35.3	41.2
Beginning Algebra Review Course	18	100.0	16.7	5.6	50.0
Pre-Algebra 12-Week Math Class	10	100.0	30.0	40.0	20.0
Beginning Algebra 12-Week Math Class	21	100.0	19.0	14.3	57.1
Intermediate Algebra 12-Week Math Class	1	100.0	100.0	100.0	0.0

Of the 10 students who took Pre-Algebra, 30%, 40%, and 20% enrolled in the spring, summer, and fall 2013 semesters, respectively. Of the 21 students who took Beginning Algebra, 19%, 14%, and 57% enrolled in the spring, summer, and fall 2013 semesters, respectively. And finally, the one student who took Intermediate Algebra continued to take spring and summer classes at MathCC. Represented in the overall three-week review course row, in Table 42, are the three students who did not take a 12-week math class. Two of these three students did enroll in spring and fall 2013 classes, and one of these two took a summer 2013 class.

Splitting out retention of the review course and 12-week math course by grades earned, and of the 35 who enrolled in a review course, 80% (28 students) passed, 11% (four students) failed, 6% (two students) dropped, and 3% (one student) never attended their three-week placement review course (see Table 43). Of the 28 who passed their review course, 29%, 18%, and 50% enrolled in a spring, summer, and fall 2013 class, respectively. On the other hand, only one of the four students (25%) who failed their review course enrolled in a spring, summer, or fall 2013 semester.

Table 43: Review Course Students' Retention Rates Based on Review Course Grades

Review Course Grades	n	Semesters Enrolled (percentages)		
		SP13	SU13	FA13
Pass	28	28.6	17.9	50.0
Fail	4	25.0	25.0	25.0
Drop	2	50.0	50.0	50.0
Never Attended	1	0.0	0.0	0.0

Similarly, one of two students who dropped their review course ended up enrolling in spring, summer, and fall 2013 classes. The one student who registered for a review course, and never attended a class session did not re-enroll in any classes at MathCC by the end of this study. In summary, students who enrolled in a review course had a winter-to-fall retention rate (46%) slightly higher than the overall MathCC winter-to-fall retention rate range (29% to 42%) and much higher than the winter-to-fall retention rate range for all students after their first semester enrolled in a developmental math course (27% to 32%). The same is true for all Beginning Algebra review course and 12-week math class students; however, the Pre-Algebra review course students had a winter-to-fall retention rate within the overall MathCC retention rate range, and students who took a 12-week Pre-Algebra or Intermediate Algebra course had retention rates lower than MathCC's overall retention rate and the retention rate for students' first semester enrolling in a developmental class.

In terms of grades, 39% of the 32 students who took a 12-week math class passed their class with a C grade or better, and 39%, 39%, and 75% enrolled in a spring, summer, or fall 2013 semester, respectively (see Table 44). On the other hand, 15%, 5%, and 25% of the 19 students who failed, dropped, or never attended their 12-week math class enrolled in a spring, summer, or fall 2013 class, respectively.

In summary, the winter-to-fall retention rate for the 12-week students who passed their course was 69% (9 of 13 students), was 26% for students who did not pass (5 out of 19 students), and was 42% overall for all 32 12-week students. None of these results were statistically significant; however, the retention rate for students who passed their 12-week course was much higher than MathCC's overall and developmental math retention rates.

Table 44: Review Course Students' Retention Rates Based on 12-Week Course Grades

12-week Course Grades		Semesters Enrolled (percentages)		
	n	SP13	SU13	FA13
A	1	0.0	0.0	100.0
B	9	33.3	33.3	66.7
C	3	66.7	66.7	66.7
E	9	11.1	0.0	22.2
Drop	7	28.6	14.3	28.6
Never Attended	3	0.0	0.0	33.3

Overall MathCC success. Thirty-four of the 35 students (97%) who enrolled in a three-week placement review course enrolled in at least one more class at MathCC after the review course. By the end of the fall 2013 semester, the average cumulative GPA at MathCC for these students was approximately 1.6, with a median GPA of approximately 1.8, and a standard deviation of approximately 1.3. Furthermore, approximately 21% of these students had an overall college GPA of 0.0, 27% had a GPA within the 0.0 range, 9% had an overall college GPA in the 1.0 range, 32% had a GPA in the 2.0 range, and 12% had a GPA greater than 3.0 (see Table 45). Overall, 44% (15 students) had a cumulative MathCC GPA greater than a 2.0. And not included in Table 45 are the two students who had an overall cumulative MathCC GPA of exactly 2.0 – hence, half of the students who enrolled in at least one additional MathCC class earned a cumulative MathCC GPA of 2.0 or greater. Furthermore, 46% of the 28 students who passed the review course also had an overall cumulative MathCC GPA greater than 2.0 at the end of the fall 2013 semester. On the other hand, 12 students (43%) earned a passing grade in their three-week review course but by the end of the fall 2013 semester had an overall cumulative GPA of 1.0 or less. Finally, two students, by the end of the fall 2013 semester, had a cumulative MathCC GPA greater than a 3.0, but either dropped or failed their review course. The percentage of overall cumulative MathCC GPA ranges students earned after taking classes at MathCC did not differ statistically as a result of the grades that were earned in a review course, $\chi^2(12, N = 34) = 15.64$, $p = .22$; hence, review course grades are not good predictors for overall MathCC GPA ranges.

There were 32 students who took a 12-week math course. Looking at these 12-week math courses and students' cumulative MathCC GPA, Table 46 shows that students with higher 12-week course grades had higher overall cumulative MathCC GPAs. In addition, 31% (10 students) earned at least a C in their 12-week math course and had an overall MathCC cumulative GPA of 2.0 or greater, which is lower than the average pass rates of 42% for all MathCC developmental mathematics courses. Of the 19 students who did not pass their 12-week math course, only 16% (three students) had a cumulative MathCC GPA that was not a 1.0 or less, but rather were in the 2.0 range. The percentage of overall cumulative MathCC GPA ranges students earned after taking classes at MathCC did differ statistically, with a large effect size, as a result of the grades students earned in 12-week math courses, $\chi^2(20, N = 32) = 41.92$, $p = .003$, $V = .57$; hence, 12-week math course grades are good predictors for overall MathCC GPA ranges.

Table 45: Overall MathCC GPA Ranges, Based on Review Course Grades, for Students Who Took at Least One Additional Class

Review Course Grade	n	Overall MathCC GPA Range (percentages)				
		0.0	0.0<GPA≤1.0	1.0<GPA≤2.0	2.0<GPA≤3.0	3.0<GPA≤4.0
Pass	28	17.9	25.0	10.7	39.3	7.1
Fail	4	25.0	50.0	0.0	0.0	25.0
Drop	1	0.0	0.0	0.0	0.0	100.0
Never Attended	1	100.0	0.0	0.0	0.0	0.0
Total	34	20.6	26.5	8.8	32.4	11.8

Table 46: Overall MathCC GPA Ranges for Students Who Took a 12-Week Math Class

12-Week Course Grade	n	Overall MathCC GPA Range (percentages)				
		0.0	0.0<GPA≤1.0	1.0<GPA≤2.0	2.0<GPA≤3.0	3.0<GPA≤4.0
A	1	0.0	0.0	0.0	100.0	0.0
B	9	0.0	0.0	11.1	77.8	11.1
C	3	0.0	0.0	66.7	0.0	33.3
E	7	44.4	55.6	0.0	0.0	0.0
Drop	9	28.6	28.6	0.0	42.9	0.0
Never Attended	3	33.3	66.7	0.0	0.0	0.0
Total	32	21.9	28.1	9.4	34.4	6.3

Review Course & Placement

Does enrolling in a three-week placement review course (review course) improve college math placement?

