DISSERTATION

# RELATIONSHIPS BETWEEN MOTIVATIONAL, DEMOGRAPHIC, AND ACADEMIC VARIABLES AND COURSE GRADE IN DEVELOPMENTAL MATHEMATICS AMONG STUDENTS AT NORTH CENTRAL STATE COLLEGE

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In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Summer 2014

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# ABSTRACT

## RELATIONSHIPS BETWEEN MOTIVATIONAL, DEMOGRAPHIC, AND ACADEMIC VARIABLES AND COURSE GRADE IN PRE-ALGEBRA AMONG STUDENTS AT NORTH CENTRAL STATE COLLEGE

To assist North Central State College with the identification of students who are not likely to receive a grade of A, B, or C in their Pre-Algebra course, a regression equation was developed. The variables used in the analysis were representative of previous academic performance, depth and breadth of developmental education needs, recency of math education, motivational scores from the College Student Inventory Form B™ (CSI-B), and self-reported demographic data such as the number of hours planned to work. The overall accuracy of the success prediction, both yes and no, would have been 62% had the model been used with the students in the historical sample. This was supported by a logistic regression model which produced similar results.

The development of student success plans based upon the model at the individual and section levels, implementation of other assessments to learn more about the relationships between self-efficacy, resilience and grit, and a review of the Mathway for each major provided the College with implications for advising and student success practices. Implications for future research included the addition of other variables, further study of males to determine variables that matter most to their success prediction, and determination of the value of other motivational assessments like Grit Scales and their associations to course grade.

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# CHAPTER 1: INTRODUCTION

Successful completion of developmental education course requirements at the community college has come under the microscope of higher education professionals and nonprofit organizations in recent years. Researchers, practitioners, and nonprofit organizations such as Bryk and Treisman (2010), Hern and Snell (2010), Achieving the Dream (2006), and Complete College America (2012) have provided studies and other data which clearly illuminate the issues. Complete College America (2012), pointed out that many remedial classes are failing the higher education system in that developmental students are leaving the system via a variety of exit ramps.

The four exit ramps identified by Complete College America (2012) included: too many students, with nearly 52 percent at the community college level being placed into remedial education, thus discouraging students from continuing; nearly 40 percent of students not completing their remedial courses and many do just as well without remediation; too few, about 23% completing remedial and gateway courses within two years; and, fewer than one in ten graduating. While this study provided data in all remedial areas, specific disciplines, like mathematics, may need greater attention.

The 2011 Legislative Report on Remedial Education, released by the Colorado Commission On Higher Education (2012), identified mathematics as the subject area where more students have need. "When examining remediation by discipline, most Colorado students required remediation in mathematics, followed by writing and then reading. At both two-year and four institutions mathematics is by far the subject with the highest number of students assigned to remedial study" (p. 6). Related data points from the State of Texas (Smith, 2012) revealed that, "students referred to developmental classes are 50 percent less likely than their peers to earn a

credential or transfer to a four-year college. Mathematics is often their biggest hurdle, and students are steered into algebra-based remediation regardless of their majors" (p. 1).

Many studies over the years (Edwards, (1972), Long (2003), Stephens (2005), Lynch-Newberg (2010), and Rambish (2011) have analyzed different variables in order to determine what factors have the greatest relationship to success in developmental mathematics. The variables included academic, demographic, breadth and depth of developmental need, faculty placement, course delivery approaches and student engagement levels in the classroom. Many times the research questions in the studies were answered using singular variable associations or limited multivariate analysis. The studies have provided evidence of the need for additional research using many of the same variables in those studies, while adding a greater number of variables and variable types.

An early study using stepwise linear regression analysis conducted by Edwards (1972) attempted to determine which factors, from a selected list of ten possible predictors, "…were the best predictors of success in remedial mathematics courses in the public community junior college and to develop a regression equation based upon those predictors" (p. 157). While the study was delimited to six colleges in Connecticut and one in Massachusetts, Edwards found that the … "prediction of success in remedial mathematics courses can be made correctly 71 percent of the time using five select predictors: high school average, mathematics test score from the CEEB Comparative Guidance Placement Battery (CGP), attitude toward mathematics scores (Dutton Test), sentence test score (CGP), and mathematics interest score (CGP)" (p. 160). While Edwards was able to produce predictors of success in remedial mathematics, the study was limited to ten independent variables and was conducted forty years ago.

Long (2003) provided a lens on how course placement policy may affect success in remedial math. She examined the "relationship between the single predictor of a mathematics placement test score and successful completion of the first mathematics course taken by community college students…" (p. 5). Additionally, she attempted to determine relationships between a limited number of academic independent variables and course success. She concluded that "no relationship between mathematics placement score or a combination of variables and successful completion was found" (p. 110). She recommended the inclusion of other variables "such as number of hours worked, number of credit hours carried in the semester, income, marital status, and other personal variables…" (p. 109).

Stephens (2005) revealed that there were some correlations between a limited number of variables related to previous academic performance and course success, but they were dependent on the student's age and the course for which they were enrolled. For example, Stephens noted that for elementary algebra students "…very few of the variables studied seemed to have much correlation with a student's grade. The only one of six variables chosen for correlation which showed a definite relationship was the overall grade point average from high school" (p. 70). Stephens concluded that

> Obviously, more factors influence the grade of a student in a college mathematics class besides previous performance. Certainly, attendance, attitude, effort, anxiety levels, learning styles, personal issues and perhaps even odd factors such as the time of day the student takes the class may have a larger effect on a student performance than the variables considered in this study (p. 79).

Studies conducted by Lynch-Newberg (2010) and Rambish (2011) analyzed the course delivery approaches and the relationships to success in developmental mathematics. Lynch-

Newberg (2010) explored the relationships between retention and success rates of females in a Wyoming community college taking developmental mathematics online compared to those enrolled in a traditional lecture format. The purpose of the study was to determine if the community college was properly addressing the needs of students who were not within commuting distance of the college. In other words, the study was designed to determine, in part, if additional online developmental mathematics courses might benefit rural community college female students in Wyoming. In a similar approach Rambish (2011) investigated significant differences in student success based upon two instructional delivery approaches, conceptual versus traditional, used among community college students. She concluded that the conceptual approach did produce results among different learner types. In summary, these studies used limited numbers of variables and primarily focused on very specific subpopulations.

The studies presented above (Edwards, 1972, Long, 2003, Stephens, 2005, Lynch-Newberg, 2010, and Rambish, 2011) have all contributed to the body of knowledge regarding successful completion of developmental mathematics. While sound research approaches were in place, the independent variables used were usually representative of previous academic performance, demographic indicators, placement scores or delivery methods. As the researchers themselves (Long, 2003 and Stephens, 2005) pointed out, their studies paid little attention to other factors such as attendance, attitude, effort, anxiety levels, learning styles, number of hours worked, number of credit hours carried in the semester, income, marital status, personal issues, or how the student might self-assess his or her own skill levels. While Edwards (1972) did use a few of these indicators, the research was conducted 40 years ago. Additional research using many of the same variables employed in previous studies and adding a greater number of variables and variable types is needed.

## Purpose of the Study

The purpose of this study was to assist North Central State College with the identification of students who are not likely to receive a grade of A, B, or C in their Pre-Algebra course, Mth 0072/Math 102 via the development of a regression equation. The course number and name were changed during the time period for which data were collected for use in this study. Throughout the study, Pre-Algebra will be used to identify the course. A secondary purpose was to provide advising and student success recommendations which may assist the faculty and staff as they attempt to best situate and affiliate students who are not likely to receive a grade of A, B, or C.

The study used concurrent and predictive associational design including One Way ANOVA, Pearson r, Spearman Rho, and multiple regression analysis. Additional interests were explored using Chi Square to determine associations which are of value to describe the results, but outside the scope of the initial design. Ultimately, by employing six of the sixteen independent variables an equation that predicted a student's grade in Pre-Algebra was developed. The variables were representative of previous academic performance, depth and breadth of developmental education needs, recency of math education, motivational scores from the College Student Inventory Form B™ (CSI-B) such as math skills self-assessment and desire to finish to college, and self-reported demographic data such as the number of hours planned to work.

## Research Questions

The analysis used in this study attempted to determine if any associations existed between the variables and the course grade for students enrolled in Pre-Algebra. The primary research question below guided the study. Additional research questions and areas of interest are outlined in Chapter three and are included in the results and discussion sections.

Research Question 10: How well does the combination of gender, CSI™ hours planned to work, ACT Compass® Math score, CSI™ Study habits scale, CSI™ Math and Science Confidence scale, and CSI™ Receptivity to Academic Assistance predict course grade in Pre-Algebra?

The research questions were answered using de-identified data provided by the College. The dependent variable was course grade in Pre-Algebra.

## Delimitations

This study was delimited to students who were enrolled in the Pre-Algebra course at North Central State College during the fall semesters in 2010, 2011, and 2012. All students who met these criteria were included regardless of a demographic condition such as age or gender.

The study was also delimited to an examination of the associations between the students' grade in Pre-Algebra and the de-identified variables which were drawn from the college's database. The results of the study are generalizable to the faculty, staff, and administration at North Central State College.

## Limitations

Generalizability of this study is limited in the following ways. First many colleges, and specifically North Central State College, employ different policies and procedures with respect to placement and assessment prior to enrollment in Pre-Algebra. Some colleges use standardized assessments, such as ACT's Compass®, for course placement, while others use in house instruments or multiple measures. This study is limited to the use of ACT's Compass® for course placement. Second, generalizability is limited due to variation in instructional approaches of the faculty who teach Pre-Algebra at North Central State College. Third, the data that served

as the independent variables to determine the relationships to course grade and to produce a regression analysis may limit the overall conclusions of the study.

Lastly, any overall conclusions can only be applied to North Central State College and students enrolled in this course for the fall semester. In a presentation to the Tennessee Association for Developmental Education, Hopkins and Stephens (2002) noted that students at East Tennessee State University who were enrolled in developmental mathematics courses in the fall semester had significant differences in average grades as compared to those students enrolled in spring or summer. Summer grades were typically higher than fall while spring average grades were lower than fall.

**Definition of Terms**

For purposes of this study the following terms were defined.

Developmental education:

> A field of practice and research within higher education with a theoretical foundation in developmental psychology and learning theory. It promotes the cognitive and affective growth of all postsecondary learners, at all levels of the learning continuum. Developmental education is sensitive and responsive to individual differences and special needs among learners. (Delta College, 2012.)

Success in Pre-Algebra: was defined as the grades of C or higher. The grades of C- and lower and grades representative of withdrawal or incomplete were not considered successful since that is the policy of the community college.

## Significance of the Study

Overall conclusions of the study may empower faculty and staff at North Central State College to make improvements to the way the course is delivered and or to provide services to

those students who are most at risk for not being successful in Pre-Algebra. In addition the study supplements the gaps recognized in studies conducted by Long, (2003) and Stephens, (2005) and adds to the existing body of literature which has attempted to determine which variables have the greatest relationship to and or are predictive of successful completion of Pre-Algebra.

## Summary

It is clear that many studies have contributed to the body of knowledge regarding successful completion of developmental mathematics. Additional studies and other related data sources have shown that the factors which affect successful completion of developmental math are numerous and not solely based on previous academic performance or demographic data. The need for a multivariate analysis to determine significant relationships to successful completion of developmental mathematics is necessary and will assist North Central State College with important course delivery and service decisions.

# CHAPTER 2: REVIEW OF THE LITERATURE

The factors which affect successful completion of developmental mathematics among community college students are the focus of this literature review. For purposes of this study the descriptors developmental and remedial as well as math and mathematics are used interchangeably. Included are citations from books, journal articles, professional organizations, dissertations and theses, and web sites which all have contributed to the body of knowledge regarding successful completion of developmental mathematics primarily at community colleges, but at institutions of higher education in general.

This review has five major sections beginning with the history, theory and practice of developmental education and student success in developmental education at the community college. Section three continues with a discussion regarding success in remedial mathematics among community college students and transitions to section four which includes seven factor types believed to have relationships with successful completion of developmental math. The study will conclude with a summary of the literature review.

## Developmental education history, theory, and practice

According to Casazza (1999) developmental education supports the needs of all learners. She defined it as a process which concentrates on the student holistically and addresses the intellectual, social and emotional growth and development of all learners. “It promotes the cognitive and affective growth of all learners, at all levels of the learning continuum. It is sensitive and responsive to the individual differences and special needs among learners” (Harvard Symposium 2000, Discussion section, para. 29).

Casazza (1999) outlined how respect for diverse talents and ways of learning was and is apparent in developmental education. Casazza described two historical issues which have influenced modern-day practice. The first issue, practices of early universities, was described using examples of how Harvard and other "institutions of higher learning have been accepting students who may not have met their standards for almost 200 years and, at the same time, have also been developing ways to meet the needs of these diverse learners" (Harvard Symposium 2000, Discussion section, para. 5).

The second historical theme centered on the influence of government, war, business, and secondary education. According to Casazza (1999), "it was government that led the way to opening the doors to diverse populations and broadening the curriculum of colleges and universities," as she referenced the Morrill Acts and the G.I. Bills (Harvard Symposium 2000, Discussion section, paras. 8 and 16). "It was business leaders who cried out for more relevant preparation of their future employees," (Harvard Symposium 2000, Discussion section, para. 9), and "it was higher education that recognized the need to connect with earlier levels of educational preparation" (Harvard Symposium 2000, Discussion section, para. 12). Casazza (1999) continued that "all of these connections contributed to the broadening of higher education, both its curriculum and student body," (Harvard Symposium 2000, Discussion section, para. 20), and as a result "students came through the doors with a variety of learning profiles, levels of preparation, goals, and talents" (Harvard Symposium 2000, Discussion section, para. 20).

Casazza explained that modern day higher education has been dealing with many more issues which surround developmental learners.

> Today's students differ, however, in several respects. They have more diverse cultural and ethnic backgrounds. They often come from homes where English is not the primary language. Increasingly, the new students come with more diagnosed learning disabilities than ever before. And the new students are very apt to be returning adults who have stopped out of the educational system for varying periods of time. (Harvard Symposium 2000, Discussion section, para. 18)

Second, Caszaaz explained that it becomes increasingly important to respond to the depth and breadth of current-day diversity via the strategies which are implemented. Practice implications as a result are varied and many according to Casazza.

> Developmental educators manage learning centers at high schools and colleges, direct community-based literacy programs, deliver basic skills training in the workplace to employees at all levels, teach GED and ABE courses, create "bridge" programs for students transitioning from high school to college, and develop curriculum for and teach developmental courses which range from "Strategies for Effective Reading" to "Integrated Academic Discourse" to "Organizing the Thesis" (Harvard Symposium 2000, Discussion section, para. 30).

Finally, Casazza explained three underlying assumptions which described the theory and practice of developmental education.

> First, developmental education is a comprehensive process. In other words, it looks at the learner holistically, not piecemeal, and assumes that development is a process, not a product that simply measures success by an increased test score or a grade in a skills-based class. Second, it focuses not only on the intellectual growth of the learner, but the social and emotional development…. That is what developmental education is all

> about. This brings us to a very distinctive feature of developmental education and that is the assumption that all learners have talents; it is up to us as educators to identify them and use to support other areas….One last assumption about developmental education is that it is not limited to learners at any particular level (Harvard Symposium 2000, Discussion Section, paras. 30-32).

Many researchers (Boylan, Bliss, & Bonham, 1997; Boylan, 1999; Boylan and Saxon, 1999; Maxwell, 1997; National Center For Educational Statistics, 2003; Brown and Rivas, 2011) support Casazza's discussion regarding access and success of developmental leaners served at the community college. The next section will expand upon the history, theory and practice of developmental education and provide relevance for learners enrolled at community colleges.

**Developmental education and student success at the community college**

The history of developmental education, its theory and practices, and associated learner types, which Casazza (1999) described, may be more prevalent at the community college than at many other institutions. Boylan (1999) reported that "almost a third of those entering our colleges and universities are underprepared" (p. 3). The National Center for Educational Statistics (2003) reported that about 60 percent of first-year community college students placed into at least one developmental class and many test into two or more. Maxwell (1997), cited by Brown and Rivas (2011), described underprepared students as "having skills, knowledge, and motivation that are significantly below those of the typical student in the program or college in which they are enrolled" (p. 54). Brown and Rivas (2011) suggested that "understanding student qualities and the characteristics that place them at risk for not succeeding in college is essential" (p. 53). Inherent in this discussion is the issue of supporting success at the community college for developmental learners.

In a study conducted by Boylan, Bliss, and Bonham (1997) six components and their impact on student success measures, such as first-term GPA and course success, were assessed. The components in the study were centralized structures, mandatory assessment, mandatory placement, and availability of tutoring, counseling/advising and the presence of program evaluation. Of the components, centralized organization, tutoring with tutor training and systematic program evaluation were related to the highest number of success measures. The authors concluded that there appeared to be definite relationships between developmental education program components and student success outcomes.

In 1999, Boylan and Saxon reported on 30 years of research which had guided and continues to inform remedial practices at the community college. They listed 20 techniques, models or structures which have contributed to successful remediation at the course and institutional levels. Some of the items at the course level included: mandatory assessment and placement, the use of mastery learning, high structure in remedial courses, a use of a variety of instructional approaches, and the integration of a laboratory experience into the classroom setting.

While the preceding discussion focused on developmental student success in general at the community college, the subsequent sections of this review analyze and synthesize the literature which addressed issues of success in developmental mathematics. Many of the issues identified as having relationships to success in remedial education generally listed above by Boylan and Saxon (1999) - mandatory assessment and placement, the use of mastery learning, high structure in remedial courses, a use of a variety of instructional approaches, and the integration of laboratory into the classroom setting - were also discovered as having relationships to success in developmental mathematics. Section three outlines developmental math success

issues in a general way with section four providing a review of the seven factors which impact success in remedial math at the community college.