Improved score or level. More than three out of every four students (77%, 13 students) who took the Pre-Algebra and less than half (44%, 8 students) who took the Beginning Algebra review courses improved their COMPASS test score; thus, 60% of the students who took a review course improved their COMPASS math score (see Table 47). The percentage of students who improved their mathematics placement score did not differ statistically as a result of three-week review courses, $\chi^2(4, N = 35) = 8.37, p = .053$, and hence enrolled in a review course is not a good predictor for improving COMPASS math scores. On the other hand, of the 27 students who had a COMPASS math score on file before taking a review course, and retook the COMPASS math test, 78% improved their score.

Table 47: Review Courses and Improving COMPASS Math Scores (DV)

Review Course	n	Improved COMPASS Math Score (percentages)				
		Yes	No	Did Not Retest	First Score	No Score on File
Pre-Algebra	17	76.5	0.0	11.8	5.9	5.9
Beginning Algebra	18	44.4	33.3	16.7	0.0	5.6
Total	35	60.0%	17.1%	14.3%	2.9%	5.7%

However, improving a COMPASS math score doesn't always translate to a higher-level math placement. Looking at the 77%, or 27 students from Table 48 that had a pre-COMPASS math score on file (Yes or No columns), only 37% (ten students) improved their math placement level (see Table 49). Hence, only 48% (10 students) of the 21 students who improved their COMPASS math score actually improved their placement level. The majority of the students who improved their placement level took the Pre-Algebra review course, where 54% of the 13 students who had a pre-COMPASS math score on file improved their placement by one level to be Beginning Algebra eligible.

Table 48: Review Courses and Number of Mathematics Levels Improved (DV)

Review Course	n	Levels Improved (percentages)		
		Zero	One	Two
Pre-Algebra	13	46.2	53.8	0.0
Beginning Algebra	14	78.6	14.3	7.1
Total	27	63.0%	33.3%	3.7%

Furthermore, there was one student who enrolled in the three-week Pre-Algebra review course that did not have an initial COMPASS test score on file. Upon testing at the end of the three-week review course, this student improved his or her score enough to place two levels higher than Pre-Algebra. Including this student with those that did place higher, and overall 41% of the review course students who had an initial COMPASS math score on file improved their math placement level at the end of the three-week placement review course. A question that cannot be answered in this study, but is worth stating, is if this student would have taken the COMPASS math test prior to the review course, would the student have needed to take the review course? The percentage of students who improved their mathematics placement level did not differ statistically as a result of three-week review courses, $\chi^2(2, N = 27) = 5.22, p = .07$, and hence the enrolled review course is not a good predictor for the number of mathematics levels improved.

Splitting all review course students up in terms of grades earned in the three-week placement review courses and levels improved after taking the COMPASS test at the end of the three-week period, 32% of the students who passed their review course improved their placement level by one math course. Again, there was one student who passed the three-week review course, took the COMPASS math test at the end of the three-week period, and tested two levels higher; this student is included in the Zero column in Table 49. In addition, there was one student who dropped his or her review course, but took the initiative to retake the COMPASS test and improved his or her mathematics placement by two levels. Every student who failed or never attended the three-week review course did not have a COMPASS math test score on file, and did not take the test at the end of the three weeks. The percentage of students who improved their placement levels statistically differed, with a large effect size, based on the grades students earned in a review course, $\chi^2(9, N = 35) = 39.69, p = .01, V = .62$. Hence, grades earned in a review course are a good predictor of the number of levels improved after taking the COMPASS test after the review course.

Table 49: Review Course Grades and Number of Mathematics Levels Improved (DV)

Grade	n	Levels Improved (percentages)			
		Zero	One	Two	Did Not Test
Pass	28	60.7	32.1	0.0	7.1
Fail	4	0.0	0.0	0.0	100.0
Drop	2	0.0	0.0	50.0	50.0
Never Attended	1	0.0	0.0	0.0	100.0
Total	35	48.6%	25.7%	2.9%	22.9%

Satisfied program's math requirement. At the end of the review course's three week period, 11% (four students) satisfied their program's math requirement and 60% (21 students) did not as a result of their COMPASS math test score (see Table 50). The remaining 23% and 6% had a program of study on file that did not require math and did not have a specified program of study on file, respectively. Furthermore, although the percentage of students who satisfied their program's math requirement did not differ statistically as a result of three-week review courses, $\chi^2(3, N = 35) = 5.91, p = .12$, three of the four students who satisfied their program's math requirement were in the Pre-Algebra review course, which represents 18% of the Pre-Algebra students, and one student in Beginning Algebra satisfied his or her program's math requirement, 6% of the Beginning Algebra students. The enrolled review course is not a good predictor to satisfying math requirements.

Table 50: Review Courses and Satisfying Program's Math Requirement (DV)

Three-Week Review Course	n	Satisfied Program's Math Requirement (percentages)			
		Yes	No	Not Applicable	No Program on File
Pre-Algebra	17	17.6	70.6	5.9	5.9
Beginning Algebra	18	5.6	50.0	38.9	5.6
Total	35	11.4%	60.0%	22.9%	5.7%

Review Course & Math Success

> *Does enrolling in a three-week placement review course (review course) improve success in math classes?*

Math enrollment and math success. Thirty-five students registered to take a Pre-Algebra or Beginning Algebra review course, 80% of them (28 students) successfully completed the review course, 11% (four students) failed, 6% (two students) dropped, and 3% (one student) never attended a review course session.

Removing the two students who dropped their review class (and their co-requisite late start 12-week winter 2013 math class), the one student who never attended the review class, and the one student who dropped the co-registered 12-week math class because the student tested two levels higher and out of the program's math requirement, there were a total of 31 students (89% of the original 35) who enrolled or kept their enrollment in a 12-week winter 2013 math class (see Table 51). Of these 31 students, 29% (9 students) stayed in Pre-Algebra, 68% (21 students) enrolled or stayed in Beginning Algebra and 3% (1 student) enrolled in Intermediate Algebra for the final 12-weeks of the winter 2013 semester. Furthermore, 44% passed Pre-Algebra and 43% passed Beginning Algebra with a C grade or better. Overall, 42% of students who took a 12-week math course passed their class with a C or better. The one student who tested into Intermediate Algebra, and enrolled in Intermediate Algebra for the winter 2013 12-week session, failed the class with an E grade. The percentage of students who earned particular grades in their 12-week math course did not differ statistically as a result of the 12-week math course in which they were enrolled, $\chi^2(18, N = 31) = 37.89, p = .11$. However, these results are nearly the same as MathCC's overall developmental math pass rate of 42%.

Table 51: Final 12-Week Math Courses Taken and Earned Grades

12-Week Math Course Grades	Review Course Grades (percentages Pass	Fail	12-Week Math Course (percentages) Pre-Algebra	Beginning Algebra	Intermediate Algebra
A	3.7	0.0	0.0	4.8	0.0
B	33.3	0.0	44.4	23.8	0.0
C	7.4	25.0	0.0	14.3	0.0
E	33.3	0.0	22.2	28.6	100.0
Drop	18.5	50.0	22.2	23.8	0.0
Never Attend	3.7	25.0	11.1	4.8	0.0
n	*27*	*4*	*9*	*21*	*1*

Analyzing student grades in the review course versus the 12-week math course, 42% (13 students) passed their three-week review course and earned a C grade or greater in their 12-week math course. A total of 23% (seven students of the 31) dropped their 12-week math course (five that passed and two that failed the review course), 29% (nine students) failed their 12-week math course (the 33% of 27), and 7% (two students) never attended their 12-week math course (one that passed and one that failed the review course). Overall, 58% (18 of the 31 students) did not successfully complete their 12-week math course, which includes 15 students who passed their three-week placement review course. The percentage of students who earned particular grades in their 12-week math course did not differ statistically as a result of the grades these students earned in their review course, $\chi^2(5, N = 31) = 7.91, p = .19$.