## Developmental mathematics success and the community college

Successful completion of developmental mathematics for many community college students can be the number one barrier to matriculation and eventual credential attainment as described by Stigler, Givvin, and Thompson (2010), and Hern and Snell (2010). Students who have been placed into developmental math many times must complete two or three levels of coursework before they may enroll for a gateway course in their discipline or educational plan of study. Some recent studies have identified the levels of coursework required of developmental students can number up to five. "A student placed into basic arithmetic may face two full years of mathematics classes before he or she can take a college-level course" (Stigler, Givvin, & Thompson, 2010, p.1). According to Stigler, Givvin, and Thompson this might be acceptable if students were successful during the two years, but data reveal that is not the case. Other longitudinal studies, such as data from Achieving the Dream (2006), have concluded that nearly 77% of students referred to developmental math never attempted or completed it successfully (Achieving The Dream: Community Colleges Count, 2006, p. 1).

Some researchers (Leinbach and Jenkins, 2008) have called this concept milestone achievement and momentum point analysis. Their research focused on community college students and their achievement of milestones and the measurable points in time they call momentum points as they persist and progress.

> Understanding how students actually progress through their college programs is essential in developing strategies and choosing appropriate interventions to improve student outcomes. The challenge is to build expertise and capacity in college and state agency

research departments to transform raw SUR (Stohl) data into meaningful information of practical use for policymakers and practitioners" (p. 1).

Based upon these data it is clear that faculty, administrators, staff, and students should all be concerned with the solutions which might improve the achievement of milestones. The solutions have been evolving through the years with professional organizations and those responsible for the delivery of developmental math continuing to provide approaches to attack the problem. Schwartz (2007), Bryk and Treisman (2010), Hern and Snell (2010), Stigler, Givvin, and Thompson (2010), Achieving The Dream, the American Mathematical Association of Two-Year Colleges (AMATYC) and others are providing data and solutions.

AMATYC provides publications and guidance to improve student performance in mathematics. Schwartz (2007) offered his supportive commentary on these AMATYC guidelines with respect to the use of technology in the classroom, collaboration with K-12, the need for quantitative literacy, professional standards, and testing and placement in math courses. Other academics such as Bryk and Treisman (2010) have advocated for multiple pathways to complete the mathematics sequence.

According to Bryk and Treisman (2010) many times students are asking the question of why they have to take the course(s). In other words why are four courses in a developmental math sequence leading to college algebra or some other gatekeeper course relevant? "It's time to decide what these students really need to know to succeed. For these reasons, we think that it's time to revisit both the structure and goals of remedial math" (p. B19-B20). Bryk and Treisman believed that the math pathways for those students interested in STEM (Science, Technology, Engineering and Math) disciplines is and has been well-defined for many years. On the other hand…"students in the social sciences, arts, and humanities, and those seeking careers in

business, applied technologies, health sciences, and other fields could be served just as well by another pathway" (p. B19-B20). In addition to the number of courses required, the pathways to success and the determination of college-level readiness, the ways courses are offered also compound the problem. Faculty members such as Hern and Snell (2010) have advocated for changes in the way the courses are delivered and still others (Bahr, 2008) have asked the question of whether math remediation even works?

There are a growing number of faculty members such as Hern, Co-Director of the Faculty Inquiry Network and English Instructor at Chabot College, who believe that collapsing the levels of coursework and establishing accelerated courses improve success rates. According to Hern and Snell (2010) "There is a harsh reality that these students may not understand…the more semesters of remedial courses a student is required to take, the more remote that student's chances of passing college-level Math or English…" (p. 1).

On the other hand there are some researchers (Bahr, 2008) who ask the question whether or not math remediation even works. In his 2008 study Bahr posed the question does "remediation in math resolve the academic disadvantage faced by mathematically underprepared students" (p. 424)? In terms of credential attainment and transfer, Bahr discovered that students who remediate successfully in math have comparable outcomes as those students who achieve college level math without remediation. He continued, that while the goal of math remediation was being achieved in his study, a bigger issue was that of students who do not successfully remediate, which was about seventy-five percent of his sample. This finding supported previously cited works. (Achieving the Dream, 2006; Stigler, Givvin, & Thompson, 2010; Hern and Snell, 2010)

It is clear that solutions are evolving. There appears to be some agreement that course redesign, including mastery and modularized learning, pathways for success, and maintenance of standards are important parts of the solution.(Stigler, Givvin, & Thompson, 2010; Hern and Snell, 2010) While those responsible for implementing improvements continue to debate the possible solutions, success rates are not improving nationally (Achieving the Dream, 2006). However, some developmental mathematics programs (Hern & Snell, 2010; Stigler, Givvin, & Thompson, 2010) are showing improvement slowly by implementing some of these solutions.

The discussion will now continue with section four and attempt to expand upon seven factors which emerged as variables affecting successful completion of developmental math at the community college. In order to better understand the types of studies used to assess effectiveness of developmental education a brief discussion will be provided regarding study types. Following this discussion, factor one the impact of policy decisions regarding the definition of success, will begin section four.

**Factors affecting successful completion of developmental mathematics**

The preceding sections have discussed the basic foundations of developmental education theory and practice at the community college and have provided some overall insights into the issues of successful remedial math completion. It is important to note that the types of studies used to assess effectiveness of programs and courses were also an issue raised in the literature. Some researchers (Melguizo, Bos, & Prather, 2011) asked the basic question of whether or not the type of study used to assess success in developmental math made a difference with respect to success outcomes such as completion of the remedial course, completion of college level mathematics, retention and credential attainment. They cited multiple descriptive studies, such as those conducted by the National Center for Developmental Education (Boylan, Bliss, &

Bonham, 1997), O'Connor and Morrison (1997), Adelman (1999), and James, Morrow and Perry (2002), which have a wide range of findings. "The wide disparity in these findings of these studies confirms that descriptive studies present conflicting evidence that makes it really hard to understand the impact of basic skills math on students' educational outcomes" (p. 177). As Melguizo, Bos, and Prather (2011) continued their review of the literature they discovered similar results with studies which were quasi-experimental or used regression discontinuity design.

This section will include a review of the literature with respect to the prediction of success in developmental mathematics no matter what type of study. The factors impacting success in remedial math which emerged from the literature included policy decisions, placement testing, breadth of skill deficiencies, characteristics of the course delivery approach, faculty characteristics, student beliefs, characteristics and attitudes toward mathematics and other academic and demographic factors. The section will begin with a discussion regarding how state and institutional policies may impact success in remedial math.

**The impact of policy and the definition of student success in developmental math**

The first factor affecting successful completion of developmental math discovered was the impact of policy decisions at the state and local level. The definitions of success and the typical elements which surround the definitions are still in question by many leaders. The definitions of success in developmental education varied from state to state and college to college; some having singular or multiple outcomes. Many states, colleges and universities had established recommendations and or developed policies and practices in order to improve success among students who had been assessed and placed into developmental mathematics. Bahr (2008) pointed out that one of the issues facing practitioners was which academic outcome

or outcomes should be studied? Course success, retention, mean grade point averages, pre and post –test scores on standardized assessments and persistence to degree were among typical outcomes on the list. Some studies (Abraham, 1992; Perin, 2006) have provided recommendations on how to best formulate regional, state, and local policy to best serve students' success.

Eight recommendations regarding the definition of student success and other policy decisions related to remedial education emerged from a study conducted by Abraham (1992) and the Southern Regional Education Board (SREB). The survey was administered to SREB state schools in 1988-89. In this study only 31 percent of the survey respondents reported that they kept retention records for students taking remedial education. Less than 50 percent of the respondents reported that they operated under specific requirements to determine and report remedial program effectiveness.

Perin (2006) outlined 22 institutional practices from 15 community colleges studied. The purpose of the study was to "investigate state and institutional practices for remediation in 15 community colleges selected for region, size, and urbanicity" (p. 339). The success measure which she used was retention where she identified three practices which appeared to promote retention of students placed into developmental course work. The three practices identified were that: 1) Assessment was not required until the student was well into their college degree program; 2) The official transcript did not show any grade for failed remedial courses; and, 3) College credit was awarded for remedial courses. According to Bahr (2008) evidence still existed that policy decisions affecting the definition of success in developmental education remain an issue for practitioners

A common policy finding for both studies (Abraham 1992, Perin 2006) was the lack of exit criteria from remedial to college-level coursework. Abraham made the recommendation that "every institution should have exit-criteria for remedial courses that establishes readiness to begin college-level study" (p. 28). Similarly, Perin (2006) discovered that the study participants did not set policy for the advance and exit from developmental courses. Most leaders used course grades, test scores or instructor approval for progression to college-level coursework.

The general conclusion made from reading these studies was that until policy makers decide on which practices, such as exit criteria, and which definition of success should be used, little may be accomplished with the predictive capabilities of faculty and staff charged with assisting students to completion. For purposes of this literature review, success is defined as course grade, retention, graduation, completion of milestone, or any indicator of progression to persistence.

One of the common factors used to predict success in developmental math is course placement. Abraham (1992) and Perin (2006) concurred with such findings as four-fifths of colleges and universities had written placement polices (Abraham, 1992) and institutions in their studies used state-developed tests, commercially developed assessments, and locally-developed informal instruments or approaches such as self-placement, whether in single or multiple measures. Placement testing is an important factor in the prediction of success in developmental math and is discussed as factor two in the next part of this section.

**Placement testing as a factor**

Akst and Hirsh, 1991; Matthews-Lopez, 1998; and Perin and Charron, 2003 all reported that the placement testing procedure for initial course placement was central to ensuring students get started on the most successful path possible. Other researchers (Gillespie, 1993; Armstrong,

1995; Sawyer, 1997) indicated that assessment policies and procedures should place students into initial courses for which they will be able to achieve success. The importance of proper assessment procedures is very evident in the literature with multiple studies described below conducted on various methods of placement.

An early study conducted by Abraham (1992) and the Southern Regional Education Board indicated that nearly 125 combinations of about 75 different tests in the areas of reading, writing or mathematics were used to place students in either college or developmental courses. Nearly fifteen years later, Perin (2006) determined, in her study of 15 community colleges, that none of the institutions were entirely satisfied with their placement approaches and many times informal approaches were used to check the accuracy of the standardized assessments.

The precision or predictive value of placement tools is a question that many colleges and universities regularly ask. Jacobson (2006) reported that "The obvious direct way to determine the value of the new placement procedure would be to examine the success rates in the target courses" (Jacobson, 2006, p. 139). Earlier studies attempted to answer that question. King, Rasool, and Judge (1994) completed a study at Westfield State College following a Massachusetts Board of Regents directive in 1990 that mandated the assessment of basic skills for all first-time degree-seeking students. King et al. discovered after a study of correlations between Math SAT scores, high school rank, gender, age, transfer status and course success that the only significant variable was Math SAT. The relationship, however, was not strong enough to recommend Math SAT as a tool for placement. In fact, only 63 percent of students placed using the Math SAT had successful outcomes, meaning that 37 percent were misplaced.

Wangsness-Hartl (1997) and Long (2003) attempted to determine the relationships between course placement and course success. Wangsness-Hartl (1997) concluded that the

"Numerical Skills test scores [on the ASSET test] were most useful for placement into introductory courses. The Numerical Skills test was less useful for courses designed for transfer…" (p. 135). At the same time Long (2003) summarized that "no relationship between mathematics placement score or a combination of variables and successful course completion was found" (p. 110).

Waycaster (2004) concluded that the readiness tests used (ASSET, COMPASS, and in house assessments) at Southwest Virginia Community College "did not predict a significant percentage of the variation in the core final exam" (no page number). Waycaster recommended further consideration of the use of the tools and the selection of one tool which might better serve the students.

Perin (2006), in a related study of 15 community colleges around the country, discovered four practices among the colleges that increased the precision of placement. She recommended that separate tests for native-English and ESL students, use of institutional assessments to confirm or change standardized test placements, adjustment of cut scores as demographics change, and use of multiple measures such as student appeal, retests or instructor approval were practices that would increase the precision of placement. This recommendation was in line with King et al. (1994) who stated that colleges should consider a review of other variables such as student motivation, level of interest, math anxiety, and class size. These may provide a clearer path for advisors and counselors as they make course recommendations for students.

Hughes and Scott-Clayton (2010) found that "common assessments currently in use have some utility but are insufficient in terms of providing enough information to determine the appropriate course of action that will lead to academic progress and success for the vast range of underprepared students" (p. 21). Placement instruments are used to help students, faculty and

staff to decide which courses are best suited for the student's skill levels in reading, writing, and math. While this literature review focuses on success in math, studies emerged which showed evidence that having other skills needs such as English or reading might impact success in math. Bahr (2010) referred to this as breadth of skill deficiency and is discussed below as factor three.

**Breadth of skill deficiencies as a factor**

It is important to recognize that students who are placed into remedial mathematics may also have other developmental needs in English and reading. In order to test this hypothesis Bahr (2010) analyzed a cohort of nearly 69,000 students from the California community college system who began their enrollment in 1995. He tracked them up and through the spring of 2003 to determine what effect breadth and depth of skill deficiency might have on student outcomes. He discovered that breadth "…skill deficiencies in English and math go hand in hand….that there is "a nearly linear relationship between declining math skills and the shrinking likelihood of not requiring some type of remedial English" (p. 187). He continued that "the more severe a student's math skill deficiency at college entry, the more likely the student will be to have an English deficiency and the more likely it is that the deficiency will be severe" (p. 187). The final breadth of skill deficiency which was discovered was that the "…number of initial skill deficiencies is correlated negatively with attaining college-level skill" …. "…that less than one-fifth of students who entered college with two skill deficiencies (both math and English) attained college-level skills in both math and English" (p. 187).

Adding to the complexity of the aforementioned factors affecting success in developmental math a discussion of course delivery and the impact on student success emerged as factor number four. Issues such as how many hours the course is offered, how it is delivered in terms of traditional lecture, computer-assisted, online or distance and the instructional

strategies used by the faculty members all surfaced as having relationships to student success in remedial math.

**Course delivery strategies as factors**

The complexity of the prediction of the success in developmental math becomes even more acute when the next factor is added to policy decisions, placement testing and the breadth of skill deficiencies. The literature provided some evidence that the way the courses are delivered may have an impact on student success. The number of course hours, the delivery approach, and the associated instructional strategies appeared in the literature as having some type of relationship to the prediction of success among remedial math students. The discussion below begins with course credit hours, continues to delivery approaches and concludes with instructional strategies.

**Course credit hours.**

Woodard and Burkett (2010) conducted a follow up study to their 2003 assessment of whether delivering developmental math in three or five credit hour sections made a difference with respect to success rates. They discovered no significant differences when the courses were offered in three or five credit sections and concluded "that three-credit courses are just as effective as five-credit courses for developmental math students…" (p. 26). A further review of this factor needs to occur in order to determine if other research exists to explain the relationships between credit hours and student success. Along with the number of hours expected in the instructional approach, the way the course was delivered has also been studied with respect to student success.

**Distance and computer-assisted instruction.**

Blackner (2000), Taylor (2008), and Lynch-Newberg (2010) conducted studies to measure differences in student achievement in traditional and web-based and computer-assisted curricula for students enrolled in remedial mathematics. Blackner concluded that the beginning Algebra students achieved higher grades but similar final exam scores using computer assisted instruction than did students who were in traditional classrooms. Similar assessment approaches were used to determine the relationships for distance students enrolled in computer-assisted instruction versus distance students enrolled in traditional delivery approaches. There were no significant differences for distance students in either category. On the other hand, intermediate Algebra students demonstrated no significant differences in final grades for each instructional approach but traditionally-enrolled students did show significantly higher final exam scores.

In related studies Taylor (2008) and Lynch-Newberg (2010) attempted to answer the question whether online or traditionally-delivered and computer-assisted courses resulted in any differences with respect to student success. Taylor suggested that the delivery method was "instrumental in improving mathematical achievement of some students but not of all the students" (p. 43). In other words, for some students lecture was better and for other students computerized approaches worked better. Lynch-Newberg (2010) confirmed that female students enrolled as "online participants were just as successful in retention, success, and progression as the traditional lecture participants" (p. 65). In addition to the course platform, the way the faculty members provided instruction also emerged within the body of knowledge. Mastery learning, traditional lecture, use of learning logs, and conceptual learning strategies were discussed by Stanton, 1997; Boaler, 2001; Tien, 2009; and, Rambish, 2011.

**Instructional strategies.**

In addition to the literature on delivery mode and computer-assisted approaches one study emerged (Stanton III, 1997) which concluded that cooperative grouping and learning approaches for community college arithmetic students resulted in higher course success rates for the course, but did not hold true for the subsequent course for which students enrolled. Students who were enrolled in a traditional lecture approach had higher course success rates in the subsequent math course. As Stanton pointed out, there are many possible reasons for this and further study should be conducted.

Tien (2009) attempted to determine if course success, problem solving performance, and attitudes toward mathematics were improved by the use of Cognitive Monitoring Learning Logs where students kept a journal of their reflective writings based upon their experiences in the course. The conclusions of the study were that the strategy "can positively impact specific student outcomes (such as final grades)…and…"students' attitudes toward math" (p. 152). No significant differences for their problem-solving performance emerged as a result of using learning logs.

Rambish (2011) provided a study on the differences in achievement when an arithmetic course was taught via a traditional lecture mastery learning approach and a conceptual learning method. The differences in delivery were defined as traditional delivery "is rote, where students are taught an algorithm and are expected to use it without understanding the concepts behind it" (p. 63). Conceptual delivery was defined as teaching the language and concepts behind the computation leading the students to discovery of everyday uses of arithmetic. Rambish discovered that conceptual learning approaches did produce higher course grades for students

than traditional approaches but revealed that other similar studies (Boaler, 2001) did not. Rambish recommended further study.

Along with the type of instructional strategy delivered in the classroom came literature which attempted to determine the role a faculty member may have on student success. Factor five emerged with literature regarding the relationships between faculty characteristics and student success. Issues of employment status, credential, personal characteristics and other demographic factors are described below.

**Faculty characteristics as factors**

Related to the number of credit hours and instructional strategies are the characteristics of the faculty member who is responsible for teaching the course. Studies which were designed to determine the association of faculty members' personal and experiential traits to course success (grade C or better) in developmental math were conducted by Penny and White (1998), Fike and Fike (2007) and Preuss (2008). Penny and White (1998) used faculty characteristics of age, gender, educational preparation, teaching experience, and employment status to determine if there were any relationships of faculty characteristics to student success in both developmental and college-level mathematics courses. The authors concluded that faculty gender and employment status related to student performance in developmental math.

Fike and Fike (2007) discovered, in a study of 1,318 students enrolled in an intermediate algebra course, that outcomes of students taught by part-time faculty did not differ in a significant manner from outcomes of students taught by full-time faculty. According to Fike and Fike this finding did contradict earlier findings by Henebry, (1997) and Penny & White, (1998) where there were significant differences. Fike and Fike (2007) continued that the differences might be due to other variables not used in their study such as prior experience, professional

development and type of degree. The authors did find, however, those faculty members who held a graduate degree had better student success outcomes than those with baccalaureate credentials.

The faculty characteristics studied by Preuss (2008) were age, gender, employment status, county of residence, instructional experience in secondary education, present employment in secondary education, graduation from a community college, credential attained, predominant type of math studied in graduate school, graduate hours in math, years of instructional experience in higher education and at the college used in the study, and academic rank. Preuss concluded that faculty characteristics and personal traits were related to student success at this North Carolina Community College.

> Twenty-five of the 114 points of comparison calculated yielded statistically significant results at $\alpha = .05$ level or higher. Twenty-one of the groups of faculty formed around variables or subcategories of variables investigated were found to have relationships to student success rates which were uniformly negative or positive across all three levels of instruction" (p. 169).

The addition of faculty characteristics to this review certainly added to the intricacy of being able to predict success in developmental math among community college students. Thus far this review has focused on policy decisions, placement testing, and breadth of skills deficiencies, course delivery approaches, and faculty characteristics. The next part of this section will address the literature related to the student voice. Student beliefs and motivations, engagement, math anxiety, locus of control and learning styles will be discussed as factor number six.

**Student beliefs, characteristics and behaviors as factors**

The importance of including student beliefs, attitudes, and other non-cognitive variables about mathematics as critical factors in the prediction of success in developmental math has been well documented. Muis (2004) reviewed 33 studies on students' epistemological beliefs about mathematics and concluded that "All studies revealed significant relationships between beliefs and cognition, motivation, and achievement" (p. 317). According to Muis, the National Council of the Teachers of Mathematics (NCTM) suggested that "the assessment of students' beliefs about mathematics is a crucial component of the general assessment of students' knowledge of mathematics" (p. 363). Similarly, Hughes and Scott-Clayton (2010) recommended non-cognitive assessments to correctly place students into proper courses. This part of section four will review the research which has studied the effect of student beliefs and motivations, engagement, math anxiety, locus of control and learning styles on achievement in developmental math.

**Student beliefs and motivations.**

Many academicians and researchers (Edwards, 1972; Strowbridge, 1987; Goolsby et.al, 1988; Taylor, 2008; Briley et.al, 2009; George, 2010; Mesa, 2011) contended that student motivation, goal orientation and emotions are powerful predictors of remedial mathematics success. An early study conducted by Edwards (1972) attempted to determine which factors, from eight possible variables, were the best predictors of success in developmental math. A stepwise multiple regression analysis was employed by Edwards and the independent variables of high school average, attitude toward math score, math interest score, work status, number of class hours, reading test score, sentence test score, and math test score were used in the analysis. He concluded that "…prediction of success in remedial mathematics courses can be made

correctly 71 percent of the time" (p. 160) using high school average, math test score, attitude toward math score, sentence test score and math interest score. In a related study Strowbridge (1987) stated that students' emotions, feelings and attitudes about math are "intimately connected with past experiences and with the student's perceptions that his or her needs have not been met. Thus, both success and achievement are key needs" (p. 88).

Goolsby, Dwinell, Higbee, and Bretscher, at the University Of Georgia (1988), conducted a mixed variable analysis primarily using attitudinal variables but also included the high school grade point average and Scholastic Aptitude Test –Quantitative score. The attitudinal variables included mathematics anxiety, math confidence, attitudes toward success, perception of teachers' attitudes toward the student as a learner of mathematics, and locus of control. When coupled with the two academic variables, a regression analysis revealed that of the attitudinal variables only math confidence contributed significantly to first quarter grades in developmental mathematics.

Taylor (2008) analyzed the impact of attitudes toward math as an outcome for two groups who were enrolled in different delivery systems. She found that mathematics attitudes possibly could contribute to mathematical achievement for some students. The attitudes of the control group, which was represented by students who were enrolled in traditional lecture approaches versus computerized approaches, declined at the end of the semester while the attitudes of those students in the computerized delivery model improved. She concluded that the attitudes of the control group did not positively contribute to achievement. On the other hand Briley, Thompson, and Iran-Nejad (2009) concluded that the more "useful the participants thought mathematics to be, whether for a career or just in everyday life, the more they saw the need to

learn mathematics. Thus, they applied themselves more and were more likely to earn a better grade" (p. 24).

George (2010) stated that students who have higher motivation and engagement levels tend to have better course outcomes than students who participate at lower levels. In addition, at the annual meeting of the American Educational Research Association Mesa (2011) reported the achievement goal orientation of 777 students enrolled in remedial and college level mathematics. Using adaptive learning and views about mathematics surveys (PALS and VAMS) Mesa concluded that "students' achievement goal orientation are consistent with adaptive learning patterns: students are interested in developing competence, expect and believe they can handle challenging work, avoid self-handicapping behaviors, and exhibit a positive mathematics self-concept" (p. 2). While Mesa was not attempting to predict success in math courses other studies have used these type attitudes and achievement goal orientations associated with engagement levels to predict success in developmental math courses.

**Student Engagement.**

In an attempt to measure the relationship between engagement levels and developmental mathematics success, Smith et al. (1996) conducted an ethnographic observation study of 218 students enrolled in five sections of developmental math at a four year commuter campus. Generally the findings revealed that "characteristics such as mean grade point average, mean credit hours, attendance, note taking, and interaction all have an impact on student grades. The levels of engagement in the classroom led to a discussion in the literature regarding how the level of math anxiety, locus of control and learning styles may have an impact on engagement and resulting levels of success.

**Math anxiety, locus of control, and learning styles.**

Math anxiety, locus of control and learning styles may also contribute to success in remedial mathematics. Blackner (2000) attempted to determine the relationships between mathematics anxiety, locus of control and learning styles with respect to final grade and final exam score. For the beginning algebra students in the study none of three affective factors were predictive of final grade or exam score. For the intermediate algebra students, however, math anxiety was predictive for final exam score while locus of control significantly contributed to final grade significantly. Spybrook (2008) added that math anxiety did not contribute to achievement among remedial math students.

In the most recent study discovered, Keller (2011), using a multi-factor approach included non-cognitive variables in addition to four other variable types. The primary research questions centered on relationships between the non-cognitive variables and various success outcomes of students enrolled in Elementary Algebra. Eight non-cognitive variables including knowledge acquired in a field, preference for long-term goals, realistic appraisal, self-concept, effectively handling the system, community service, supportive persons, and leadership experiences acted as variables to predict student success and persistence. Keller reported that "non-cognitive variables do capture significant differences in all six (of my) measures of student success and persistence" (p. 212). Knowledge acquired in a field and preference for long-term goals "were the most powerful noncognitive variables, both in terms of the number of significant results and positive direction of correlation" (p. 212). "Self Concept, Effectively Handling the System, and Leadership Experience all had significant negative correlations with at least one success or persistence measure" (p. 212). Keller explained that the latter finding "may suggest

overconfident students and students less willing to change their behaviors are more prone to suffer academically early in their college experience" (p. 213).

The final part of this section will discuss factor seven which includes academic and demographic factors. Example variables used in the studies were high school GPA, ACT or SAT scores, gender, race, age, and course grades. Blackner (2000); Stephens (2005); Fike and Fike (2007); and, Taylor (2008) have conducted studies in order to determine which academic and demographic factors have significant relationships to student success in developmental math.

**Academic and demographic factors**

Analysis of success in remedial mathematics using academic and demographic variables comes in many forms. Most of these studies used a combination of academic and demographic data in order to predict student success. Using the demographic variables of age, ethnicity, gender and employment status, in conjunction with the academic variables of previous math courses and previous attempts at math courses, the following conclusions emerged from Blackner (2000). For beginning algebra students only gender was significantly related to both final exam score and final grade with females more likely to outperform males. For intermediate algebra students age was a predictor, with older students more likely to have a higher final exam grade. With respect to attrition no differences emerged for the beginning algebra students while previous course attempts for intermediate algebra students were significantly correlated.

The purpose of a study conducted by Stephens (2005) was to "develop a model for predicting success (as measured by end-of-course grade) in developmental mathematics courses…" (p. 4). Multiple regression analysis was used to develop the success equation given the student's age at the beginning of the term, recency of mathematics courses, ACT composite sand mathematics score and other section scores (or SAT-I equivalent) for students who have

them. COMPASS scores were used for those students who did not have ACT or SAT scores. High school grade point average and the number of years of college-preparatory high school classes completed in mathematics rounded out the variables. Stephens concluded that for the elementary algebra course, the only variable with a significant correlation to final grade was high school grade point average. For the intermediate algebra course the final grade was correlated with ACT math and reading scores, COMPASS intermediate algebra and reading scores, number of college preparatory mathematics courses taken in high school, and overall high school grade point average.

Fike & Fike, (2007) revealed that student gender, race and age were associated with successful completion of intermediate algebra among 1,318 students enrolled in a Texas community college. The findings indicated that female students outperformed male students, white students outperformed other races, and older students had higher success rates than younger students. A study conducted by Taylor (2008) showed no significant differences in achievement could be attributed to gender, ethnicity or age.

**Summary of the literature review**

In order to better understand the success issues surrounding developmental mathematics a discussion of developmental education theory and practice in general and how it relates to the community college student was included. The discussion continued with the current body of knowledge regarding success in developmental math and the seven factors which impact successful course completion and other progression and persistence factors. The seven factors which have relationships to success in remedial math were discussed in section four and included: the impact of policy, placement testing, breadth of skill deficiencies, course delivery approaches, faculty characteristics, student beliefs, characteristics, and behaviors, and academic

and demographic factors. It is clear that the variables which impact student success are complex and, when combined, might explain possible reasons why solutions to the failure rates in developmental math within the community college system are not generally forthcoming or accepted.

# CHAPTER 3: METHODOLOGY

In Chapters one and two, it became clear that community colleges are faced with unacceptable course grades for students who enroll in developmental mathematics. Many of the studies conducted to date have included sound research approaches and focused on independent variables which were usually representative of previous academic performance, demographic indicators, placement scores or delivery methods. Some researchers (Long, 2003 and Stephens, 2005) have pointed out their studies paid little attention to other factors such as attendance, attitude, effort, anxiety levels, learning styles, number of hours worked, number of credit hours carried in the semester, income, marital status, personal issues, or how the student might self-assess his or her own skill levels. One study conducted by Edwards (1972) used a few of these type indicators, but the research was conducted 40 years ago. Additional research using many of the same variables employed in previous studies and adding a greater number of variables and variable types is needed.

In the Chapter 2, review of the literature, seven factors emerged which also served as guides for this study. This study took the advice of Long (2003) and Stephens (2005) and attempted to add additional variables to determine if any relationships between those variables and previously studied variables might exist at North Central State College, a community college in Ohio. In addition to previous academic performance, demographic indicators, and placement scores, this study added data which represented breadth and depth of skill deficiencies and student beliefs, characteristics, and behaviors. It is clear that the variables which impact student success are complex and, when combined, might suggest possible reasons why course grades among community college students are not acceptable.

## Research Design

This study used a non-experimental research design and more specifically an associational, sometimes referred to as correlational approach. The purpose of relational or associational research is to identify the relationships or associations between two or more characteristics within the same group of participants (Gliner, Morgan, & Leech, 2009). It should be noted that this study did not attempt to provide casual relationships between the variables. Gliner, et al. (2009) pointed out that there are three criterion for determining causation and that ruling out other possible explanations, the third criterion "…is never possible in the comparative and associational approaches" (p. 102). The population used for this study and the sampling approach to collect the data are described in the next section.

## Population and Sample

In order to conduct this archival study, convenience sampling was used to determine which community colleges had administered the College Student Inventory Form B™ (CSI-B) in each of the fall semesters during 2010, 2011, and 2012. Conversations were held with the convenience sample of those community colleges in order to provide an overview of the planned study and to discuss possible participation. North Central State College in Mansfield, Ohio agreed that the study would be beneficial to their student success planning efforts and agreed to provide data for the study pending Institutional Review Board approval. Approval was sought and gained both at Colorado State University and at North Central State College.

### Instrumentation

Data were obtained from three different sources. The instruments included the academic records of the student information system which is Datatel, ACT Compass® Math assessment

from American College Testing (American College Testing, 2014) and the College Student Inventory Form B™ (CSI-B) (Stratil, 2001).

**Historical Data from Student Information System, Datatel.**

Archival data housed within Datatel had been part of the Achieving the Dream project which North Central State College continues to participate in. Achieving the Dream's goal, per their website, is to assist colleges to provide higher levels of "success for more community college students, especially students of color and low-income students."(Achieving The Dream, 2014) One element of their approach is to guide evidence-based institutional change by providing colleges coaching and technical assistance for data collection, analysis, and decision making. (Achieving The Dream, 2014) The non-College Student Inventory™ data used in this study were data which had been collected for this project.

**American College Testing Course Placement Assessment**

ACT's Compass® "…is a computer-adaptive college placement test that lets educators evaluate incoming students' skill levels in Reading, Writing Skills, Writing Essay, Math, and English as a Second Language….place students in appropriate courses, and….connect students to the resources they need to achieve academic success." (American College Testing, 2014) For purposes of this study, the ACT Compass® Mathematics Test score will be used to determine relationships with course grade. The test provides colleges and universities with five placement domains including pre-algebra which is the focus of this study. The test uses a multiple choice format that assesses students' abilities in basic, application, and analysis skills. (ACT, 2007)

According to the Compass Reference manual (ACT, 2012), reliability coefficients were computed using simulation studies that "covered a broad range of ability levels in the relevant content areas and were large enough to ensure stable results." The coefficients were high

(Gliner, Morgan, & Leech, 2009) ranging from .86 to .90 for the pre-algebra test depending on the test length administered. In order to provide evidence of predictive validity, logistic regressions models were used to calculate probabilities of success in courses that had lower-level offerings in which a student could be placed. The "probabilities were used to calculate the estimated percentage of students who would be assigned to the lower-level mathematics class (for a particular cut-off score) and the estimated accuracy rates (the estimated percentage of students correctly placed). (ACT, 2012) Increases in accuracy rates were computed using the difference between the estimated accuracy rates and the estimated accuracy rate had no placement test been used. (ACT, 2012) Median increases in accuracy rates ranged from 16 to 25 points depending upon the mathematics course type.

**College Student Inventory Form B™ (CSI-B).**

The College Student Inventory – Form B™ (CSI-B) (Stratil, 2001) is a motivational assessment designed for colleges and universities to better understand student needs, as reported by the student, as he or she enters and persists during the first year. The CSI-B is comprised of 100 items contributing to 17 individual scales. The average length of each scale is five items, with the lengths ranging from two to eight items. (Herr, 2009) They are based on a number of items, some of which are added to the scale (protraits) and some of which are subtracted from the value of the scale (contraits). Each item can have a minimum value of 1 and a maximum value of 7.

The minimum value of a scale then is achieved by assigning a value of 1 to all the added items (protraits), and a 7 to all the subtracted items (contraits). A scale with 6 items, three of which are protraits and the other three are contraits, has a minimum value of -18. (3*1 – 3*7 = 3-21=18). Similarly, the maximum value is achieved by assigning a 7 to the positive items and a 1

to the negative items, which gives you a +18. (3*7 – 3*1=21-3=18) Scales with the same number of protraits and contraits will show this symmetry between the minimum and the maximum value, while those with different numbers of protraits and contraits will not.

All CSI surveys use lookup tables that contain the national norms for each of the survey scales. The norms tables align the raw scale values with the corresponding percentile values. The percentiles are nationally normed in that they are based on either the complete data set for a given year or a representative sample of records for that time period, separated by school type. The norms tables are used to look up calculated raw scale values, translate them into percentiles, and then report them on the appropriate CSI reports for practitioners. As student responses to items and scales shift over time, the percentile norms will assure a relative position for any score. Norms are updated every three years.

Gliner, Morgan, and Leech (2009) suggested a process to determine reliability and validity of summated or aggregate scales. First it was suggested that once literature or theory was used to drive the scale development that Cronbach's alpha be computed to determine internal consistency of the items that make up each scale. Second, factor analysis should be used to determine if items were organized properly in scales based upon the literature review or theory. Studies of this nature were conducted for the College Student Inventory™ (CSI-B) with results included below.

Cronbach's alpha among the two year college norm group ranged from .67 to .86 among all the scales. The average reliability coefficient alpha was 0.79 for two year schools, .81 for four-year private colleges, and .82 for four-year public institutions. (Herr, 2009) Factor analysis in 2008 reconfirmed the scale structure with the factors explaining 57 percent of the variance in

the data. These measures are within acceptable ranges as advised by Gliner, Morgan, and Leech (2009).

**Data Collection**

De-identified data, for each of the fall semesters 2010, 2011, and 2012, were collected by Tom Prenderagst, Director of Institutional Research at North Central State College, and transmitted to the researcher in the fall of 2013. Two sources of data were used in this study. Source one represented data from the college's academic records which included over 100 variables from an existing Achieving the Dream database. Source two provided items and scale scores from the College Student Inventory Form B™. Many of the variables were not needed to describe the sample or to answer the research questions and were discarded. Prior to the finalization of the independent variables, exploratory factor analysis was conducted on the 26 items from the College Student Inventory Form B™ (CSI-B.) in order to determine if the constructs purported to be measured and which are being used in this study actually provided a reliable and valid measure.