Beyond the winter 2013 semester, 17% (six students) of the original 35 students enrolled in a spring 2013 math course after taking a three-week placement review course. A third of them enrolled in Technical Math I, which has the same placement level as Beginning Algebra, and two-thirds of them (four students) enrolled in Intermediate

Algebra. None of the 35 students enrolled in a summer 2013 math course. All six of these students earned passing grades in their review course, but only half of them successfully completed their spring 2013 course with a grade of C (see Table 52). Two of the four that passed were in Intermediate Algebra, and the other student was in a Technical Math I class. The other three students dropped their spring 2013 math class.

Table 52: Spring 2013 Math Course Grades (DV) Corresponding to Winter 2013 Review and 12-Week Math Course Grades (percentages)

Spring 2013 Math Grades	Pass Winter 2013 Review Course[a]	Winter 2013 12-Week Math Grades[b]			
		B	C	E	Drop
C	50.0	100.0	0.0	0.0	0.0
Drop	50.0	0.0	100.0	100.0	100.0
n	*6*	*3*	*1*	*1*	*1*

Looking at these six students in terms of their winter 2013 12-week math class, the three who passed their spring math class earned a B grade in their winter math class. One student earned a C grade in his or her 12-week winter class, but dropped the spring math class, and the other two students dropped their spring class after having dropped or failed their winter 12-week math class. The sample size is small, and the percentage of spring 2013 math grades that students earned did not differ statistically as a result of the grades earned in a 12-week winter 2013 math class, $\chi^2(3, N = 6) = 6.00, p = .10$.

Continuing to the fall 2013 semester, 17% (six of the original 35 students) enrolled in a fall 2013 math course, 17% of which (one student) self-selected to enroll in Basic Mathematics, 17% (one student) enrolled in Beginning Algebra, 50% (three students) in Intermediate Algebra, and 17% (one student) in College Algebra. For the six students who registered for a fall class, all of them passed their three-week winter 2013 review course, but only one third of them (two students) passed their fall math class with a B grade (see Table 53). The other four students did not pass their fall 2013 math class, with half earning an E grade, and 17% (one student) dropped his or her fall 2013 math class.

Table 53: Fall 2013 Math Course Grades (DV) Corresponding to Winter 2013 Review and 12-Week Math Course Grades (percentages)

Fall 2013 Math Grades	Pass Winter 2013 Review Course[a]	Winter 2013 12-Week Math Grades[b]			
		A	B	C	Never Attend
B	33.3	0.0	66.7	0.0	0.0
E	50.0	100.0	33.3	0.0	100.0
Drop	16.7	0.0	0.0	100.0	0.0
n	*6*	*1*	*3*	*1*	*1*

In terms of the fall 2013 math class and the winter 2013 12-week math classes, one student earned an A in the winter 2013 12-week math class (100% of the A grades for Winter 2013) and failed his or her fall 2013 math class, two students who passed their fall math class had previously earned a B grade in their winter 12-week math class (67% of the three students who earned a B in the winter 2013 semester), one student who earned a B in his or her winter 2013 12-week math class earned an E in his or her fall 2013 math class, and the other two students did not successfully complete either of their winter 12-week or fall math courses. The sample size is small, and the percentage of fall 2013 math grades that students earned did not differ statistically as a result of the grades earned in a 12-week winter 2013 math class, $\chi^2(6, N = 6) = 8.67, p = .50$.

In summary, the pass rates for review course students who took their 12-week math course were nearly the same as MathCC's overall developmental math pass rates. The pass rates for the review course students who took spring 2013 math classes were greater than MathCC's overall developmental math pass rates; however, the pass rates for review course students who took fall 2013 math classes were lower than MathCC's overall developmental math pass rates.

Math enrollment and college success. Three students enrolled in a spring 2013 math class, earned a C grade in that courses, and their overall cumulative MathCC GPA at the end of the fall 2013 semester was within the 2.0 to 3.0 range (see Table 54). The three students, who dropped their spring 2013 math class had a cumulative GPA at MathCC of 2.0 or lower at the end of the fall 2013 semester. This sample size is small, and the percentage of overall MathCC GPA ranges did not differ statistically as a result of the grades earned in a spring 2013 math class, $\chi^2(3, N = 6) = 6.00, p = .10$.

Table 54: Overall MathCC GPA Ranges (DV) for Students Who Took a Spring or Fall 2013 Math Class (percentages)

Overall MathCC GPA Ranges	Spring 2013 Grades		Fall 2013 Grades		
	C	Drop	B	E	Drop
$2.0 < GPA \leq 3.0$	100.0	0.0	100.0	66.7	0.0
$1.0 < GPA \leq 2.0$	0.0	33.3	0.0	0.0	100.0
$0.0 < GPA \leq 1.0$	0.0	33.3	0.0	33.3	0.0
0.0	0.0	33.3	0.0	0.0	0.0
n = 12	*3*	*3*	*2*	*3*	*1*

Six students took a fall 2013 math class. A third of them earned a B grade in their fall 2013 math class and had an overall MathCC GPA in the 2.0 range at the end of the fall 2013 semester. The remaining two-thirds did not pass their fall 2013 math class, half of which had a cumulative GPA in the 2.0 range, and the other half had a GPA of 2.0 or less by the end of the fall 2013 semester. The sample size for fall 2013 grades is also small, and again the percentage of overall MathCC GPA ranges did not differ statistically as a result of the grades earned in a fall 2013 math class, $\chi^2(4, N = 6) = 7.00$, $p = .33$.

Review course students who needed more math classes. Sixty percent (21 of 35 students) still needed to take at least one more math class, based on their program of study, after the winter 2013 semester. Of the rest, 11% (four students) completed their program's math requirement and no longer needed to take another math class after the winter 2013 semester, and the remaining 29% (ten students) did not need to take any math at MathCC, based on their program of study.

Out of the 21 students who still needed to take at least one more math class, 29% (six students) continued to take at least one more math class in either the spring or fall semester (see Table 55). Again, no students took a math class in the summer 2013 semester. Hence, the other 71% (15 students) still needed to enroll in, and pass, at least one math class beyond the fall 2013 semester. Three of the ten students (30.0%) who did not need to take any math at MathCC, based on their program of study, decided to enroll in a math class (Intermediate Algebra) after the winter 2013 semester. And finally, only one of the four students (25.0%) who completed his or her program's math requirement by the end of the winter 2013 semester continued to take at least one more math class beyond his or her program's requirement. The percentage of students completing math requirements after completing the winter 2013 semester did not differ statistically as a result of the subsequent spring, summer, or fall semester math classes in which students enrolled, $\chi^2(8, N = 35) = 4.50, p = .82$.

Table 55: Subsequent Math Enrollments (DV) for Students Who Already Completed Their Program's Math Requirement After the Winter 2013 Semester

Completed Math Requirement After Winter 2013	n	Subsequent Math Enrollments (Spring, Summer, or Fall 2013) Percentages				
		Basic Math	Beginning Algebra	Intermediate Algebra	Technical Math I	None
Yes	4	0.0	0.0	25.0	0.0	75.0
No	21	4.8	4.8	9.5	9.5	71.4
Not Applicable	10	0.0	0.0	30.0	0.0	70.0
Total	35	2.9%	2.9%	17.1%	5.7%	71.4%

In summary, only ten students enrolled in a math class within the spring or fall 2013 semesters (see Table 56). Half of them successfully completed their subsequent math class; 20% of the ten students earned a B grade, and 30% earned a C grade in their subsequent math class. In addition, there was one student who took and failed Basic Math, one student who took and passed Beginning Algebra, one of the two students who took Technical Math I passed it with a C grade, and half of the students who took Intermediate Algebra passed Intermediate Algebra. The percentage of student grades earned within a spring or fall 2013 math classes did not differ statistically as a result of the math classes enrolled, $\chi^2(9, N = 10) = 9.44$, $p = .51$. Furthermore, two of the students who took Intermediate Algebra for the subsequent spring math enrollment took a fall math class. One of the students was a student who dropped his or her Intermediate Algebra class in the spring, took it again in the fall, and again dropped the class in the fall. The other student earned a C grade in Intermediate Algebra in the spring semester and failed College Algebra in the fall.

Finally, of these ten students, 20% (two students, or 6% of the original 35) successfully completed their program's math requirement by the end of the fall 2013 semester, 40% (four students, or 11% of 35) took a math class even though it was not required of them for their program of study, and 40% (four students, or 11% of 35) still had at least one more math class that they must complete beyond the fall 2013 semester to satisfy their program's math requirement.

Table 56: Subsequent Math Enrollments to Review Courses and Grades Earned (DV)

Spring & Fall 2013 Math Classes	n	Grades (percentages)			
		B	C	Drop	E
Basic Math	1	0.0	0.0	0.0	100.0
Beginning Algebra	1	100.0	0.0	0.0	0.0
Intermediate Algebra	6	16.7	33.3	33.3	16.7
Technical Math I	2	0.0	50.0	50.0	0.0
Total		20.0%	30.0%	30.0%	20.0%

Review Course & Demographics

The average MathCC review course student age was 22 years old, with a median age of 19, compared to MathCC's average age of 27. Categorizing students by ages, approximately 20% were 18 years old, 31% were 19 years old, and 23% were 20 years old (see Table 57). The rest were 21 years of age or older.

Table 57: Age Ranges for Students Who Enrolled in a Review Course

Age Ranges	Frequency	Percent
18	7	20.0
19	11	31.4
20	8	22.9
21-23	3	8.6
24-28	3	8.6
30+	3	8.6

Recall from Table 47 that 27 of these students had an initial COMPASS math score on file and retook the COMPASS math test at the end of the review course.

Approximately 22% of these students were 18 years old, 33% were 19 years old, 22% were 20 years old, and the remaining age groups each represented 7% of the 27. Overall, almost four out of every five students (78%) in this category were 20 years of age or younger, and 80% of those that improved their math level were also 20 years of age or younger (see Table 58). The percentage of students who improved their placement level after a review course did not differ statistically by age, $\chi^2(5, N = 27) = 3.89$, $p = .57$, but students who were 19 years of age had the highest percentage of students who improved their placement by at least one level.

Table 58: Improved Placement Level After Review Courses (DV) Based on Age

Improved At Least One Level	n	Age (percentages)					
		18	19	20	21-23	24-28	30+
Yes	10	10.0	50.0	20.0	10.0	10.0	0.0
No	17	29.4	23.5	23.5	5.9	5.9	11.8
Total	27	22.2%	33.3%	22.2%	7.4%	7.4%	7.4%

The number of students was small, but the number of males and females were close, 46% to 54%, respectively (16 males and 19 females). Recall from Table 47 that 27 of these students had an initial COMPASS math score on file and retook the COMPASS math test at the end of the review course. A total of 44% and 56% were males and females, respectively (see Table 59). In addition, of those that improved their math placement level, 30% were males and 70% were females. The percentage of students who improved their placement level after a review course did not differ statistically by gender, $\chi^2(1, N = 27) = 1.34$, $p = .42$, but females did improve scores and placement levels at a higher percentage than males. These results are interesting; however, it is unknown why females improved the most. All that can be determined with the data obtained is that gender is not a good predictor for improving math placement levels.

Finally, according to the linear regressions test with independent variables of gender and age, and dependent variable of improved math placement level after enrolling in a review course (see Table 60), gender had a small, not significant, effect on improving placement levels after participating in a review course, $\beta = .19$, $t(27) = .87$, $p = .39$. The effect was small, and does not explain a significant proportion of variance in improving placement levels, $R^2 = .058$, $F(2, 27) = .73$, $p = .49$.

Table 59: Improved Math Placement Level After Review Courses (DV) Based on Gender

Improved At Least One Level	n	Gender (percentages)	
		Male	Female
Yes	10	30.0	70.0
No	17	52.9	47.1
Total	27	44.4%	55.6%

Table 60: Linear Regression Test: Gender & Age (IVs) on an Improved Placement Level After a Review Course (DV)

	Unstandardized Coefficients		Standardized Correlation Coefficient		
Category	B	Std. Error	Beta	t	Sig.
(Constant)	.231	.544		.426	.674
Age	-.007	.015	-.096	-.447	.659
Gender	.181	.208	.186	.869	.394

CHAPTER FIVE: ANALYSIS

This chapter summarizes the results of this study related to the stated hypotheses and relative to the collected baseline MathCC data and findings from literature.

Overall College Success Hypotheses

1. Students who participated in a placement improvement program enrolled in MathCC classes in subsequent semesters after participating in a placement improvement program.

There was not enough evidence to support this hypothesis – not all students who participated in a placement improvement program enrolled in MathCC classes in subsequent semesters after participating in a placement improvement program. Actually, less than 40% of students who attended a workshop, and less than half of the students who enrolled in a review course, enrolled in the subsequent semester (counting fall as subsequent to winter, spring, and summer semesters). Although more than four out of every five workshop attendees and every review course student enrolled in classes at some time during this study's time frame, not every student decided to enroll in the subsequent semester, and not every student enrolled, or reenrolled, in any MathCC classes.

Although both percentages are higher than the 39% that Bailey, et al. (2010) found in their study of student placed into developmental mathematics courses, and the enrollment rate for students who participated in a workshop is within the enrollment range for students who participated in a placement program at CCD and EPCC, it should be in MathCC's best interest to analyze these programs, and students who participated, in more detail. Determining why students aren't enrolling in subsequent semesters to a program, or why some students don't enroll at all, through qualitative measures, can help MathCC determine factors that are contributing to attrition and could lead to practices that might help MathCC improve retention, student satisfaction, and students services such as the programs highlighted in this study. The implications are that all students who participated in a placement improvement program reached out to MathCC for a form of educational assistance; however, close to 20% chose not to continue with MathCC. It is not known what percent was initially going to enroll in classes at MathCC, but these programs likely attracted some students and detracted others.

2. Students who participated in a placement improvement program had greater retention rates than all students who placed into developmental mathematics courses and all MathCC students.

As was found by Weissman, et al. (2009) for Math Jam students at PCC, it was expected that students who participated in a MathCC placement improvement program would be retained at a greater rate than those who didn't (and hence overall).

Although baseline student data were not separated out by participating and not participating in placement improvement programs, there was enough evidence to support this hypothesis when comparing findings against all MathCC students, and students who took a developmental math course. In other words, the semester-to-semester retention rate was greater for students who participated in a placement improvement program, regardless if they enrolled in a math class or other college class, compared to MathCC students who placed into developmental math courses.