## Factor Analysis

Thompson (2004) and Gliner, Morgan, and Leech (2009) suggested that exploratory factor analysis can be used to summarize relationships of multiple items into a set of more useable, parsimonious factors. "In exploratory factor analysis one postulates that there is a smaller set of unobserved (latent) variables or constructs that underlie the variables that actually were observed or measured. (Gliner, Morgan, & Leech, 2009). This study was designed to use four scale scores from the College Student Inventory Form B™ (CSI-B) (Stratil, 2001). Those scale scores, Study Habits, Desire to Finish College, Math and Science Confidence, and

Receptivity to Academic Assistance are comprised of 26 items designed to measure the noted constructs.

Thompson (2004) described that "…factor analysis can be used to inform evaluations of score validity." In order to determine if the items actually did produce a construct score intended to measure the scales noted above, I used SPSS 18 to conduct principal axis factor analysis of the 26 items. Gliner, Morgan, and Leech (2009) explained that investigators complete such analyses in order to determine if items designed to measure constructs, such as habits, confidence, desire, and receptivity, actually "hang together." This allows the researcher to determine if the responses to confidence questions were more similar to each other than to their responses on the habits, desire and receptivity scales.

Principal axis factor analysis with varimax rotation was conducted to assess the underlying structure for the twenty-six items which make up the Study Habits, Desire to Finish College, Math and Science Confidence, and Receptivity to Academic Assistance scales from the College Student Inventory Form B™ (CSI-B). Items 16, 73, 85, 94, 37, 64, 72, 30, 40, and 83 were written as contraits therefore their raw scores were reversed to match the scale for positively-written or protrait items.

Four factors were requested based on the idea that the items were designed to measure constructs for habits, desire, confidence, and receptivity. The result produced twenty-six factors with the four factors having eigenvalues of greater than one after rotation. Leech, Barrett, and Morgan (2011) and Gliner, Morgan, and Leech (2009) suggested that "factors with eigenvalues of one or greater is a common criterion for a factor to be useful."

In the initial four component request all factor loadings were in excess of |.40| which is considered high by Leech, Barrett, and Morgan (2011). Items designed to measure study habits

and desire to finish college loaded well in the same factor even though the intention of the items is to measure two different components, desire and habits. Items designed to measure receptivity to academic assistance, math confidence and science confidence "hung together" in the three additional components. Table 3.1 below shows the results of the four component analysis.

Table 3.1

*Factor Loadings for the Rotated Factors - Four Component Solution*

| Item | Factor Loading | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Communality |
| CSI Item 38 Desire | .736 | | | | 1.0 |
| CSI Item 62 Habits | .718 | | | | 1.0 |
| CSI Item 40 Habits | .705 | | | | 1.0 |
| CSI Item 16 Desire | .705 | | | | 1.0 |
| CSI Item 51 Desire | .688 | | | | 1.0 |
| CSI Item 30 Habits | .676 | -.303 | | | 1.0 |
| CSI Item 85 Desire | .676 | | | | 1.0 |
| CSI Item 83 Habits | .675 | | | | 1.0 |
| CSI Item 60 Desire | .662 | | | | 1.0 |
| CSI Item 25 Desire | .653 | | | | 1.0 |
| CSI Item 18 Habits | .648 | | | | 1.0 |
| CSI Item 73 Desire | .632 | | | | 1.0 |
| CSI Item 94 Desire | .619 | | | | 1.0 |
| CSI Item 78 Habits | .617 | | | | 1.0 |
| CSI Item 28 Receptivity | | .775 | | | 1.0 |

| | | | | | |
|---|---|---|---|---|---|
| CSI Item 42 Receptivity | | .760 | | | 1.0 |
| CSI Item 82 Receptivity | | .700 | | | 1.0 |
| CSI Item 99 Receptivity | | .693 | | | 1.0 |
| CSI Item 17 Receptivity | | .668 | | | 1.0 |
| CSI Item 37 Math Confidence | | | .902 | | 1.0 |
| CSI Item 64 Math Confidence | | | .847 | | 1.0 |
| CSI Item 86 Math Confidence | | | .822 | | 1.0 |
| CSI Item 58 Receptivity | | .569 | -.633 | | 1.0 |
| CSI Item 50 Science Confidence | | | | .844 | 1.0 |
| CSI Item 93 Science Confidence | | | | .810 | 1.0 |
| CSI Item 72 Science Confidence | | | | .688 | 1.0 |
| Eigenvalues | 6.48 | 3.25 | 2.82 | 2.05 | |
| % of Variance | 24.93 | 12.51 | 10.86 | 7.88 | |

Applying the same process as above, five factors were requested to further determine if the desire items and the habits items would “hang” separately in scales per the intention of the CSI-B™, see Table 3.2 below. After rotation, factor one accounted for 15.7% of the variance, factor two accounted for 11.8% of the variance, the third component accounted for 10.7% of the variance, component four accounted for 9.6% of the variance, and the fifth factor accounted for 6.1% of the variance.

Table 3.2

*Factor Loadings for the Rotated Factors – Five Component Solution*

| Item | Factor Loading | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Communality |
| CSI Item 85 Desire | .682 | | | | | .56 |
| CSI Item 16 Desire | .680 | | | | | .53 |
| CSI Item 60 Desire | .652 | | | | | .54 |
| CSI Item 51 Desire | .651 | | | | | .57 |
| CSI Item 73 Desire | -.651 | | | | | .47 |
| CSI Item 38 Desire | .644 | .322 | | | | .52 |
| CSI Item 25 Desire | .616 | | | | | .43 |
| CSI Item 94 Desire | .592 | | | | | .41 |
| CSI Item 40 Habits | .309 | .741 | | | | .63 |
| CSI Item 62 Habits | .344 | .705 | | | | .58 |
| CSI Item 83 Habits | .307 | .677 | | | | .55 |
| CSI Item 78 Habits | | .677 | | | | .49 |
| CSI Item 18 Habits | .325 | .585 | | | | .48 |
| CSI Item 30 Habits | .397 | .567 | -.305 | | | .59 |
| CSI Item 28 Receptivity | | | .743 | | | .53 |
| CSI Item 42 Receptivity | | | .687 | | | .47 |
| CSI Item 82 Receptivity | | | .636 | | | .46 |
| CSI Item 99 Receptivity | | | .599 | | | .40 |
| CSI Item 17 Receptivity | | | .588 | | | .41 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CSI Item 37 Math Confidence | | | | .892 | | .69 |
| CSI Item 64 Math Confidence | | | | .811 | | .67 |
| CSI Item 86 Math Confidence | | | | .724 | | .51 |
| CSI Item 58 Receptivity | | | .569 | -.590 | | .63 |
| CSI Item 50 Science Confidence | | | | | .758 | .43 |
| CSI Item 93 Science Confidence | | | | | .747 | .46 |
| CSI Item 72 Science Confidence | | | | | .560 | .33 |
| Eigenvalues | 4.08 | 3.08 | 2.79 | 2.49 | 1.58 | |
| % of Variance | 15.69 | 11.83 | 10.72 | 9.57 | 6.09 | |
| Cronbach's Alpha | .83 | .88 | .82 | .86 | .74 | |

A review of the factor loadings revealed five components from the College Student Inventory Form B™ items (CSI-B) (Stratil, 2001) instead of the four intended scale measures of Study Habits, Desire to Finish College, Math and Science Confidence, and Receptivity to Academic Assistance. The Math and Science Confidence items, when processed through a five factor component solution, split into two different factors, math confidence and science confidence.

Component one ($\alpha$=.62) seemed to measure desire to finish college as was intended even though the reliability was considered minimally adequate (Gliner, Morgan, & Leech, 2009). Factor loadings of the first eight items (85, 16, 60, 51, 73, 38, 25, 94) were all .59 and higher.

Item 38 cross loaded into component two but at less than acceptable levels of .40 and was ignored in component two. Items 40, 62, 83, 18, and 30 cross loaded at less than acceptable levels of .40 and higher but more than acceptable levels in component two.

Component two (α=.88) appeared to measure study habits as was intended by the College Student Inventory™. Factor loadings in component two were all higher than .40 with the exception of the cross loading of item 38 which loaded better in component one, desire to finish college and per the intent of the survey.

A review of the items in component three (α=.82) 30, 28, 42, 82, 99, 17, and 58 showed that the receptivity to academic assistance construct was being measured with the exception of item 58. Item 58 cross loaded equally well in component four and was removed from the analysis because it did not singularly measure the intended construct of receptivity to academic assistance. Subsequently, the receptivity to academic assistance scale score was re-computed to remove item 58. Item 30, due to less than acceptable loading and a higher cross loading in component two and due to the intent of the survey, was ignored for inclusion in component three.

Component four (α=.86) included items 37, 64, and 86 which were intended to measure math confidence and item 58, which also loaded in the third construct, which appeared to measure receptivity to academic assistance. In accordance with the discussion above, Item 58 was removed from the analysis because it did not singularly measure the intended construct of receptivity to academic assistance or math confidence as was evidenced by the equally strong loading in math confidence. Component five (α=.74) included items 50, 93, and 72 and had factor loadings of .56 or greater. The construct appeared to measure a science confidence component which was initially part of a math and science construct. The study continued as

planned based upon the exploratory factor analysis described above and Alphas within acceptable ranges.

## Variable Definitions

Table 3.3 below includes the variable list, level of measurement and the levels included in this study.

Table 3.3

*Variable Definitions*

| Variables | Variable Type and Level of Measurement | Levels |
|---|---|---|
| Term of Enrollment | Nominal<br>Attribute IV | 1=Fall 2010, 2=2011, 3=2012 |
| Academic Interest | Nominal<br>Attribute IV | 1=Allied Health and Nursing, 2=Business, 3=Education, 4=Engineering and Computer Technology, 5=Humanities, 6=Public Service, 7=Transfer, 8=Undecided |
| Gender/Sex | Nominal<br>Attribute IV | 0=Female, 1=Male |
| Race/Ethnicity | Nominal<br>Attribute IV | -1=Missing, 1=American Indian/Alaskan Native, 2= Asian, 3=Black African American, Non-Hispanic, 5=White, Non-Hispanic, 7=Non-resident Alien |
| Diploma Type | Nominal<br>Attribute IV | 1=High School Diploma, 2=GED |
| Combination of Developmental Course Placements by Subject (Reading, English, Math) | Nominal<br>Attribute IV | 1=English, 2=English and Reading, 3=Math, 4=Math and English, 5=Math and Reading, 6=Math and English and Reading |
| Number of Developmental Course Placements by Subject Type (Reading, English, Math) | Nominal<br>Attribute IV | 1=One developmental placement, 2= Two developmental placements, 3=Three developmental placements |
| Years Since High School or GED | Scale<br>Attribute IV | -1=Missing, 0=0, 1=1 to 5, 2= 6 to 10, 3=11 to 20, 4=21 to 30, 5=More than 30 |
| CSI™ Number of hours | Scale | 0= Had no plans to work, 1= Planned to work 1 |

| | | |
|---|---|---|
| planned to work | Attribute IV | to 10 hours per week, 2=Planned to work 11 to 20 hours per week, 3=Planned to work 21 to 30 hours per week, 4=Planned to work 31 to 40 hours per week, 5=Planned to work more than 40 hours per week |
| Number of Developmental Courses Recommended | Scale<br>Attribute IV | 1=One, 2=Two, 3=Three, 4=Four, 5=Five, 6=Six |
| Number of Levels Below College Math | Scale<br>Attribute IV | 0=0, 1=One, 2=Two, 3=Three |
| ACT Compass® Math Placement Score | Scale<br>Attribute IV | 0 to 100 |
| CSI™ Study habits scale score | Scale<br>Attribute IV | -18 to 18 |
| CSI™ Desire to finish college scale score | Scale<br>Attribute IV | -24 to 24 |
| CSI™ Math and Science confidence scale score | Scale<br>Attribute IV | -18 to 18 |
| CSI™ Receptivity to academic assistance scale score (recomputed less item 58) | Scale<br>Attribute IV | 5 to 35 |
| Course Success | Nominal DV | 0= Less than C, 1= C or Higher |
| Course Grade | Scale DV | 0=F, 1=D-, 2=D, 3=D+, 4=C- , 5=C, 6=C+, 7=B-, 8=B, 9=B+, 10=A-, 11=A |

## Data Analysis

Steinberg, Bringle, and Williams (2010) discussed that associational type research designs accomplish three tasks. First, they serve to gauge the nature and degree of relationships between variables. Second, they summarize the degree to which the two variables are linearly associated. Third, a positive or negative direction of the linear relationship is produced. In other words, higher values on one variable are associated with higher values on the other variable when the association is positive. Likewise, when the association is negative an inverse

relationship exists between the variables whereas higher values on one variable produce lower values on the second variable.

This study applied One Way ANOVA, Pearson r, and Spearman Rho associational tests in order to determine what relationships if any exist between variables. Testing and analysis of this nature answered the first nine research questions.

Research Question 1: What differences exist among the number of developmental course placements, combination of developmental course placements, and the number of levels below college math on course grade in Pre-Algebra?

Research Question 1a: Are there differences among the three levels of developmental placements on course grade in Pre-Algebra?

Research Question 1b: Are there differences among the four combinations of developmental course placements on course grade in Pre-Algebra?

Research Question 1c: Are there differences among the number of levels below college math on course grade in Pre-Algebra?

Research Question 2: What association exists between the number of all developmental education courses (reading, math and English) recommended and the course grade in Pre-Algebra?

Research Question 3: What association exists between the number of levels below college math and the course grade in Pre-Algebra?

Research Question 4: What association exists between the number of years since high school graduation or GED completion and the course grade in Pre-Algebra?

Research Question 5: What association exists between the planned number of hours to work as reported on the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

Research Question 6: What association exists between the study habits self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

Research Question 7: What association exists between the math and science confidence self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

Research Question 8: What association exists between the desire to finish college self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

Research Question 9: What association exists between the receptivity to academic assistance scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

Second, multiple regression analysis was used to determine which variables most accurately predicted the course grade in Pre-Algebra at North Central State College. This analysis answered the final research question.

Research Question 10: How well does the combination of gender, CSI™ hours planned to work, ACT Compass® Math score, CSI™ Study habits scale, CSI™ Math and Science Confidence scale, and CSI™ Receptivity to Academic Assistance predict course grade in Pre-Algebra?

## Additional Interests

An additional area of interest but not formally part of the research design was explored in an additional findings section which concludes the results Chapter. Chi Square tests were run to better understand differences in Pre-Algebra grades based upon gender/sex, diploma type and academic interest. Three additional items of interest included:

- Do males and females differ on course success in Pre-Algebra?
- Do diploma types (High School or GED) differ on course success in Pre-Algebra?
- Are there differences among academic interests on course success in Pre-Algebra?

## Summary

This study used a non-experimental design and more specifically associational data analysis methods in order to determine relationships between 16 independent attribute variables and the dependent variable, Pre-Algebra course grade at North Central State College in Ohio. Ten research questions were answered using One Way ANOVA, Pearson r, Spearman Rho, and multiple regression analysis. Additional interests were explored using Chi Square to determine associations which were of value to describe the results but outside the scope of the initial design. The results of the study were shared with the community college and included recommendations that might serve to inform first year interventions for students enrolled in Pre-Algebra. The results may have broader applicability to the field of developmental education in that other researchers interested in the prediction of success in developmental math would be able to adapt this study to best serve their research needs.

# CHAPTER 4: RESULTS

The purpose of this study was to assist North Central State College with the identification of students who are not likely to receive a grade of A, B, or C in their Pre-Algebra course via the development of a regression equation. A secondary purpose was to provide advising and student success recommendations which may assist the faculty and staff as they attempt to best situate and affiliate students who are not likely to receive a grade of A, B, or C.

The study used concurrent and predictive correlational design including One Way Anova, Pearson r, Spearman Rho, and multiple regression analysis. Additional interests were explored using Chi Square to determine associations which were of value to describe the results but outside the scope of the initial design. Ultimately, by employing six of the sixteen independent variables an equation that best predicted a student's grade in Pre-Algebra was developed. The variables were representative of previous academic performance, depth and breadth of developmental education needs, recency of math education, motivational scores from the College Student Inventory Form B™ (CSI-B) such as math skills self-assessment and desire to finish to college, and self-reported demographic data such as the number of hours planned to work. Testing and analysis of this nature answered the first nine research questions.

Research Question 1: What differences exist among the number of developmental course placements, combination of developmental course placements, and the number of levels below college math on course grade in Pre-Algebra?

Research Question 1a: Are there differences among the three levels of developmental placements on course grade in Pre-Algebra?

Research Question 1b: Are there differences among the four combinations of developmental course placements on course grade in Pre-Algebra?

Research Question 1c: Are there differences among the number of levels below college math on course grade in Pre-Algebra?

Research Question 2: What association exists between the number of all developmental education courses (reading, math and English) recommended and the course grade in Pre-Algebra?

Research Question 3: What association exists between the number of levels below college math and the course grade in Pre-Algebra?

Research Question 4: What association exists between the number of years since high school graduation or GED completion and the course grade in Pre-Algebra?

Research Question 5: What association exists between the planned number of hours to work as reported on the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

Research Question 6: What association exists between the study habits self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

Research Question 7: What association exists between the math and science confidence self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

Research Question 8: What association exists between the desire to finish college self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

Research Question 9: What association exists between the receptivity to academic assistance scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

Second, multiple regression analysis was used to determine which variables most accurately predicted the course grade in Pre-Algebra at North Central State College. This analysis answered the final research question.

Research Question 10: How well does the combination of gender, CSI™ hours planned to work, ACT Compass® Math score, CSI™ Study habits scale, CSI™ Math and Science Confidence scale, and CSI™ Receptivity to Academic Assistance predict course grade in Pre-Algebra?

**Additional Interests**

One additional area of interest, but not formally part of the research design, was explored in an additional findings section which concludes the results Chapter. Chi Square tests were run to better understand differences in Pre-Algebra grades based upon gender/sex, diploma type and academic interest. Three additional items of interest included:

- Do males and females differ on course success in Pre-Algebra?
- Do diploma types (High School or GED) differ on course success in Pre-Algebra?
- Are there differences among academic interests on course success in Pre-Algebra?

Chapter Four will present the results of the study in four sections. Section one will describe the sample and provide descriptive statistics for the scale variables. Section two will provide results for each research question, section three includes additional findings of interest and the final section will summarize the chapter and transition to Chapter Five for discussion.

## Demographics and Descriptive Statistics

Statistical Package for the Social Sciences (SPSS) 18.0 was used to analyze the data to provide descriptives and answer the ten research questions and additional items of interest. A description of the 295 students within the study includes term of enrollment, academic interest, gender/sex, race/ethnicity, diploma type, years out of high school, planned work hours, number of developmental course placements, developmental course placement combinations, number of developmental courses recommended, number of levels below college math, and course success. The variables are described below in Table 4.1

Table 4.1

*Demographics of the Population*

| Characteristic | N | % |
|---|---|---|
| Term of Enrollment | | |
| Fall 2010 | 116 | 39.3 |
| Fall 2011 | 91 | 30.8 |
| Fall 2012 | 88 | 29.8 |
| Academic Interest | | |
| Allied Health and Nursing | 154 | 52.2 |
| Business | 21 | 7.1 |
| Education | 14 | 4.7 |
| Engineering/Computer Technology | 28 | 9.5 |
| Humanities | 2 | .7 |
| Public Service | 40 | 13.6 |
| Transfer | 9 | 3.1 |
| Undecided | 27 | 9.2 |
| Gender/Sex | | |
| Female | 202 | 68.5 |
| Male | 93 | 31.5 |
| Race\Ethnicity | | |
| American Indian\Alaskan Native | 1 | .3 |

| | | |
|---|---|---|
| Black African American, Non-Hispanic | 22 | 7.5 |
| White, Non-Hispanic | 226 | 76.6 |
| Non-resident Alien | 5 | 1.7 |
| Missing values | 41 | 13.9 |
| Diploma Type | | |
| High School Diploma | 256 | 86.8 |
| GED | 39 | 13.2 |
| Developmental Course Placement Combinations | | |
| Math | 115 | 39.0 |
| Math and English | 79 | 26.8 |
| Math and Reading | 34 | 11.5 |
| Math, English, Reading | 67 | 22.7 |
| Number of Developmental Course Placements | | |
| One | 120 | 40.7 |
| Two | 108 | 36.6 |
| Three | 67 | 22.7 |
| Years Since High School or GED | | |
| 0 | 119 | 40.3 |
| 1 to 5 | 70 | 23.7 |
| 6 to 10 | 29 | 9.8 |
| 11 to 20 | 23 | 7.8 |
| 21 to 30 | 12 | 4.1 |
| More than 30 | 3 | 1.0 |
| Missing values | 39 | 13.2 |
| Planned Hours of Work | | |
| None | 49 | 16.6 |
| 1 to 10 per week | 23 | 7.8 |
| 11 to 20 per week | 94 | 31.9 |

| | | |
|---|---|---|
| 21 to 30 per week | 74 | 25.1 |
| 40 or more per week | 55 | 18.6 |
| Number of Recommended Developmental Courses | | |
| One | 3 | 1.0 |
| Two | 107 | 36.3 |
| Three | 99 | 33.6 |
| Four | 54 | 18.3 |
| Five | 29 | 9.8 |
| Six | 3 | 1.0 |
| Levels Below College Math | | |
| One Level Below | 6 | 2.0 |
| Two Levels Below | 250 | 84.7 |
| Three Levels Below | 39 | 13.2 |
| Course Success | | |
| C or Higher | 176 | 59.7 |
| C- or lower and W | 119 | 40.3 |

Upon analysis of the variables it appeared that similar numbers of students were enrolled in Pre-Algebra during each of the fall terms used in this study. The majority of students had academic interests in Allied Health and Nursing and Public Service. Similar to the institutional demographics for fall 2012 (National Center for Educational Statistics, 2014), 68.5 percent of the students were female and mostly white, non-Hispanic with nearly 87 percent having achieved a high school diploma.

About 25 percent of the study's population had been out of high school or had achieved a GED more than six years ago, but the majority, 40.3 percent, of students had graduated from high school that same year. Sixty percent of the students had at least two developmental course placements with nearly one-fourth referred to math, English, and reading. Almost 75 percent of

the students reported they had plans to work at least eleven hours per week and as many as 40 plus hours per week.

Math recency, course placement and success data provided multiple measures for this study. Based upon ACT Compass® placement scores, nearly 60% of students were required to complete two or more developmental courses prior to enrollment in college level math, program path curriculum. Almost one-fourth of the population needed math, reading and English with nearly 63 percent referred to between three and six developmental courses. Not surprisingly, almost 85 percent of students were two levels below college readiness in math with just over 40 percent achieving a grade less than C or W.

The means, standard deviations, and skewness of the ten continuous, math recency, course placement and CSI™ survey variables are presented in Table 4.2. The means and standard deviations vary widely given differences in scale, but all variables appeared to be approximately normally distributed with the exception of the number of levels below college math and the CSI™ Desire to Finish College Scale.

As was noted in the frequency descriptions in the previous section, the majority of students had been out of formal education for less than a year. On average, students scored 47.3 on the ACT Compass® placement exam which resulted in students being placed into about two levels below college math Overall, students were referred to about three total developmental courses on average. As was indicated per the factor analysis in Chapter 3, item 58 was excluded from the CSI™ Receptivity to Academic Assistance Scale because it did not measure the intended construct. Analysis revealed that two cases did not have item 58 scores however did have scale scores. Those two cases were included in the sample by using the mean score (four)

for all cases as the score for item 58. The statistics below are representative of the scale less item 58.

Table 4.2

*Math Recency, Course Placement Score and CSI™ Constructs*

| Variables | Valid N | Missing | Mean | Mdn | SD | Skewness |
|---|---|---|---|---|---|---|
| Years since high school or GED | 295 | 0 | .75 | 0.00 | 1.347 | .987 |
| Number of developmental courses recommended | 295 | 0 | 3.03 | 3.00 | 1.036 | .647 |
| Number of levels below college math | 295 | 0 | 2.11 | 2.00 | .375 | 1.218 |
| ACT Compass® Math Score | 295 | 0 | 47.26 | 48.0 | 8.716 | -.269 |
| CSI™ Number of hours planned to work | 295 | 0 | 2.40 | 2.00 | 1.587 | .202 |
| CSI™ Study Habits Scale | 295 | 0 | 5.61 | 6.0 | 7.834 | -.332 |
| CSI™ Receptivity to Academic Assistance Scale (less item 58) | 295 | 0 | 18.85 | 19.00 | 6.702 | .108 |
| CSI™ Math and Science Confidence Scale | 295 | 0 | -3.23 | -4.00 | 6.918 | .205 |
| CSI™ Deisre to Finish College Scale | 295 | 0 | 16.74 | 19.00 | 7.427 | -1.262 |
| Course Grade | 295 | 0 | 5.31 | 6.00 | 4.317 | -.115 |

The next section will describe the results for each of the ten research questions. The results will be organized per question with descriptions for each finding based upon the outputs from Statistical Package for the Social Sciences (SPSS) 18.0.

## Research Question Results

### Research Question One

Research Question 1: What differences exist among the number of developmental course placements, combination of developmental course placements, and the number of levels below college math on course grade in Pre-Algebra?

In order to answer Research Question 1 concisely, three research questions, 1a, 1b, and 1c were created and are included below. Each of the questions met the three assumptions for use of one-way ANOVA which is the appropriate statistical test when three or more groups are compared using one dependent variable. (Morgan, Leech, Gloeckner, & Barrett, 2011) Due to the exploratory nature of this study, the Bonferroni technique was not used to correct for multiple comparisons.

**Research Question 1a.**

Research Question 1a: Are there differences among the three levels of developmental placements on course grade in Pre-Algebra?

One-way ANOVA was used to determine if differences existed among the three levels of developmental course placements on grades in Pre-Algebra. The Levene's test (.081) was used to check the assumption that the variances of the three levels were equal and because the test was not significant at the .05 level the assumption was not violated. (Morgan, Leech, Gloeckner, & Barrett, 2011) A statistically significant difference, however, was found among the three levels of developmental course placement and grades in Pre-Algebra, $F$ (2, 292) = 3.68, $p$ = .026. Therefore a post hoc test using Tukey HSD (honestly significant differences) was conducted to determine where the significance existed among the groups.

Table 4.3 shows that the mean grade in Pre-Algebra was 6.12 for students with one developmental course placement, 4.85 for students with two developmental course placements, and 4.60 for students with three developmental course placements. Post hoc Tukey HSD tests indicated that students in the lowest placement group and highest placement group differed significantly ($p$ = .05) on their grades with a small effect size (d =.35) per Cohen (1988). (Morgan et al., 2011)

Table 4.3

*Means and Standard Deviations Comparing Three Levels of Developmental Course Placements and Pre-Algebra Grades*

| | | Pre-Algebra Grades | |
|---|---|---|---|
| Number of Developmental placements | *n* | *M* | *SD* |
| One developmental placement (low) | 120 | 6.12 | 4.15 |
| Two developmental placements (medium) | 108 | 4.85 | 4.28 |
| Three developmental placements (high) | 67 | 4.60 | 4.50 |
| Total | 295 | 5.31 | 4.32 |

Table 4.3.1

*One-Way Analysis of Variance Summary Table Comparing Three Levels of Developmental Course Placement on Grades in Pre-Algebra.*

| Source | *df* | *SS* | *MS* | *F* | *p* | *d* |
|---|---|---|---|---|---|---|
| Between groups | 2 | 134.81 | 67.41 | 3.68 | .026 | .35 |
| Within groups | 292 | 5344.12 | 18.30 | | | |
| Total | 294 | 5478.93 | | | | |

**Research Question 1b.**

Research Question 1b: Are there differences among the four combinations of developmental course placements on course grade in Pre-Algebra?

One-way ANOVA was used to determine if differences existed among the four combinations of developmental course placements on grades in Pre-Algebra. The Levene's test (.149) was used to check the assumption that the variances of the three levels were equal and because the test was not significant at the .05 level, the assumption was not violated. (Morgan, Leech, Gloeckner, & Barrett, 2011) A statistically significant difference was not found among the four combinations of developmental course placements and grades in Pre-Algebra, $F$ (3, 291) = 2.39, $p$ = .069. Table 4.4 shows that the mean grade in Pre-Algebra was 6.13 for students who

placed into math only, 4.84 for students who placed into math and English, 5.03 for students who placed into math and reading, and 4.60 for students who placed into all three course types.

Table 4.4

*Means and Standard Deviations Comparing Four Combinations of Developmental Course Placement and Pre-Algebra Grades*

| | | Pre-Algebra Grades | |
|---|---|---|---|
| Course combinations of developmental placements | *n* | *M* | *SD* |
| Math | 115 | 6.13 | 4.18 |
| Math and English | 79 | 4.84 | 4.33 |
| Math and reading | 34 | 5.03 | 4.11 |
| Math, English and reading | 67 | 4.60 | 4.50 |
| Total | 295 | 5.31 | 4.32 |

Table 4.4.1

*One-Way Analysis of Variance Summary Table Comparing Four Combinations of Developmental Course Placement on Grades in Pre-Algebra*

| Source | *df* | *SS* | *MS* | *F* | *p* |
|---|---|---|---|---|---|
| Between groups | 3 | 131.94 | 43.98 | 2.39 | .069 |
| Within groups | 291 | 5346.99 | 18.38 | | |
| Total | 294 | 5478.93 | | | |

**Research Question 1c.**

Research Question 1c: Are there differences among the number of levels below college math on course grade in Pre-Algebra?

One-way ANOVA was used to determine if differences existed among the number of levels below college math on grades in Pre-Algebra. The Levene's test (.308) was used to check the assumption that the variances of the three levels were equal and because the test was not significant at the .05 level the assumption was not violated. (Morgan, Leech, Gloeckner, &

Barrett, 2011) A statistically significant difference was not found among the three levels and grades in Pre-Algebra, $F$ (2, 292) = 2.14, $p$ = .119. Table 4.5 shows that the mean grade in Pre-Algebra was 6.83 for students who were one level below college math, 5.46 for students who were two levels below college math and 4.08 for students who were three levels below college math.

Table 4.5

*Means and Standard Deviations Comparing Three Levels Below College Math and Post Hoc Tukey HSD Homogeneous Subsets*

| | | Pre-Algebra Grades | |
|---|---|---|---|
| Levels below college math | *n* | *M* | *SD* |
| One level below | 6 | 6.83 | 4.12 |
| Two levels below | 250 | 5.46 | 4.32 |
| Three levels below | 39 | 4.08 | 4.18 |
| Total | 295 | 5.31 | 4.32 |

Table 4.5.1

*One-Way Analysis of Variance Summary Table Comparing Three Levels Below College Math on Grades in Pre-Algebra*

| Source | *df* | *SS* | *MS* | *F* | *p* |
|---|---|---|---|---|---|
| Between groups | 2 | 7.15 | 39.58 | 2.14 | .119 |
| Within groups | 292 | 5399.78 | 18.49 | | |
| Total | 294 | 5478.93 | | | |

Research questions two through nine were designed to determine if any associations existed between the number of developmental courses recommended, levels below college math, years since high school graduation or GED attainment, CSI™ planned hours to work, CSI™ study habits, CSI™ math and science confidence, CSI™ desire to finish college, and CSI™ receptivity to academic assistance measures and grades in Pre-Algebra. Morgan et al. (2011)

explained that parametric statistics such as Pearson r are used to determine associations when both variables are approximately normally distributed and a non-parametric equivalent, such as Spearman rho, should be used when the assumption of normality has not been satisfied.

The skewness of the nine continuous variables used for research questions two through nine were checked and were included in Table 4.2. Seven of the nine variables appeared to be approximately normally distributed with the number of levels below college math and the CSI™ desire to finish college scale outside the normal range. Research questions two, four, five, six, seven and nine applied Pearson r correlations while questions three and eight used the non-parametric test Spearman rho.

**Research Question Two**

Research Question 2: What association exists between the number of all developmental education courses (reading, math and English) recommended and the course grade in Pre-Algebra?

To investigate if there was a statistically significant association between the numbers of developmental education courses recommended and grade in Pre-Algebra, a correlation was computed. The number of developmental education courses recommended was not skewed (skewness = .647) therefore the assumption of normality was satisfied. The Pearson r correlation statistic was calculated, $r$ (293) = -.155, $p$ = .008. The correlation was negative, which meant that students with higher numbers of developmental education courses recommended tended to have lower grades in Pre-Algebra and vice-versa. Using Cohen's (1988) guidelines, the effect size is small for studies in this area. The $r^2$ indicated that approximately 2% of the variance in Pre-Algebra grades can be predicted from the number of developmental courses recommended.

**Research Question Three**

Research Question 3: What association exists between the number of levels below college math and the course grade in Pre-Algebra?

To investigate if there was a statistically significant association between the numbers of levels below college math and grade in Pre-Algebra, a correlation was computed. The number of levels below college math was skewed (skewness = 1.218) therefore the assumption of normality was not satisfied. The Spearman rho statistic was calculated, $r$ (293) = -.115, $p$ = .048. The correlation was negative, which meant that students who placed more levels below college math tended to have lower grades in Pre-Algebra and vice-versa. Using Cohen's (1988) guidelines, the effect size is small for studies in this area. The $r^2$ indicated that approximately 1% of the variance in Pre-Algebra grades can be predicted from number of levels below college math.

**Research Question Four**

Research Question 4: What association exists between the number of years since high school graduation or GED completion and the course grade in Pre-Algebra?

To investigate if there was a statistically significant association between the numbers of years since high school graduation or GED completion and grade in Pre-Algebra, a correlation was computed. The number of years since high school graduation or GED completion was not skewed (skewness = .987) therefore the assumption of normality was satisfied. The Pearson r correlation statistic was calculated, $r$ (293) = .025, $p$ = .668. The correlation was not significant which meant that there was no significant association between the number of years since high school graduation or GED completion and grades in Pre-Algebra.

**Research Question Five**

Research Question 5: What association exists between the planned number of hours to work as reported on the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

To investigate if there was a statistically significant association between the numbers of hours to work as reported on the College Student Inventory Form B™ (CSI-B) and grade in Pre-Algebra, a correlation was computed. The number of hours to work as reported on the College Student Inventory Form B™ (CSI-B) was not skewed (skewness = .202) therefore the assumption of normality was satisfied. The Pearson r correlation statistic was calculated, $r$ (293) = -.070, $p$ = .229. The correlation was not significant which meant that there was no significant association between the planned hours to work as reported on the College Student Inventory Form B™ (CSI-B) and grades in Pre-Algebra.

**Research Question Six**

Research Question 6: What association exists between the study habits self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

To investigate if there was a statistically significant association between the study habits self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and grade in Pre-Algebra, a correlation was computed. The study habits self-assessment scale score from the College Student Inventory Form B™ (CSI-B) was not skewed (skewness = -.332) therefore the assumption of normality was satisfied. The Pearson r correlation statistic was calculated, $r$ (293) = .170, $p$ = .003. The correlation was positive, which meant that students with higher study habits self-assessment scale scores from the College Student Inventory Form B™ (CSI-B)

tended to have higher grades in Pre-Algebra and vice-versa. Using Cohen's (1988) guidelines, the effect size is small to typical for studies in this area. The $r^2$ indicated that approximately 3% of the variance in Pre-Algebra grades can be predicted from the study habits self-assessment scale score from the College Student Inventory Form B™ (CSI-B).