In terms of the first semester a workshop student enrolled, the cumulative semester-to-semester (including fall as subsequent to winter and spring/summer) retention rate was at least eleven percentage points greater than MathCC's baseline semester-to-semester retention rates. Students who enrolled in the semester subsequent to a workshop had cumulative semester-to-semester retention rates within MathCC's overall retention rates, or were higher, depending on the semester. For workshop students that enrolled in a math class, the cumulative semester-to-semester retention rates were greater than overall MathCC retention rates and the retention rates for students after their first semester enrolled in a developmental math course. In addition, review course students were retained from winter to spring or summer, and from winter to fall, at rates that were at least 14 percentage points greater than MathCC's retention rates for students after their first semester enrolled in a developmental math class and three percentage points greater than MathCC's overall retention rates. And although MathCC's review courses only had one semester-to-semester rate to analyze (winter-to-fall), it was nearly 15 percentage points greater than the winter-to-fall retention rates, between the fall 2011 and fall 2013 semesters, for all MathCC students after their first semester in a developmental math course.

The same is true for year-to-year retention rates – students who participated in a placement preparation workshop had higher year-to-year retention rates than all MathCC students who placed into developmental math courses. The retention rate based on students' first semester enrolled was 74%, and based on enrolling in classes the subsequent semester following the attended workshop was 81%. These rates are greater than the fall-to-fall retention rates for students who enrolled in a developmental math class and the overall MathCC fall-to-fall retention rates. In fact, the year-to-year retention rates for workshop students were double MathCC's overall retention rate and the retention rate for students after enrolling in their first developmental math course, for most semesters.

In summary, it seems as if more motivated students, and students more invested in their education, attended a workshop. Students who participated in one of the placement improvement programs were retained at greater rates than all MathCC students. Doing more analysis on the students who did not have a pre-COMPASS math score on file could help MathCC understand what students need prior to testing and registration to ensure these students register and are retained. A qualitative study measuring students' satisfaction, connection to the college, feelings of being cared about, etc. could help MathCC direct future foci towards efforts to retain more students.

3. Students who participated in a placement improvement program obtained overall MathCC GPA success, as measured by cumulative overall GPAs greater than 2.0.

There was not enough evidence to support this hypothesis – not all students who participated in a placement improvement program had an overall GPA greater than 2.0. Actually, 46% of review course students and 78% of workshop students who enrolled in classes at MathCC had an overall MathCC GPA greater than 2.0.

In contrast, the percentage of workshop students earning a 2.0 GPA is much higher than MathCC's developmental math pass rate of 42% (which includes a 2.0). Including a 2.0 GPA as a success for workshop students, 82% of earned an overall GPA of 2.0 or greater, which is even higher than the developmental mathematics pass rate of 42%, and 50% of review course students earned an overall GPA of 2.0 or greater. Furthermore, since a 2.0 GPA is successful, and workshop students earned an average GPA of 2.7, they seem (in terms of success) to be more motivated to succeed than the overall MathCC student body. Further follow-up on the connection to MathCC's tutoring center could help MathCC analyze the value of the tutoring center to the students who participated in a workshop and the initial success it could have contributed.

College Math Placement Hypotheses

1. Students who participated in a placement improvement program took the COMPASS math test prior to participating and after participating in a placement improvement program.

There was not enough evidence to support this hypothesis. Only 55% of workshop students and 91% of review course students had a pre-COMPASS math score on file before participating in a placement review program. Similarly, only 37% of workshop students (67% of those who had a pre-COMPASS math score) and 77% of review course students (84% of those who had a pre-COMPASS math score) took the COMPASS math test after participating in a placement improvement program. If the intentions of MathCC's placement improvement programs, in the future, are to help students improve their placement, they must strategically target students who have already taken the placement test. Furthermore, targeting students near cut scores (including those from standardized ACT, SAT, or other tests), on waiting lists for programs, or students who have completed higher levels of high school math courses, could have more of an impact on helping students improve their mathematics placement. However, if the intentions of programs such as these are to educate and prepare students prior to testing for the first time, then a larger scale approach must be taken to reach most, if not all, new incoming students.

2. Students who participated in a placement improvement program improved their COMPASS math score, math placement level, and satisfied their program's math requirements.

MathCC was in great need of helping students improve their initial mathematics placement as nearly every incoming student placed into a developmental math course (93% average), with more than half of which placed two levels below college level. As a result of these programs, review courses and workshops, and those found in literature, it was expected that students would improve their placement. As reported by Sherer & Grunow (2010) on MCCC's Fast Track program and EPCC's PREP program, it was expected that MathCC would see a comparable percentage of students improve their placement levels. MCCC saw two out of every three program completers move up at least one level, and EPCC saw between 52% and 66% move up at least one level. MathCC did not see percentages this high.

Out of the students who had a pre-placement improvement program COMPASS math score on file, approximately four out of every five workshop students and half of the review course students improved their COMPASS math score after retesting. Overall, 20% of students who attended a workshop and 29% of students who enrolled in a review course improved their placement level. Of the students who had a pre-COMPASS math score on file, more than half (53%) of workshop students and 37% of review course students improved at least one level. In other words, two out of every three workshop students and just less than half (48%) of review course students who improved their score did it enough to improve their mathematics placement by at least one level. Finally, 26% of workshop students and 16% of review course students satisfied their program's math requirement after participating in a program and retaking the COMPASS math test.

Again, not every student who attended a placement improvement program had a pre-COMPASS math score that they wanted to improve; some may have wanted understanding and assistance preparing before testing. And even though many had a declared program of study, knowing students' goals and college intentions remain uncertain. Doing a follow-up analysis of students' goals and intentions could better help understand why students participate in a program. The implications of this study are that it adds additional support to the fact that incoming community college students can succeed at higher levels, and many should be placed into higher levels. Providing support for these students through workshop or review courses is one of many ways to help educate students and then help them in proper course placements.

3. Students who participated in a placement improvement program improved their placement at higher rates if they attended multiple workshops.

It was assumed that the more a student practiced and obtained guided help, the greater his or her chances of obtaining a higher math placement level. There was not enough evidence to support this hypothesis. MathCC did not have a large sample of students who attended more than one workshop, and there was no correlation between students who attended more than one workshop and improved math placement levels. Regardless, it is still uncertain how much practicing a student truly did. Some students could have practiced no more after attending a workshop, and other could have practiced on their own for hours or days, or obtained assistance in MathCC's tutoring center.

Rather than measuring success in terms of the number of workshops attended, measuring success based on the amount of time put into preparing, practicing, and obtaining assistance may better reveal information about improving students' placement levels.

Success in Math Classes Hypotheses

1. Students who participated in a placement improvement program and enrolled in a math class after participating in a placement improvement program had calculated math GPA success, as measured by calculated math GPAs greater than 2.0.

As reported by Sherer & Grunow (2010) on the Math My Way program at Foothill College and the Cool at School program at Daytona State College, it was expected that students who participated in one of MathCC's placement improvement programs would be successful in subsequent math enrollments and would persist to complete the developmental sequence at higher rates than all MathCC students. Overall, students who participated in a placement improvement program were similar in math success as over half (56%) of workshop students and half of review course students earned a calculated math GPA greater than 2.0 by the end of the fall 2013 semester. These rates, although not encompassing just developmental courses, were greater than the pass rates for all MathCC's students after enrolling in a developmental math class. In addition, the pass rates for all MathCC students who enrolled in Pre-Algebra or Beginning Algebra (42% and 47%, respectively) were similar to the pass rates for review course students enrolled in Pre-Algebra or Beginning Algebra (44% and 43%, respectively). On the other hand, the pass rates for students who attended a workshop and enrolled in Pre-Algebra or Beginning Algebra were much higher, between 22 and 28 percentage points, than MathCC's Pre-Algebra and Beginning Algebra baseline data.

Workshop or review course students' developmental sequence completion rate was not as successful compared to the population of students who started in Pre-Algebra at MathCC. For all MathCC Pre-Algebra students, the developmental completion rate was 15%; however, it was only 4% and 11% for workshop and review course students. The amount of time since the conception of the workshops was short; thus, this isn't necessarily a good, or accurate, measure of the completion rates for developmental math.

2. Students who participated in a placement improvement program, and enrolled in a math class after participating in a placement improvement program had overall GPA success, as measured by GPAs greater than 2.0.

It was assumed that students who participated in a placement improvement program would have been successful in their enrolled math classes, and hence successful at MathCC. Overall, 77% of the students who participated in a workshop and enrolled in a math class after a workshop earned an overall MathCC GPA greater than 2.0 by the end of the fall 2013 semester. Almost an additional 2% earned an overall GPA of 2.0, bringing the success of earning a GPA of 2.0 or greater up to nearly 79%. In addition, 34 review course students enrolled in a 12-week review course. Of them, 44% had a cumulative MathCC GPA greater than a 2.0, and including a 2.0 GPA 50% of students earned a 2.0 GPA or greater. Thus, students who participated in a workshop and enrolled in a math class were overall more successful than students who enrolled in a review course. Furthermore, it is interesting to note that the rate of workshop students who earned a GPA greater than 2.0 is nearly the same for students who took any classes at MathCC and students who took math classes at MathCC. In other words, 78% of workshop students who enrolled in MathCC classes earned an overall GPA greater than 2.0 and 77% of workshop students who enrolled in math classes at MathCC earned an overall GPA greater than 2.0. What still needs to be determined is why didn't students who had to take at least one math course, and had the opportunity to do so within this study's timeframe, chose not to take a math class.

Age and Gender Hypothesis

1. Students who participate in a placement improvement program, and are within certain age or gender groups, are more likely to improve their math placement test score after participating in a placement preparation program.

There were two small correlations, one between gender and an improved placement level for students who retook the COMPASS math test after attending a workshop and the other between age and an improved placement level for students who enrolled in a review course. Both correlations were small, not strong, and not statistically significant; however, it is worth noting that the majority of students who participated in a placement improvement program were 20 years of age or younger, and hence were within several years of either earning their GED or high school diploma. For students who were older, and had potentially earned high school credentials numerous years ago, it was assumed that they would either want to refresh their memories, or obtain some baseline knowledge prior to testing. Certainly some older students would practice enough to recall knowledge that could assist them in placing higher; however, the longer a student is out of an educational setting, the greater the amount of knowledge attrition they could encounter.

CHAPTER SIX: DISCUSSION, CONCLUSIONS, RECOMMENDATIONS, AND FURTHER STUDY

Accurate course placement should not be an afterthought with colleges, but rather colleges should be reaching out to students prior to placement testing – to educate them first, guide them to resources for student success before testing, and then help students who could perform better after they have retested once. As Hughes and Scott-Clayton (2011) note, mistakes will be made, and some students wil inevitibly be placed higher or lower than their skill level. However, actively engaging students to help them on the initial road to success and educating them before enrolling in classes could increase student enrollment, success, retention, completion, and satisfaction. Policy makers and decision makers within colleges should be able to weigh the pros and cons of placement preparation or improvement programs, similar to those described or evaluated in this study, and allocate resources accordingly.

Discussion

Overall, several measures of success occur for students who participate in a placement improvement program. First, students at MathCC and other colleges that participated in placement programs improved their placement levels after participating in a placement preparation or improvement program and retesting. Sherer and Grunow (2011) reported that 67% of CCD's College Connection program students, 78% of

LaGuardia’s Math Intensive program students, 67% of MCCC’s Fast Track program students, 54% of EPCC’s Dream program students, 56% of PCC’s Math Jam program students, and 66% of EPCC’s PREP program students improved their mathematics placement by at least one level. And now, 53% of MathCC’s workshop students and 37% of review course students, who had a pre-COMPASS math score on file, improved their mathematics placement by at least one level. In summary, this evaluation and literature show that students can improve their math placement level with the right support.

Second, MathCC’s programs, and programs at other colleges, have seen students perform successfully in math classes after participating in a placement improvement program. According to Sherer and Grunow (2011), LaGuardia’s Math Intensive and Daytona State College’s Cool at School programs found between 50% and 75% of successful program completers who attempted Pre-Algebra successfully completed Pre-Algebra, and between 51% and 59% of successful program completers who attempted Beginning/Introductory Algebra successfully completed Beginning/Introductory Algebra. And now, three out of every five students that participated in a MathCC workshop and two out of every five students that enrolled in a review course attempted and successfully completed Pre-Algebra, and almost three out of every four workshop students and a little more than two out of every five review course students that attempted Beginning Algebra at MathCC successfully completed Beginning Algebra. In summary, this study showed that students who participated in a placement improvement program and enrolled in a developmental math course were more successful than all MathCC students that enrolled in a developmental math course.

Third, students who participate in placement programs are successful overall in college. The percentage of MathCC's review course students who had overall MathCC GPAs greater than 2.0 were higher than the pass rate for all developmental math students. Furthermore, 82% of MathCC students who participated in a workshop found overall success at MathCC by earning a cumulative GPA of 2.0 or greater.

Fourth, students who participate in a placement improvement program are retained at a higher rate than the general study body. Overall, nearly 90% of all MathCC students who participated in a workshop and enrolled in a fall semester were retained to the winter semester. This includes the fall-to-winter retention rates for students who attended a spring or summer 2012 workshop, and the fall-to-winter retention rates for students who attended a winter 2012 workshop which were both greater than 91%. Although the review course data did not cover a fall-to-winter time period, the workshop retention data was greater than MathCC's 74% to 76% fall-to-winter retention rates from fall 2009 through fall 2013. In summary, students that engaged in a placement preparation workshop were more persistent than MathCC's overall student body.

Conclusions

As Sherer & Grunow (2011) found, in their evaluation of intensive math programs, and as this evaluation of MathCC's programs found, placement improvement programs can help contribute to the success and retention of students who desire to improve their course placement. And although a workshop, review course, or placement preparation program might contribute to a student's success, it is not the only agent leading the students to improved placement success. There are other influencing variables that could contribute to a student's success on a placement test. However, generalizing this information to a larger scale, community colleges can use placement preparation or improvement programs to help students improve their placement, be more successful within college, satisfy their goals and objectives, and start on the initial path towards success by reaching out and engaging students.

Furthermore, programs, such as those mentioned in this study, could serve as an education foundation for new incoming students. By means of a little outreach, guided direction, and resources for preparation, a community college could help prepare students for college entrance and better solidify the bridge between high school and community college enrollments.

Recommendations

Based on the data found within this evaluation and in literature, it is recommended that MathCC require students to prepare for taking the COMPASS math test. It is also recommended that MathCC continue to reach out to students after they have taken the placement test to offer assistance in preparing to retake the placement test. In addition, it is highly recommended that MathCC regularly educate all incoming students on the placement test, what students can do to prepare prior to testing, and offer drop-in assistance so that students can obtain support services when it is convenient for them and their schedules. Although the review courses were only measured for one semester, it is recommended that MathCC determine a new model, or find alternative ways to assist students in accelerating their developmental math sequence. And if MathCC decides to continue the program, embedding in additional support or computer remediation is highly recommended.

In light of this study, and through the findings in literature, it is recommended that MathCC and other community colleges:

- Determine strategies to encourage students to enroll in college classes after participating in a placement preparation or improvement program. Strategies may include a centralized location, incorporating student services such as counseling, advising, or registration, or marketing or case management measures.

- Regularly connect with past program participants to encourage them to seek out additional assistance for success, keep the connection to the college and their success, and encourage them to set and attain their academic goals.