**Research Question Seven**

Research Question 7: What association exists between the math and science confidence self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

To investigate if there was a statistically significant association between the math and science confidence self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and grade in Pre-Algebra, a correlation was computed. The math and science confidence self-assessment scale score from the College Student Inventory Form B™ was not skewed (skewness = .205) therefore the assumption of normality was satisfied. The Pearson r correlation statistic was calculated, $r$ (293) = .148, $p$ = .011. The correlation was positive, which meant that students with higher scores on the math and science confidence self-assessment scale score from the College Student Inventory Form B™ tended to have higher grades in Pre-Algebra and vice-versa. Using Cohen's (1988) guidelines, the effect size is small for studies in this area. The $r^2$ indicated that approximately 2% of the variance in Pre-Algebra grades can be predicted from the math and science confidence self-assessment scale score from the College Student Inventory Form B™.

**Research Question Eight**

Research Question 8: What association exists between the desire to finish college self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

To investigate if there was a statistically significant association between the desire to finish college self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and grade in Pre-Algebra, a correlation was computed. The desire to finish college self-assessment scale score from the College Student Inventory Form B™ (CSI-B) was skewed (skewness = -1.262) therefore the assumption of normality was not satisfied. The Spearman rho statistic was calculated, $r$ (293) = .122, $p$ = .036. The correlation was positive, which meant that students with higher scores on the desire to finish college self-assessment scale from the College Student Inventory Form B™ (CSI-B) tended to have higher grades in Pre-Algebra and vice-versa. Using Cohen's (1988) guidelines, the effect size is small for studies in this area. The $r^2$ indicated that approximately 1.5% of the variance in Pre-Algebra grades can be predicted from the desire to finish college self-assessment scale from the College Student Inventory Form B™ (CSI-B).

**Research Question Nine**

Research Question 9: What association exists between the receptivity to academic assistance scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra?

To investigate if there was a statistically significant association between the receptivity to academic assistance scale score from the College Student Inventory Form B™ (CSI-B) and grade in Pre-Algebra, a correlation was computed. The receptivity to academic assistance scale

score from the College Student Inventory Form B™ (CSI-B) was not skewed (skewness = .108) therefore the assumption of normality was satisfied. The Pearson r correlation statistic was calculated, $r$ (293) = .017, $p$ = .772. The correlation was not significant which meant that there was no significant association between receptivity to academic assistance scale score from the College Student Inventory Form B™ (CSI-B) and grades in Pre-Algebra.

**Research Question Ten**

Research Question 10: How well does the combination of gender, CSI™ hours planned to work, ACT Compass® Math score, CSI™ Study habits scale, CSI™ Math and Science Confidence scale, and CSI™ Receptivity to Academic Assistance predict course grade in Pre-Algebra?

In order to address research question ten, multiple regression was conducted to examine how well the six predictor variables of gender, CSI™ hours planned to work, ACT Compass® Math score, CSI™ Study habits scale, CSI™ Math and Science Confidence scale, and CSI™ Receptivity to Academic Assistance predicted course grade in Pre-Algebra. When all six predictor variables were considered together, they significantly predicted course grade in pre-algebra $F$ = (6, 288) = *7.42*, $p$ = < *.001*. CSI™ hours planned to work and CSI™ Math and Science Confidence did not significantly contribute to the prediction; however, CSI™ Math and Science Confidence did have a significant correlation, $r$ (293) = .148, $p$ = .005, to course grade while CSI™ hours planned to work did not, $r$ (293) = -.070, $p$ = .115. In order to lessen the number of variables in the model and make the equation easier to administer, CSI™ hours planned to work was removed from this analysis and model two was developed using five predictor variables of gender, ACT Compass® Math score, CSI™ Study habits scale, CSI™ Math and Science Confidence scale, and CSI™ Receptivity to Academic Assistance

When all five predictor variables were considered together, they significantly predicted course grade in pre-algebra $F = (5, 289) = 8.75, p = < .001$ with four of the five variables significantly contributing to the prediction. CSI™ Math and Science Confidence did not significantly contribute to the prediction. The adjusted *R* squared value was .12 and tolerance levels using $1 - R^2$ (Leech, Barrett, & Morgan, 2011) to test for multicollinearity were not acceptable for CSI™ Study habits scale (.84), CSI™ Math and Science Confidence scale (.84), and CSI™ Receptivity to Academic Assistance (.86).

In order to again lessen the number of variables in the model to make the equation easier to administer and to correct multicollinearity, CSI™ Math and Science Confidence scale was removed from this analysis and model three was developed using four predictor variables of gender, ACT Compass® Math score, CSI™ Study habits scale, and CSI™ Receptivity to Academic Assistance scale. When all four predictor variables were considered together, they significantly predicted course grade in pre-algebra $F = (4, 290) = 10.14, p = < .001$ with three of the four variables significantly contributing to the prediction. The adjusted *R* squared value was .11. This indicated that 11% of the variance in pre-algebra course grade was explained by the model. According to Cohen (1988) this is a small effect. Tolerance levels using $1 - R^2$ (Leech, Barrett, & Morgan, 2011) to test for multicollinearity were acceptable.

Due to the fact that the CSI™ Receptivity to Academic Assistance scale provided no significant contribution to the prediction and if removed would provide a much simpler equation, a fourth model was developed by removing it. When all three predictor variables were considered together, they significantly predicted course grade in pre-algebra $F = (3, 291) = 12.61, p = < .001$ with all three of the variables significantly contributing to the prediction. The adjusted *R* squared value was .12. This indicated that 12% of the variance in pre-algebra course

grade was explained by the model. According to Cohen (1988) this is a small effect. Tolerance levels using $1 - R^2$ (Leech, Barrett, & Morgan, 2011) to test for multicollinearity were more than acceptable all being higher than .95. The beta weights presented in Table 4.6 suggest that the ACT Compass® Math score contributed most to predicting course grade in Pre-Algebra at North Central State College. Being male and having higher CSI™ Study habits scale scores also contributed to this prediction.

Table 4.6

*Means, Standard Deviations, and Intercorrelations for Pre-Algebra Course Grade and Predictor Variables (N = 295)*

| Variable | *M* | *SD* | 1 | 2 | 3 |
|---|---|---|---|---|---|
| Pre-Algebra Grade | 5.31 | 4.32 | -.16** | .24*** | .17** |
| Predictor variable | | | | | |
| 1. Gender | .32 | .46 | - | .05 | -.18** |
| 2. ACT Compass® Math score | 47.26 | 8.72 | | - | -.13* |
| 3. CSI™ Study habits scale | 5.61 | 7.83 | | | - |

*$p < .05$; ** $p < .01$; $p < .001$; ***

Table 4.6.1

*Simultaneous Multiple Regression Analysis Summary for Gender, ACT Compass® Math score, and CSI™ Study habits scale Predicting Course Grade in Pre-Algebra (N = 293)*

| Variable | *B* | *SEB* | *β* |
|---|---|---|---|
| Gender | -1.28 | .52 | -.14* |
| ACT Compass® Math score | .13 | .03 | .27*** |
| CSI™ Study habits scale | .10 | .03 | .18** |
| Constant | -1.07 | 1.37 | |

Note $R = .34$; $R^2 = .12$; $F = (3, 291) = 12.61$, $p = < .001$
*$p < .05$; ** $p < .01$; *** $p < .001$

## Additional Findings

Of interest but not part of the original research design, this section provides three additional findings which were discovered during the analysis. Chi Square and One Way ANOVA tests were run to better understand differences in Pre-Algebra grades based upon gender/sex, diploma type and academic interest. When two nominal or dichotomous variables are being tested for differences between the groups, Chi-square is the appropriate statistic with either phi or Cramer's V used to describe the effect size of any significant differences which emerge. (Morgan et al., 2011) These additional items of interest and the results of each are described below. Course success was defined as grades of C or greater for the first two items.

**Additional item of interest one**

Did males and females differ on course success in Pre-Algebra?

To investigate whether males and females differed on whether they were successful or not successful in Pre-Algebra, a chi-square statistic was conducted. Assumptions were checked and were met. Table 4.7 shows the Pearson chi-square results and indicated that males and females were significantly different on course success ($\chi^2 = 5.87$, $df = 1$, $N = 295$, $p = .015$). Females were more likely to achieve a grade of C or higher than were males. Phi which indicates the strength of the relationship between the two variables was .14.

Table 4.7

*Chi-square Analysis of Prevalence of Course Success among Males and Females*

| | | Gender | | | | |
|---|---|---|---|---|---|---|
| Variable | *n* | Males | Females | $\chi^2$ | *p* | *Phi* |
| Course success | | | | 5.87 | .015 | .14 |
| C or higher | 176 | 46 | 130 | | | |
| C or less | 119 | 47 | 72 | | | |
| Totals | 295 | 93 | 202 | | | |

**Additional item of interest two**

Did diploma types (High School or GED) differ on course success in Pre-Algebra?

To investigate whether students with high school diplomas or with a GED differed on whether they were successful or not successful in Pre-Algebra, a chi-square statistic was conducted. Assumptions were checked and were met. Table 4.8 shows the Pearson chi-square results and indicated that students with a high school diploma and students with a GED were not significantly different on course success ($\chi^2 = .631$, $df = 1$, $N = 295$, $p = .427$) Students with a high school diplomas were not more likely to achieve course success than students with a GED. Phi which indicates the strength of the relationship between the two variables was .05.

Table 4.8

*Chi-square Analysis of Prevalence of Course Success among Males and Females*

| | | Diploma type | | | |
|---|---|---|---|---|---|
| Variable | *n* | High School | GED | $\chi^2$ | *p* |
| Course success | | | | .631 | .427 |
| C or higher | 176 | 155 | 21 | | |
| C or less | 119 | 101 | 18 | | |
| Totals | 295 | 256 | 39 | | |

**Additional item of interest three**

Are there differences among the academic interests on course grade in Pre-Algebra?

One-way ANOVA was used to determine if differences existed among the academic interests on grades in Pre-Algebra. The Levene's test (.730) was used to check the assumption that the variances of the three levels were equal and because the test was not significant at the .05 level the assumption was not violated. (Morgan, Leech, Gloeckner, & Barrett, 2011) A statistically significant difference was found among the eight academic interests and grades in

Pre-Algebra, $F$ (7, 287) = 2.50, $p$ = .016. Table 4.9 shows that the mean grade in Pre-Algebra for each academic interest. Post hoc Tukey HSD tests indicated that students with academic interests of Allied Health and Nursing and Undecided students differed significantly ($p$ = .05) on their grades with an effect size (d =.63) between typical and larger than typical per Cohen (1988). (Morgan et al., 2011)

Table 4.9

*Means and Standard Deviations Comparing Eight Academic Interests and Post Hoc Tukey HSD Homogeneous Subsets*

| | | Pre-Algebra Grades | |
|---|---|---|---|
| Academic Interests | *n* | *M* | *SD* |
| Allied Health/Nursing | 154 | 6.15 | 4.12 |
| Business | 21 | 6.05 | 4.15 |
| Education | 14 | 4.57 | 4.05 |
| Engineering/Computer Tech | 28 | 4.36 | 4.22 |
| Humanities | 2 | 4.50 | 3.54 |
| Public Service | 40 | 4.28 | 4.49 |
| Transfer | 9 | 3.67 | 4.09 |
| Undecided | 27 | 3.44 | 4.42 |
| Total | 295 | 5.31 | 4.32 |

Table 4.9.1

*One-Way Analysis of Variance Summary Table Comparing Academic Interests on Grades in Pre-Algebra*

| Source | *df* | *SS* | *MS* | *F* | *p* | *d* |
|---|---|---|---|---|---|---|
| Between groups | 7 | 315.41 | 45.06 | 2.50 | .016 | .63 |
| Within groups | 287 | 5163.52 | 17.99 | | | |
| Total | 294 | 5478.93 | | | | |

## Summary of the Findings

This study used a non-experimental design approach and more specifically associational data analysis methods in order to determine relationships between 15 independent attribute variables and the dependent variable, Pre-Algebra course grade at North Central State College in Ohio. Part one of this chapter described the sample while part two answered ten research questions using One Way ANOVA, Pearson r, Spearman Rho, and multiple regression analysis. Additional interests were explored using Chi Square to determine associations which were of value to describe the results, but outside the scope of the initial design. The following research questions guided the study with their respective findings summarized below.

Using One-way ANOVA, Research Question 1 was designed to determine what differences existed among the number of developmental course placements (1a.), combination of developmental course placements (1b.), and the number of levels below college math (1c.) on course grade in Pre-Algebra? For research question 1a., tests revealed that there were significant differences on course grade in Pre-Algebra between the lowest placement group (one developmental course placement) and the highest placement group (three developmental course placements). The results for research question 1b showed that a statistically significant difference was not found among the four combinations of developmental course placements and grades in Pre-Algebra. Course grade means were not significantly different for students who placed into math only or who placed into math and English or who placed into math and reading, or for students who placed into all three. Finally, for research question 1c., a statistically significant difference was not found among the three levels below college math and grades in Pre-Algebra. Course grade means were not significantly different for students who placed one, two or three levels below college math.

Research questions two through nine were designed to determine if any associations existed between the number of developmental courses recommended (RQ2), levels below college math (RQ3), years since high school graduation or GED attainment (RQ4), CSI™ planned hours to work (RQ5), CSI™ study habits (RQ6), CSI™ math and science confidence (RQ7), CSI™ desire to finish college (RQ8), and CSI™ receptivity to academic assistance (RQ9) measures and grades in Pre-Algebra. Research questions two, four, five, six, seven and nine applied Pearson r correlations while questions three and eight used the non-parametric test Spearman rho. The findings are included in Table 4.10 below.

Table 4.10

*Correlations, Research Questions Two through Eight*

| Research Question | Finding |
|---|---|
| Research Question 2: What association exists between the number of all developmental education courses (reading, math and English) recommended and the course grade in Pre-Algebra? | The correlation was significant and negative which meant that students with higher numbers of developmental education courses recommended tended to have lower grades in Pre-Algebra and vice-versa. |
| Research Question 3: What association exists between the number of levels below college math and the course grade in Pre-Algebra? | The correlation was significant and negative, which meant that students who placed more levels below college math tended to have lower grades in Pre-Algebra and vice-versa. |
| Research Question 4: What association exists between the number of years since high school graduation or GED completion and the course grade in Pre-Algebra? | The correlation was not significant which meant that there was no significant association between the number of years since high school graduation or GED completion and grades in Pre-Algebra. |
| Research Question 5: What association exists between the planned number of hours to work as reported on the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra? | The correlation was not significant which meant that there was no significant association between the planned hours to work as reported on the College Student Inventory Form B™ (CSI-B) and grades in Pre-Algebra. |
| Research Question 6: What association exists between the study habits self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre- | The correlation was significant and positive, which meant that students with higher study habits self-assessment scale scores from the College Student Inventory Form B™ (CSI-B) |

| | |
|---|---|
| Algebra? | tended to have higher grades in Pre-Algebra and vice-versa. |
| Research Question 7: What association exists between the math and science confidence self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra? | The correlation was significant and positive, which meant that students with higher scores on the math and science confidence self-assessment scale score from the College Student Inventory Form B™ tended to have higher grades in Pre-Algebra and vice-versa. |
| Research Question 8: What association exists between the desire to finish college self-assessment scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra? | The correlation was significant and positive, which meant that students with higher scores on the desire to finish college self-assessment scale from the College Student Inventory Form B™ (CSI-B) tended to have higher grades in Pre-Algebra and vice-versa. |
| Research Question 9: What association exists between the receptivity to academic assistance scale score from the College Student Inventory Form B™ (CSI-B) and the course grade in Pre-Algebra? | The correlation was not significant which meant that there was no significant association between receptivity to academic assistance scale score from the College Student Inventory Form B™ (CSI-B) and grades in Pre-Algebra. |

Multiple regression analysis was used for research question ten to determine how well the combination of gender, CSI™ hours planned to work, ACT Compass® Math score, CSI™ Study habits scale, CSI™ Math and Science Confidence scale, and CSI™ Receptivity to Academic Assistance predicted course grade in Pre-Algebra at North Central State College. The analysis produced an equation which explains 12% of the variance in course grade: Course Grade = -1.07 -1.28(Gender) + .13(ACT Compass® Math score) + .10(CSI™ Study habits scale). The ACT Compass® Math score contributed the most to predicting course grade while being male and having higher CSI™ Study habits scale scores also contributed to this prediction.

**Additional Interests**

An additional area of interest but not formally part of the research design was explored using Chi Square and One Way ANOVA tests to better understand differences in Pre-Algebra grades based upon gender/sex, diploma type and academic interest. Findings indicated that

females were more likely to receive a grade of C or higher and grades for students with high school diplomas or GED diplomas were not significantly different. Students with academic interests in Allied Health and Nursing differed significantly from Undecided students on course grades.

The purpose of this study was to assist North Central State College with the identification of students who are not likely to receive a grade of A, B, or C in their Pre-Algebra course via the development of a regression equation. A secondary purpose was to provide advising and student success recommendations which may assist the faculty and staff as they attempt to best situate and affiliate students who are not likely to receive a grade of A, B, or C. Chapter five will develop a discussion regarding the findings and will attempt to complete the study and satisfy its intended purposes.

# CHAPTER 5: DISCUSSION

Chapter two, The Review of Literature, described seven factors which impacted successful completion of developmental mathematics. The seven factors were the impact of policy, placement testing, breadth of skill deficiencies, course delivery approaches, faculty characteristics, student beliefs, characteristics, and behaviors, and academic and demographic factors. This study addressed four of the seven including placement testing, breadth of skill deficiency, student beliefs, characteristics and behaviors, and academic and demographic variables. It should be noted that the other three are still very much a part of the conversation regarding success in developmental mathematics. Policy decisions and course delivery systems are fueled by reports that "developmental mathematics is one of the most serious barriers to educational and economic achievement." (Clyburn, 2013) Decisions are being made at the local and state level on how to deliver the courses or maybe even decisions regarding elimination of them altogether.

Mangan (2014) reported that states like Florida and North Carolina are changing policies regarding placement testing and remedial courses for recent high school graduates and active-duty military while Connecticut is limiting students to one semester of developmental coursework except when it's part of college-level classes. Other decisions to better define the pathway that students should take in order to be successful in college-level mathematics are also being considered. These new and innovative course delivery approaches such as Statway and Quantway "…differ from traditional math courses in that their approaches, topics, and contexts enable students to think and reason quantitatively, unencumbered by memories of past failures" (Clyburn, 2013). Clyburn reported that statistics and quantitative reasoning are in the

foreground of instruction with the developmental support required integrated throughout the course.

Early innovators, Katie Hern, who is the Director of the California Acceleration Project, and Myra Snell, who is the Math Lead for the Project, provide colleges with research and practice which shows better outcomes for students who are enrolled in accelerated forms of developmental education. Their monograph, TOWARD A VISION OF ACCELERATED CURRICULUM & PEDAGOGY: High Challenge, High Support Classrooms for Underprepared Students, (2013) provides practitioners ideas on how to best teach accelerated models. They

> "reject the idea that academic literacy and quantitative reasoning are developed through the linear accumulation of sub-skills. It's not necessary for the basics to be separated out and front-loaded before students can tackle more challenging – and frankly more interesting – tasks. Instead, underprepared students need practice with college-level skills, content, and ways of thinking. (Hern & Snell, 2013, p. 5)"

The next part of Chapter Five will describe the relationships between four of the seven factors, which were relevant to this study, discussed in the review of literature,

**Factors Impacting Pre-Algebra Course Success at North Central State College**

This study did not address developmental education policy, course delivery systems, or faculty characteristics, which were described as factors impacting developmental education success in Chapter Two, Review of the Literature. The other four factors in Chapter Two, however, placement testing, breadth of skill deficiency, student beliefs, characteristics and behaviors, and academic and demographic variables were used to explain what associations existed between them and the Pre-Algebra course grade at North Central State College in Ohio. The primary purpose was to develop a regression equation which the College could easily apply

to each student early in the course. A secondary purpose was to provide advising and student success recommendations which may assist the faculty and staff as they attempt to best situate and affiliate students who are not likely to receive a grade of A, B, or C. Chapter five will develop a discussion regarding the findings and will attempt to complete the study and satisfy its intended purposes. The next section will provide a relevant summary of the four factors, cited in the Review of Literature, as related to the findings of the study.

**Placement Testing as a Factor**

Placement testing as a contributing factor to course success emerged in the literature and was discussed in terms of policy (Akst & Hirsh, 1991; Matthews-Lopez,1998); types and uses (Perin, 2006), and predictive value for course success (Wangsness Hartl, 1997; Waycaster, 2004; Jacobson, 2006; and Perin, 2006). This study primarily focused on the latter with research question 10 providing primary evidence of the predictive value of placement testing at North Central State College. The development of the regression equation and associated beta weights revealed that the ACT Compass® Math score contributed most, among the six variables considered, to predicting course grade. This might suggest to North Central that use of the tool for predictive value of course success should be continued as a way to place students into Pre-Algebra.

**Breadth and Depth of Skill Deficiency as Factors**

Research questions 1a, 1b, 1c, 2, and 3 were developed in order to assess the impact of depth and breadth of skill deficiency as a factor contributing to success in Pre-Algebra. As was discussed in Chapter 2, Bahr (2010) discovered that breadth "…skill deficiencies in English and math go hand in hand….that there is "a nearly linear relationship between declining math skills and the shrinking likelihood of not requiring some type of remedial English" (p. 187). He

continued that "the more severe a student's math skill deficiency at college entry, the more likely the student will be to have an English deficiency and the more likely it is that the deficiency will be severe" (p. 187). The final breadth of skill deficiency which was discovered was that the "…number of initial skill deficiencies is correlated negatively with attaining college-level skill" …. "…that less than one-fifth of students who entered college with two skill deficiencies (both math and English) attained college-level skills in both math and English" (p. 187).

While this study did not track students beyond Pre-Algebra and did not make the exact comparisons as Bahr's study, some of the findings are consistent. Research question 2 showed a significant, negative correlation between the numbers of developmental courses recommended and course grade in Pre-Algebra. This meant that students with higher numbers of developmental education courses recommended tended to have lower grades in Pre-Algebra and vice-versa.

Students at North Central State College with three course placement types (math, English and reading) were not as successful in Pre-Algebra as students with a math-only placement. At the same time, no single combination of course placement types was significant to course grade. Students with math, English and reading, however, did have the lowest mean grades among the sample, with math and English close behind. These findings are consistent with Bahr.

Two interesting discoveries surfaced from research questions 1c and 3. The results showed that course grade means were not significantly different for students who placed one, two, or three levels below college math, but there was a significant, negative correlation between the number of levels and course grade. Students who placed more levels below college math tended have lower grades even though the course means were not significantly different for each level. Previous research by Achieving The Dream (2014) suggested that only single-digit

percentages of students who were two or three levels below college mathematics were successful in their college level requirements. These findings might suggest to North Central State College that a review of the Mathway, including the number of courses, delivery methods and content, to ensure that the number of courses required advancing to college level mathematics is not excessive or not useful for the respective academic interests. This strategy is consistent with the research that Hern and Snell (2013) have conducted within the California Acceleration Project.

**Student Beliefs, Characteristics and Behaviors as Factors**

Chapter two, Review of the Literature, reviewed the research which has studied the effect of student beliefs and motivations, engagement, math anxiety, locus of control and learning styles on achievement in developmental mathematics. Many academicians and researchers (Edwards, 1972; Strowbridge, 1987; Goolsby et.al, 1988; Taylor, 2008; Briley et.al, 2009; George, 2010; Mesa, 2011) have contended that student motivation, goal orientation and emotions are powerful predictors of remedial mathematics success. In order to address these issues at North Central State College, research questions 6, 7, 8, 9, and 10 were developed.

Research questions 6, 7, 8, and 9 used existing data from the College Student Inventory™ which North Central State College administers each year. The four variables related to student beliefs and motivation included study habits self-assessment, math and science confidence, desire to finish college, and receptivity to academic assistance. Study habits self-assessment, math and science confidence, and desire to finish college all had significant, positive correlations with course grade in Pre-Algebra. This meant that students with higher values on these measures tended to have higher course grades. While this does not seem surprising, it may provide North Central State College with data to inform the design and delivery of the course. The implications for practice section which follows will attempt to expand upon this idea.

Receptivity to academic assistance had no significant relationship to course grade. This might be explained by the very high negative, correlation to study habit scores, $r$ (293) = -.257, $p$ = < .001. This meant that students with lower receptivity to assistance scores tended to have higher scores on the study habits scale.

Research question 10 provided evidence of the predictive value of student motivation and beliefs. The development of the regression equation and associated beta weights revealed that the CSI™ study habits score contributed second most, among the six variables considered, to predicting course grade. This might suggest to North Central that use of the tool for predictive value of course success should be continued as a way to embed study habits into the course. The implications for practice section which follows will expand upon this idea.

**Academic and Demographic Variables as Factors**

Blackner (2000); Stephens (2005); Fike and Fike (2007); and, Taylor (2008) have contributed to the literature using academic and demographic variables such as age, ethnicity, gender and employment status, in conjunction with the academic variables of previous math courses and previous attempts at math courses to determine if relationships to achievement existed. In order to address these type variables in this study, research questions 4, 5, and 10, as well as three additional items of interest were analyzed to determine impact of years since formal education, number of hours planned to work, gender/sex, diploma type and academic interest.

Correlations conducted between years since high school graduation or GED completion, number of hours planned to work and course grade revealed no significant associations. It should be noted that the hours planned to work were reported at a point in time early in the term and may not have reflected actual hours worked. In related academic questions, students with high school diplomas did not have significantly higher grades than students who had completed

GED diplomas. Students with academic interests in Allied Health and Nursing differed significantly from Undecided students on course grades.

Gender played a significant role in both associations with the predicted course grade and differences in course grade means. Females were more likely to have a higher course grade than males and at the same time, gender contributed significantly to the prediction of course grade. Gender, in addition to the ACT Compass® Math score and CSI™ Study habits score, provided North Central State College the best prediction among the six variables considered.

In summary, the findings from this study had relevance within the literature review and therefore seemed to be consistent with most of the previous studies which examined placement testing, breadth and depth of skill deficiency, student beliefs, characteristics and behaviors, and academic and demographic variables. At North Central State College the summary of findings as related to the four factors important to the prediction of course success was:

- There were significant differences on course grade in Pre-Algebra between the lowest placement group (one developmental course placement) and the highest placement group (three developmental course placements).
- Course grade means were not significantly different for students who placed into math only or who placed into math and English or who placed into math and reading, or for students who placed into all three.
- Course grade means were not significantly different for students who placed one, two or three levels below college math.
- Students with higher numbers of developmental education courses recommended tended to have lower grades in Pre-Algebra and vice-versa.
- Students who placed more levels below college math tended to have lower grades in Pre-Algebra and vice-versa.
- No significant association existed between the number of years since high school graduation or GED completion and grades in Pre-Algebra.
- No significant association existed between the planned hours to work as reported on the College Student Inventory Form B™ (CSI-B) and grades in Pre-Algebra.
- Students with higher study habits self-assessment scale scores from the College Student Inventory Form B™ (CSI-B) tended to have higher grades in Pre-Algebra and vice-versa.
- Students with higher scores on the math and science confidence self-assessment scale score from the College Student Inventory Form B™ tended to have higher grades in Pre-Algebra and vice-versa.

- Students with higher scores on the desire to finish college self-assessment scale from the College Student Inventory Form B™ (CSI-B) tended to have higher grades in Pre-Algebra and vice-versa.
- No significant association existed between the receptivity to academic assistance scale score from the College Student Inventory Form B™ (CSI-B) and grades in Pre-Algebra.
- The regression equation which resulted was Course Grade = -1.07 -1.28(Gender) + .13(ACT Compass® Math score) + .10(CSI™ Study habits scale).
- Females were more likely to receive a grade of C or higher.
- Grades for students with high school diplomas or GED diplomas were not significantly different.
- Students with academic interests in Allied Health and Nursing differed significantly from Undecided students on course grade.

The next part of this Chapter will fully discuss the elements of the regression equation for the total sample, females, and males as related to actual outcomes versus predicted outcomes had North Central State College used this model. The analysis includes discussion about the equation variables, the "yes" and "no" prediction, and actual outcomes.

## Model Analysis

The purpose of this study was to assist North Central State College with the identification of students who are not likely to receive a grade of A, B, or C in their Pre-Algebra course via the development of a regression equation. This part of Chapter Five provides a discussion of the actual versus predicted outcomes had the equation been used to assess the 295 students in the sample from the fall terms of 2010, 2011, and 2012. The equation, Course Grade = -1.07 - 1.28(Gender) + .13(ACT Compass® Math score) + .10(CSI™ Study habits scale) was applied using the historical data from each student to produce a predicted grade.

The predicted grade was then classified as either successful or not successful using the definition of C or higher for successful and C- or lower for unsuccessful. This classification established two categories for prediction one being a yes prediction (successful) and the other a no prediction (unsuccessful). Sample students were then sorted into one of four sub populations:

predicted and actual success was yes, predicted success was yes but actual success was no, predicted and actual success was no, predicted success was no but actual success was yes. Table 5.1 below explains the four subpopulations from the total sample.

The table includes gender descriptions, average scores from the model variables, average predicted grade, and average actual grade. As can be seen, the logic of the model holds true that it would be expected that students with the yes prediction should have higher average variable values than students with the no prediction. For example, the 135 students with the predicted grade of C or higher who actually did have grades of C or higher had average CSI™ Study Habits Scores of 8.21 while the 49 students who were not predicted nor actually achieved a C or higher had CSI™ Study Habits Scores of 2.31. The average actual and predicted grades also followed the logic of the model except for those students who achieved differently than the model would have predicted. For example, 70 students would have been predicted to achieve on average a C+ where actual outcomes were D- on average. An expanded discussion is included below for the two populations who did not achieve as predicted.

Table 5.1

*Regression Equation Analysis, Total Sample*

| | *N* | | *Gender* | | *Average ACT Compass® Math Score* | *Average CSI™ Study Habits Score* | *Average Predicted Grade* | *Average Actual Grade* |
|---|---|---|---|---|---|---|---|---|
| | *N* | *%* | *Male* | *Female* | | | | |
| *Total Sample* | *295* | | *32%* | *68%* | *47* | *5.61* | *C* | *C* |
| *Predicted Grade of C or Higher Yes, Actual Yes* | *135* | *46%* | *14%* | *86%* | *51* | *8.21* | *C+* | *B+* |
| *Predicted Grade of C or Higher Yes, Actual No* | *70* | *24%* | *27%* | *73%* | *49* | *5.87* | *C+* | *D-* |
| *Predicted Grade of C or Higher No, Actual No* | *49* | *17%* | *57%* | *43%* | *39* | *2.31* | *C-* | *F* |
| *Predicted Grade of C or Higher No, Actual Yes* | *41* | *14%* | *66%* | *34%* | *42* | *0.54* | *D+* | *B* |

This analysis also produced outcomes measurements which are included in Table 5.1.1. The equation would have predicted that 205 students or 69% would have achieved a grade of C or higher or in other words the yes prediction. The actual outcome was 176 students or 60% of the sample. Similarly, the accuracy of the yes prediction was 66% where 135 of the 205 students predicted to achieve success actually did achieve success.

The no prediction or grades of C- or lower outcomes measurements showed that the model would have predicted 90 students or 31% would have received a grade representative of

unsuccessful. The actual outcome was 119 students or 40% of the sample. Similarly, the accuracy of the no prediction was 54% where 49 of the 90 students predicted to not achieve success actually did not achieve success. An analysis of the accuracy of the overall prediction showed that 62% of the sample would have been predicted correctly, either yes or no, to achieve a grade of C or higher. Tables 5.2, 5.2.1, 5.3, and 5.3.1 continue the analysis by gender.

Table 5.1.1

*Predicted versus Actual Outcomes, Total Sample*

| | | |
|---|---|---|
| *Equation Prediction Grades of C or Higher* | *205* | *69%* |
| *Actual Grades of C or Higher* | *176* | *60%* |
| *Accuracy of Prediction - Yes* | *135/205* | *66%* |
| *Equation Prediction Grades of C- or Lower* | *90* | *31%* |
| *Actual Grades of C- or Lower* | *119* | *40%* |
| *Accuracy of Prediction - No* | *49/90* | *54%* |
| *Accuracy of Overall Prediction (Yes and No)* | *184/295* | *62%* |

Table 5.2 below includes descriptions for females, average scores from the model variables, average predicted grade, and average actual grade. As can be seen, the logic of the model holds true that it would be expected that females with the yes prediction should have higher average variable values than females with the no prediction. For example, the 116 females with the predicted grade of C or higher who actually did have grades of C or higher had average ACT Compass® Math Scores of 50 while the 21 females who were not predicted nor actually achieved a C or higher has had ACT Compass® Math Scores of 36. The average actual and predicted grades also followed the logic of the model except for those females who achieved differently than the model would have predicted. For example, 51 females would have been

predicted to achieve on average a C+ where actual outcomes were F on average. As noted above, an expanded discussion is included below for the two populations who did not achieve as predicted.

Table 5.2

*Regression Equation Analysis, Females*

| | *N* | | *Average ACT Compass® Math Score* | *Average CSI™ Study Habits Score* | *Average Predicted Grade* | *Average Actual Grade* |
|---|---|---|---|---|---|---|
| | *N* | *%* | | | | |
| *Total Sample* | 202 | *68%* | *47* | *6.56* | *C* | *C* |
| *Predicted Grade of C or Higher Yes, Actual Yes* | 116 | *57%* | *50* | *8.22* | *C+* | *C+* |
| *Predicted Grade of C or Higher Yes, Actual No* | *51* | *25%* | *48* | *5.20* | *C+* | *F* |
| *Predicted Grade of C or Higher No, Actual No* | *21* | *10%* | *36* | *4.52* | *C-* | *F* |
| *Predicted Grade of C or Higher No, Actual Yes* | *14* | *7%* | *34* | *.86* | *D+* | *B* |

This analysis also produced outcomes measurements for females which are included in Table 5.2.1. The equation would have predicted that 167 female students or 83% would have achieved a grade of C or higher or in other words the yes prediction. The actual outcome was 130 students or 64% of the sample. Similarly, the accuracy of the yes prediction was 69% where 116 of the 167 students predicted to achieve success actually did achieve success.

The no prediction or grades of C- or lower outcomes measurements showed that the model would have predicted 35 female students or 17% would have received a grade representative of unsuccessful. The actual outcome was 72 students or 36% of the sample. Similarly, the accuracy of the no prediction was 60% where 21 of the 35 female students

predicted to not achieve success actually did not achieve success. An analysis of the accuracy of the overall prediction showed that 68% of the sample would have been predicted correctly, either yes or no, to achieve a grade of C or higher.

Table 5.2.1

*Predicted versus Actual Outcomes, Females*

| | | |
|---|---|---|
| *Equation Prediction Grades of C or Higher* | *167* | *83%* |
| *Actual Grades of C or Higher* | *130* | *64%* |
| *Accuracy of Prediction - Yes* | *116/167* | *69%* |
| *Equation Prediction Grades of C- or Lower* | *35* | *17%* |
| *Actual Grades of C- or Lower* | *72* | *36%* |
| *Accuracy of Prediction - No* | *21/35* | *60%* |
| *Accuracy of Overall Prediction (Yes and No)* | *137/202* | *68%* |

Table 5.3 below includes descriptions for males, average scores from the model variables, average predicted grade, and average actual grade. As can be seen, the logic of the model holds true that it would be expected that males with the yes prediction should have higher average variable values than males with the no prediction. For example, the 19 males with the predicted grade of C or higher who actually did have grades of C or higher had average ACT Compass® Math Scores of 56 while the 28 males who were not predicted nor actually achieved a C or higher has had ACT Compass® Math Scores of 42. The average actual and predicted grades also followed the logic of the model except for those males who achieved differently than the model would have predicted. For example, 19 males would have been predicted to achieve on average a C where actual outcomes were D- on average. As noted above, an expanded discussion is included below for the two populations who did not achieve as predicted.