- Reach out to potential and incoming students, to educate them on the importance of placement testing prior to them taking a placement test, and beginning to formulate road maps for their successful start in college.

- Target specific cohorts of students for a placement preparation intervention, such as students in an Early College high school or students interested in dual enrollment, students on a wait list for a particular high demand program, students within a specific cut off range, etc.

- Use multiple considerations to place all students – such as high school transcripts, placement test results, non-cognitive test results, etc.

- Reach out to students who could benefit most from a placement preparation or improvement program – such as students near cut off scores, on waiting lists, those who have taken higher-level math courses in high school, etc.

- Create a sustainable model for helping students attain their accurate course placement.

- Incorporate support services into the programs – such as advising, counseling, tutoring, etc.

- Train and utilize admissions staff, academic advisors, counselors, tutoring staff, and faculty members in the development, improvement, and implementation of future resources intended to help prepare students for placement testing (Ingalls, 2011).

- Partner with high schools to prepare students for college, and offer placement preparation in high schools.

Further Study

As result of this study's findings, the literature presented, and the previously mentioned limitations and delimitations, there are several items that would add scholarly information to the topic of placement testing preparation and course placement accuracy:

- The impact of a placement preparation program on initial students' placement, corresponding to other measures of student knowledge such as the ACT or SAT, student transcripts, previously taken math classes, etc.
- Length of time it takes a student who participated in a placement improvement program to graduate or complete their program of study compared to students who did not.
- Developmental completion rates between students who participated in a placement preparation or improvement program and students who did not.
- Impact of race and family income on improving mathematics placements for students who participate in a placement improvement program.
- Placement level or improved placement level based on the amount of time students spent preparing for a placement math test, and cross compared with ACT, SAT, high school GPA, or other student knowledge assessments.
- Qualitative student satisfaction information regarding placement preparation and improvement programs.
- Cost benefit analyses for colleges helping students prepare for placement testing or improve placement test scores.

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APPENDIX A. DESCRIPTION OF MATHCC

MathCC is a large, southeast Michigan community college serving approximately 18,000 students each year from various communities within close proximity of a large metropolitan city. The average student age is 27 and nearly 40% of the student body is traditional aged, between 17 and 20 years of age. Each year, over 4,000 students, new to any college, register for and attend classes at MathCC. Within the county, and neighboring counties, are numerous other colleges and universities, and the MathCC community and surrounding areas are home to a variety of demographics and cultures. MathCC is comprised of a very large out-of-district student population, and has approximately 200 full-time and 600 adjunct faculty members. In addition, MathCC's mathematics department contains 18 full-time and just over 100 adjunct faculty members. The mathematics curriculum at MathCC consists of the traditional Basic Math to Calculus, Linear Algebra and Differential Equations sequence with several additional mathematics courses, such as technical math courses, business math, mathematics for elementary teachers, etc. Furthermore, there are three developmental mathematics courses at MathCC: Basic Math, Pre-Algebra, and Beginning Algebra.

APPENDIX B. DESCRIPTION OF MATHCC'S PLACEMENT PROCESS

MathCC's placement process is a product of the one-stop-shop design. Students apply to MathCC, present a GED or high school diploma, are accepted, attend a recommended new-student orientation session on campus, take the college's placement test, go through academic advising, and then progress to an open computer lab where they immediately are given support to register for classes.

Like other community colleges, MathCC students are dual enrolled high school students, new-first-time college students, returning college students, or those who have transferred from another college or university. Those returning to college, or transferring from another college, do not need to attend an orientation session or take the placement test provided they can produce recent transcripts or placement test results from their former institution(s). Those who are new to college must either take the college's placement test or provide sufficient ACT or SAT scores to place them into college level English or mathematics. New student orientation is not mandatory at MathCC, but it has been considered, and may be mandatory in the future.

MathCC uses the COMPASS placement test by ACT for determining students' math, reading, and writing abilities and course placement provided a sufficient score from another college readiness test or college transcripts cannot be provided. Students with other college readiness test results often take the COMPASS math test to obtain a placement into a higher-level college level math course (Pre-Calculus or Calculus) as MathCC does not differentiate college level courses based on other non-COMPASS test scores or results. On rare occasions, MathCC gives the ASSET test, but only if a student requests it.

MathCC has over 30 math courses from Basic Math through Differential Equations. Students can self-select to take Basic Math, but can be placed into one of the six traditional math classes with their COMPASS math score (Pre-Algebra, Beginning Algebra, Intermediate Algebra, College Algebra, Pre-Calculus, or Calculus I). The other non-traditional mathematics courses not listed have a COMPASS score range the same as one of these six traditional levels. Table 61 gives the MathCC course placement depending on students' COMPASS math score:

Table 61: ***MathCC's Course Placement Corresponding to COMPASS Score Ranges***

COMPASS Math Test	COMPASS Score	MathCC Course Placement
Pre-Algebra	CTPA score $\leq$ 38	Pre-Algebra
	CTPA score $>$ 39	Beginning Algebra
Algebra	CTAL score $\leq$ 45	
	46 $\leq$ CTAL score $\leq$ 65	Intermediate Algebra
	CTAL score $>$ 66	College Algebra
College Algebra	CTCA score $\leq$ 50	
	CTCA score $\geq$ 51	Pre-Calculus
Trigonometry	CTTR score $\leq$ 50	
	CTTR score $\geq$ 51	Calculus I

Once a MathCC student takes the COMPASS placement test, they have the option of either retaking the COMPASS test or accepting their course placement. Retests are not always openly advertised, unless a student expresses frustration about their score or an advisor or counselor recognizes a large gap in the students' prior learning and the score they earned on the COMPASS test. Students who obtain an ACT score of at least 23 may bypass the COMPASS placement test and enroll directly in College Algebra. However, if they desire to enroll in a higher-level course, they must take the COMPASS math test to obtain their specific course placement.

Lastly, until recently, prerequisites for math classes below College Algebra were not enforced; thus if a student desired, they could have enrolled in Beginning or Intermediate Algebra without actually testing into it. This information was not made public to students, but on occasion students would obtain this information from peers or on their own when registering for classes. Additionally, students could meet with the Associate Dean of Mathematics and obtain a higher placement if the Associate Dean agreed that their placement was too low for their abilities.

APPENDIX C. DESCRIPTION OF MATHCC'S PLACEMENT PROBLEM

Since 2007, between 89% and 95% of new incoming MathCC students who took the COMPASS math test placed into a developmental mathematics course. This is considerably high given the fact that Michigan requires all high school graduates to take four years of mathematics or mathematics related curricula (Michigan Depatment of Education, 2010). And this developmental placement rate is over 30 percentage points higher than the nation's 60% average (Collins, 2009).

MathCC's one-stop-shop plays a role in the placement of students. Although the student service approach is a model for efficiency and student enrollment, it is not the best example of student success and course placement. With a large portion of students applying and registering for classes a few weeks before the start of a semester, it is extremely difficult to educate students on the importance of the placement test and prepare them for successful placement. Furthermore, it is difficult to use and interpret multiple measures for placing students when high numbers of students attend a new student orientation session and are sent to receive advising immediately thereafter. Depending on the number of students, some advising sessions are group sessions, thus making advising short, general, and not individual-specific. And due to large crowds and demand for time efficacy, student services staff are forced to rely heavily on placement test results to ensure that students are quickly serviced and then register for classes.

Students who are not advised or counseled on their individual options after taking the COMPASS test may be unaware of how to obtain course placements best matching their abilities and accept their received COMPASS score. Consequently, many enroll in math courses lower than their actual capabilities and often are frustrated, bored, and disengaged in these classes to the point of attrition (Complete College America, 2012).

APPENDIX D. DETAILED DESCRIPTION OF MATHCC'S PLACEMENT PREPARATION WORKSHOPS

Placement preparation workshops at MathCC were created in the fall of 2011 by a full-time mathematics faculty member. The need to create these workshops stemmed from the fact that students within this faculty member's classes seemed to be misplaced and capable of being successful in a higher-level math class. Hence, coupled with the need to improve overall developmental placement at MathCC, this faculty member created and conducted 90-minute preparation sessions in an on-campus computer classroom. After the fall 2011 semester, several other mathematics instructors volunteered their time to assist in the delivery of additional workshops, and when available, and needed in workshops with large numbers of students attending, peer tutors from the college's tutoring center joined the instructor. All mathematics instructors volunteered their time to conduct workshops, and peer tutors recorded their time as if they were tutoring in the math help room.

The workshops were advertised internally to recently admitted students, counselors, and advisors. All students who recently were admitted for an upcoming semester were emailed about the dates, times, and places for an upcoming workshop. Flyers advertising the workshops were posted around campus and were included in the rotating announcements lists on MathCC's informational televisions. Students who were interested in attending a workshop emailed the instructor organizing the program or a staff member from the tutoring center where the workshops were held. Registrations were confirmed with an email, and followed up a day or two prior to the workshop to welcome the students and remind them to bring a calculator and writing utensil. New students to

MathCC, high school students, and students currently taking classes at MathCC registered to attend, and attended placement preparation workshops.

The structure of the workshops was relatively the same for each workshop. The instructor would arrive to the classroom early, turn computers on, organize handouts, prepare a PowerPoint presentation, and then sign in students as they arrived. When the time came to begin, the instructor welcomed students, gave them a brief 10-15 minute presentation on the COMPASS math test, why it is important, the level in which the test starts, how it progresses up, down, or places students, and how students could practice to prepare for taking or retaking the COMPASS math test. After the presentation, the instructor guided the students to an online resource that they could use to practice – these varied by semester, and are listed below – and the students practiced math problems similar to the topics represented on the COMPASS math test. As these students practiced, the instructor and peer tutors walked around to answer students' questions related to the math problems they were working on and answer general advising questions.

Most students stayed to practice and receive the free tutoring help from peer tutors and the instructor, and some left after realizing that their program of study did not require any math, or that their placement was indeed accurate for their skills, abilities, and previously taken math classes. Upon completion of the workshop, the instructor gave final concluding remarks, such as to continue to practice before testing or retesting, and other practice resources. Students who attended workshops were emailed after attending a workshop and thanked for coming, and given tips for studying and accurately placing, or improving their placement, into the math class most appropriate for their skills and abilities.

The resources used, or available for students' use, in the workshops:

- Handouts: Final exam review worksheets for MathCC's math courses – Pre-Algebra through Pre-Calculus.

- Handouts: Topic-based handouts containing Pre-Algebra and Beginning Algebra questions similar to those found on the COMPASS math test.

- Online Resource: Diagnostic sample Algebra, College Algebra, Geometry, Numerical Skills/Pre-Algebra, and Trigonometry practice tests: http://www.learnatest.com/LEL/index.cfm/learningCenter/collegePreparation/College_Placement_Prep_LEL/COMPASS_Prep

- Fall 2011 – Summer 2012: Online Pre-Algebra and Beginning Algebra diagnostic tests and practice problems, hosted by Hostos Community College: http://www.hostos.cuny.edu/oaa/compass/

- Fall 2012 – Winter 2013: An online, publisher learning management system that contained numerous math problems from Basic Math through Pre-Calculus, including animations, videos, learning resources, and more: http://www.myfoundationslab.com

- Winter 2013 – Fall 2013: An online practice test, hosted by Johnson County Community College, that contained Pre-Algebra through Advanced Algebra questions with links to online videos to assist students with individual questions they got wrong: http://blogs.jccc.edu/math/files/articulate_uploads/MathCOMPASSPreparation/story.html

APPENDIX E. DETAILED DESCRIPTION OF MATHCC'S THREE-WEEK PLACEMENT REVIEW COURSES

MathCC's three-week placement review courses were one credit hour, two days per week, 2.25 hours per class, courses intended to help students who placed into Pre-Algebra or Beginning Algebra improve their mathematics placement by at least one level. Students who self-selected to register for one of the review courses (Pre-Algebra or Beginning Algebra) had to co-enroll in a late start 12-week Pre-Algebra or Beginning Algebra course. Both courses were on the same day of the week, at the same time of the day, for 2.25 hours per day. The late start 12-week co-enrollment math course, including a late start 12-week Intermediate Algebra course, was scheduled for the same days and time of the day to ensure a seamless transition from the first three weeks of the semester to the last 12-weeks of the semester.

The three-week review courses were taught by two full-time math instructors, and the structure of these courses was similar. During each class, the instructors would use handouts consisting of topics found within each of these MathCC courses. These handouts were developed by the instructor based on previous knowledge of the COMPASS math test, online resources found, and content found in various Pre-Algebra and Beginning Algebra textbooks. The instructor would briefly introduce topics, show examples, and have the students work in class on similar questions. The intentions of these courses were to refresh students' memories of the topics, and then get them practicing them so that they could prepare for the COMPASS math test. As the students worked on worksheets, the instructor circled around to answer their questions and guide them towards understanding of the concepts. All concepts taught in Pre-Algebra, or Beginning Algebra, were covered in the three-week placement review classes.

On the last day of the three-week period, both classes met at MathCC's placement testing center, took the COMPASS math test and students received their math class placement. For the students who improved their math placement, and wanted (or needed) to take that math class, they were automatically dropped from their previously enrolled late start 12-week math class and enrolled in the higher-level late start 12-week math class by the Associate Dean of Mathematics. Students who did not improve their math placement level kept their late start 12-week Pre-Algebra or Beginning Algebra co-enrollment math course. And students who improved their placement level beyond what their program of study required, and consequently did not need to take any more math, were advised to drop their co-enrolled math course, and either enroll in a higher-level late start 12-week math course, if they so desired, or not to take any more math classes at MathCC but rather a course required by their program of study.

APPENDIX F. INSTITUTIONAL REVIEW BOARD APPROVAL

Ferris State University

Institutional Review Board (FSU - IRB)

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Ferris State University
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Big Rapids, MI 49307
(231) 591-2553
IRB@ferris.edu

To: Dr. Mary Ellen Duncan and Mr. Adam Cloutier
From: Dr. John Pole, IRB Interim Chair
Re: IRB Application #130702 (Title: *Improving Mathematics Placement for Community College Students: An Evaluation of Placement Improvement Programs*)
Date: July 23, 2013

The Ferris State University Institutional Review Board (IRB) has reviewed your application for using human subjects in the study, "*Improving Mathematics Placement for Community College Students: An Evaluation of Placement Improvement Programs*" (#130702) and determined that it is *exempt-1E* from full committee review. This approval has an expiration date of three years from the date of this letter. As such, you may collect data according to procedures in your application until *July 23, 2016*. It is your obligation to inform the IRB of any changes in your research protocol that would substantially alter the methods and procedures reviewed and approved by the IRB in this application. Your protocol has been assigned a project number (#130702) which you should refer to in future applications involving the same research procedure.

We also wish to inform researchers that the IRB requires follow-up reports for all research protocols as mandated by Title 45 Code of Federal Regulations, Part 46 (45 CFR 46) for using human subjects in research. We will send a one-year reminder to complete the final report or note the continuation of this study. The final-report form is available on the IRB homepage. Thank you for your compliance with these guidelines and best wishes for a successful research endeavor. Please let us know if the IRB can be of any future assistance.