Table 5.3

*Regression Equation Analysis, Males*

| | *N* | | *Average ACT Compass® Math Score* | *Average CSI™ Study Habits Score* | *Average Predicted Grade* | *Average Actual Grade* |
|---|---|---|---|---|---|---|
| | *N* | *%* | | | | |
| *Total Sample* | 93 | *32%* | *48* | *3.54* | *C-* | *C-* |
| *Predicted Grade of C or Higher Yes, Actual Yes* | *19* | *20%* | *56* | *8.39* | *C+* | *B* |
| *Predicted Grade of C or Higher Yes, Actual No* | *19* | *20%* | *52* | *7.68* | *C* | *D-* |
| *Predicted Grade of C or Higher No, Actual No* | *28* | *30%* | *42* | *.064* | *D+* | *F* |
| *Predicted Grade of C or Higher No, Actual Yes* | *27* | *29%* | *46* | *.050* | *C-* | *B* |

This analysis also produced outcomes measurements for males which are included in Table 5.3.1. The equation would have predicted that 38 male students or 41% would have achieved a grade of C or higher or in other words the yes prediction. The actual outcome was 46 students or 49% of the sample. Similarly, the accuracy of the yes prediction was 50% where 19 of the 38 students predicted to achieve success actually did achieve success.

The no prediction or grades of C- or lower outcomes measurements showed that the model would have predicted 55 male students or 59% would have received a grade representative of unsuccessful. The actual outcome was 47 students or 51% of the sample. Similarly, the accuracy of the no prediction was 51% where 28 of the 55 male students predicted to not achieve success actually did not achieve success. An analysis of the accuracy of the overall prediction showed that 51% of the sample would have been predicted correctly, either yes or no, to achieve a grade of C or higher.

Table 5.3.1

*Predicted versus Actual Outcomes, Males*

| | | |
|---|---|---|
| *Equation Prediction Grades of C or Higher* | *38* | *41%* |
| *Actual Grades of C or Higher* | *46* | *49%* |
| *Accuracy of Prediction - Yes* | *19/38* | *50%* |
| *Equation Prediction Grades of C- or Lower* | *55* | *59%* |
| *Actual Grades of C- or Lower* | *47* | *51%* |
| *Accuracy of Prediction - No* | *28/55* | *51%* |
| *Accuracy of Overall Prediction (Yes and No)* | *47* | *51%* |

**Logistic Regression**

In order to corroborate the model analysis above, logistic regression was conducted to examine how well the six predictor variables of gender, CSI™ hours planned to work, ACT Compass® Math score, CSI™ Study habits scale, CSI™ Math and Science Confidence scale, and CSI™ Receptivity to Academic Assistance predicted course success, defined as grades of C or higher, in Pre-Algebra. The assumptions of observations being independent and independent variables being linearly related to the logit were checked and met.

When all six predictor variables were considered together, they significantly predicted course success $\chi 2 = 34.10$, $df = 6$, $N = 295$, $p < .001$. CSI™ hours planned to work and CSI™ Receptivity to Academic Assistance failed to predict retention alone or when included with the other predictors in the model. Table 5.4 presents the odds ratios, which suggested that the odds of success in Pre-Algebra were increasingly greater for females with higher scores on ACT Compass® Math score, CSI™ Study habits scale, and the CSI™ Math and Science Confidence score. This is consistent with the regression equation produced in Research Question 10 with the

exception of the CSI™ Math and Science Confidence score which did not contribute to the prediction of course grade. This may have been due, however, to the significant correlation to the CSI™ Study habits scale which produced unacceptable tolerance values and removed it from the linear model.

Table 5.4

*Logistic Regression Pre-Algebra Course Success*

| Variables | *B* | *SE* | *Odds ratio* | *p* |
|---|---|---|---|---|
| Gender | -.652 | .27 | .52 | .017 |
| ACT Compass® Math score | .058 | .02 | 1.06 | .000 |
| CSI™ Study habits score | .038 | .02 | 1.04 | .033 |
| CSI™ hours planned to work score | -.089 | .08 | .915 | .264 |
| CSI™ Receptivity to Academic Assistance score | .033 | .02 | .992 | .113 |
| CSI™ Math and Science Confidence score | .042 | .02 | 1.04 | .041 |

Other test results which were produced using Logistic regression included Cox &Snell (.109) and Nagelkerke (.147) R Square values. Leech, Barrett, and Morgan (2011) labeled these tests as pseudo $R^2$ estimates which indicate that approximately 11% or 15% of the variance in course success "…can be predicted from the linear combination of the six independent variables" (p. 134). This is consistent with the 12% $R^2$ value produced in Research Question 10. Most interesting of value to inform the model analysis above, the six independent variables correctly predicted almost 65% of the overall prediction of either yes or no. This is consistent with the analysis above (62%) and leads to a discussion regarding the approximately 38% of students who were not predicted accurately, either yes or no.

Assuming that the fall 2014 students enrolled in the Pre-Algebra course are similar and that the course content and delivery have not changed drastically, North Central State College might conclude, using the regression equation, that approximately 62% of the overall prediction

for course success would be accurate. Per Table 5.1 above, 70 students (51 females and 19 males) would have been predicted to achieve success and did not. Forty-one students (14 females and 27 males) would have been predicted to be unsuccessful and were successful. The next part of this section discusses some possible explanations about the 38% of students who did not perform as predicted.

**Possible explanations for students who did not perform as predicted**

It should be noted that the prediction of human behavior is very complicated and models attempting to do so are always limited. This section provides some common explanations or possible reasons why students do not perform as predicted. Chapter two, The Review of Literature, described seven factors, one of which was student beliefs, characteristics, and behaviors, which impacted successful completion of developmental mathematics. This study limitedly addressed student beliefs, characteristics and behaviors using data from the College Student Inventory; however, a review of the research included in Chapter Two indicated multiple contributors to course success or lack thereof such as life responsibilities, student beliefs about mathematics, math anxiety, locus of control, learning styles, and engagement levels. Other literature suggested that low or high self-efficacy and the lack of or higher levels of resilience and grit are contributors to the reasons why students are or are not successful.

In a comprehensive literature review conducted by van Dinther, Dochy, and Segers (2011), the authors explained that multiple factors seemed to influence students' self-efficacy. The authors noted that mastery experiences were cited in the literature as the most powerful way to establish a strong sense of self-efficacy in students. "Goal setting combined with self-reflection, another self-regulation component, can provide students the opportunity of perceptions of learning progress, which can lead to a mastery experience" (p. 105).

In a related study, Pajares and Miller (1995), using the Mathematics Self-Efficacy Scale Revised (MSES-R), asked 391 undergraduates students at three large public universities in the South and Southwest, "…to provide judgments of their confidence to solve specific math problems, to perform math-related tasks, and to succeed in math-related courses" (p. 193). Following the MSES-R assessment, students' performance was measured by asking them to solve problems based upon their self-efficacy assessment. The study then used Pearson correlations and multiple regressions to develop associations between problem self-efficacy, tasks self-efficacy, courses self-efficacy, total math self-efficacy, problem-solving performance, and choice of math-related majors.

The authors concluded that math problems self-efficacy was the most appropriate measure when problem solving performance was the dependent variable, $F = (3, 387) = 120.89$, $p = < .0001$, adjusted $R^2 = .48$. Even though both problems self-efficacy and courses self-efficacy were significant in the prediction of problem solving performance, problem solving self-efficacy had a much stronger influence. Likewise, when choice of math-related majors was the dependent variable, courses self-efficacy had the only significant association in the prediction, $F = (3, 387) = 47.66$, $p = < .001$, adjusted $R^2 = .26$.

A second possible explanation for student success in mathematics is that of mathematical resilience. Johnston-Wilder and Lee (2010) described this construct as "…that quality by which some learners approach mathematics with confidence, persistence and a willingness to discuss, reflect and research" (p. 2). While their research was primarily focused in the secondary school system in England and standardized exam outcomes, it has relevance to the community college sector in the United States. Using a very positive approach by not focusing on the dismal state of mathematics instruction in England and engaging faculty, staff, and students to make their

classrooms a more positive environment, the researchers were able to show both qualitative and quantitative improvements.

Their methods included a questionnaire to measure mathematical resilience as well as selection and training of Maths Angels referred to as mathematics coaches to "…sit alongside learners and face their mathematical demons together" (p. 6). Sessions were developed for Year 10 and 11 students showing them resilient ways to study for their GCSE exams. Videos explaining mathematical ideas were produced by the students for Year 9 students. Students expressed that they enjoyed this type of learning and they became more confident with mathematics. Quantitatively, GCSE outcomes improved 12%.

Johnston-Wilder and Lee concluded that "…by naming and defining the construct of mathematical resilience the school had something that they could discuss and decide how they could develop" (p. 11). They affirmed that the tools they used seemed to produce a greater level of mathematical resilience and that students became more aware of their learning and had more positive experiences. They also noted, however, that the assessment tool needs to be further refined for global use. "We need to explore a measuring tool in much greater depth before we are ready to offer it to a wider public" (p. 11).

Hanford (2013), in a radio conversation with Angela Duckworth, explained the concept of 'grit' among college students. Duckworth suggested that grit may be as essential to achievement as is intelligence. On the other hand there are intelligent people who are not high achievers, according to Duckworth, and in a study she conducted she found that smarter students actually had less grit than students who scored lower on intelligence tests. Duckworth's test, called the "Grit Scale" is a self-assessment tool which allows students to answer such questions as "Setbacks don't discourage me" and "I have overcome setbacks to conquer an important

challenge." (Hanford, 2013) In a study conducted at West Point, "grit mattered more than intelligence, leadership ability or physical fitness" (p. 2). At the national spelling bee the grittiest contestants were most likely to advance probably because they studied longer, not because they were more intelligent. (Hanford, 2013)

While Duckworth's research is continuing as related to college students, she believes that "…grit is likely a significant factor when it comes to college completion…" (p. 3) among the students in her sample. The research sounds promising and it may have application to students enrolled in developmental mathematics at community colleges. Along with life's responsibilities, mathematical self-efficacy, and mathematical resilience, grittiness adds to the possible explanations of why students did not perform as predicted at North Central State College or at any community college.

The next section will provide a discussion of three implications for advising and student success practices which are indicated by the findings of this study. The development of student success plans at both the individual and section level is the first suggestion below. Based upon an updated review of the literature to better understand possible explanations for why students did not perform as predicted, the second implication suggests other assessments for self-efficacy, resilience and grit. Lastly, research question 3 provided a finding which may suggest that North Central State College conduct a review of the Mathway for each major.

## Implications for Advising and Student Success Practices

The first implication for advising and student success practices includes the development of a student success plan for each student, including an initial assessment with success plan strategies, and a course section success profile to better inform instructional practices. This

suggestion is supported by findings from Research Questions 1a, 2, 3, 6, 7, 8, and 10 which provided significant correlations to course grade and a prediction for success in Pre-Algebra.

## Student Success Plan

The student success plan and the course section success profile must be preceded by an assessment using the regression equation and other supporting variables. In order to establish the success prediction, both the ACT Compass® Math score and the CSI™ Study Habits Scale score along with gender will need to be provided to faculty and staff as early as possible. Data appear to be readily available at North Central State College therefore this assessment using the regression equation should be easily completed using a download from the existing databases which provided the sample data.

The development of the student success plan coupled with the assignment of a math success coach, much like the Maths Angels noted in the research conducted by Johnston-Wilder and Lee (2010), may assist students with higher achievement levels. Their research used selection and training of Maths Angels referred to as mathematics coaches to "…sit alongside learners and face their mathematical demons together" (p. 6). Finally, the creation of the course section success profile and the instructor's embedded instructional approaches could strengthen the individualized success plan and improve both the yes and no predictions. A sample student success assessment is included below.

### Student Success Assessment.

The student success assessment is based upon the regression equation and associations which are explained in Chapter Four and discussed more fully in Chapter Five. The equation includes three variables to predict course grade for Pre-Algebra. The equation is reproduced

below and shows that gender, ACT Compass® Math score, and CSI™ Study Habits Scale score provide the strongest prediction, among the variables included in the study, for course success. Using a simple spreadsheet, faculty and staff could compute predicted course grade quite easily. Perhaps a system tool used by Institutional Research could be developed to accomplish the same task. I have included a sample Student Success Assessment below.

| **Student Success Assessment** | | | |
|---|---|---|---|
| Student Name: | Success Coach: | Instructor: | |
| Model Elements | | Value | Success Prediction (Y= 5 or >, N <5) |
| Gender* | | 0 | |
| ACT Compass® Math score | | 51 | |
| CSI™ Study Habits Scale score | | 8.21 | |
| Course Grade Prediction (Course Grade** = -1.07 -1.28(Gender***) + .13(ACT Compass® Math score) + .10(CSI™ Study Habits Scale score). | | 6 | Y |

**Notes:**
*Gender Value, Female = 0, Male = 1
**Possible Course Grade Values 0=F, 1=D-, 2=D, 3=D+, 4=C- , 5=C, 6=C+, 7=B-, 8=B, 9=B+, 10=A-, 11=A;

| **Other Supporting Variables** | **Value** |
|---|---|
| # Developmental Course Placement Types (Course grade means typically are significantly different between students with one developmental course placement and three developmental course placements.) Range: 1 to 3, Historical Mean 1.8: | |
| # Developmental education courses recommended (Students with higher numbers of developmental education courses recommended tend to have lower grades in Pre-Algebra and vice-versa.) Range: 1 to 6, Historical Mean 3.03: | |
| # Levels below college math (Students who place more levels below college math tend to have lower grades in Pre-Algebra and vice-versa.) Range: 1 to 3, Historical Mean: 2.11 | |
| CSI Study Habits Scale Score (Students with higher study habits scale scores from the College Student Inventory Form B™ tend to have higher grades in Pre-Algebra and vice-versa. Same values as above) Range: -18 to 18:, Historical Mean: 5.61 | |
| CSI Math and Science Confidence Scale Score (Students with higher math and science confidence scale scores from the College Student Inventory Form B™ tend to have higher grades in Pre-Algebra and vice-versa.) Range: -18 to 18, Historical Mean: -3.23 | |
| CSI Desire to Finish College Scale Score (Students with higher desire to finish college scale scores from the College Student Inventory Form B™ tend to have higher grades in Pre-Algebra and vice-versa.) Range: -24 to 24, Historical Mean: 16.74 | |
| Intended Major (Course grade means typically are significantly different between Undecided (lowest performing group) and Allied and Health and Nursing students., highest performing group)) | |

**Student Success Plan Strategies.**

Student success plans should be developed based upon the two types of success prediction, yes and no. A student with the yes prediction might be monitored by the success coach at the 3rd week, Midterm, and 12th week of the term with focus on such elements as life circumstances (job, family, etc.), attendance, anticipated grade, engagement and interest, special program or student employment affiliation on campus and other variables known by the instructor. An awareness of the other supporting variables listed on the assessment will provide the success coach and faculty members with information to better inform referral and support.

Students with the success prediction of no might be required to meet with the success coach regularly, seek tutoring, and engage faculty during regular office hours. A similar focus for the elements noted above for students with the yes prediction should be included. Additional support and referral for assistance with improvement of the Study Habits items from the CSI (items # 18, 30, 40. 62, 78, 83), Desire to Finish College items from the CSI (items # 16, 25, 38, 51, 60, 73, 85, 94), and the Math Confidence items from the CSI (items # 37, 64, 86) should be provided.

These recommendations are supported by the regression equation and the positive correlations between Desire to Finish College and Math and Science Confidence items from the CSI and course grade. Additionally, career counseling and major selection for undecided students is indicated since they had significantly lower course grade means than the highest performing students who intended Allied Health and Nursing as their major. This finding was explained in the additional items of interest section in Chapter Four.

In addition to an individualized student success plan, faculty may be interested in classroom assessment using the regression equation as the basis to determine the success

prediction. The next part of this section will provide ideas to assist faculty with development of a classroom success profile and implementation of embedded instruction based upon the findings of the study.

**Course Section Success Profile and Embedded Instructional Plan.**

Faculty members may wish to better understand the strengths and challenges of all the students in their section and provide embedded instruction based on those needs. The development of a section success profile using elements like average ACT Compass® Math score, average CSI™ Study Habits Scale score, average predicted grade, and the yes and no success predictions for both females and males versus the historical accuracy of those predictions could be used to better prepare the faculty member to provide instructional components to best support student success.

As is noted above, the Study Habits Scale score from the CSI is predictive of course grade and the Math and Science Confidence Scale score has a positive correlation with course grade. Faculty members may wish to embed study habits and math confidence techniques into their instruction. Embedded instruction using items from the CSI Study Habits (items 18, 30, 40. 62, 78, 83) and Math Confidence scales (items 37, 64, 86) could be used to model best practices, establish assignments and develop improvement plans. Examples might include how to take notes in their class and how to study for tests. They could also assign homework to rewrite notes from the day and hand in during the next session as a graded assignment. This practice also allows the faculty member to have a better understanding of the students' needs for referral and support.

The assessment of student success using the regression equation and other supporting variables is the first step in the development of individualized success plans. This practice,

coupled with assignment of a coach, might enable students to achieve higher levels of success. Adding the instructor's success profile and embedded instructional approaches could strengthen the individualized success plan and improve both the yes and no predictions. The yes and the no prediction in this study did not include data from other promising research which could influence practices at North Central State College. Those practices described in the section regarding students who did not perform as predicted included the Math Self Efficacy Scale-Revised (MSES-R), Math Resilience, and the Grit Scale. The next part of this section describes how North Central State College might begin to incorporate these assessments within the course and improve the ability to predict course success.

**Pilots for MSES-R, Math Resilience Grit Scale**

This study limitedly addressed student beliefs, characteristics and behaviors using data from the College Student Inventory; however, a post-study review of the literature revealed some possible explanations why students at North Central State College did not perform as predicted. It may be worth the College's time to begin to pilot other assessments like the Math Self Efficacy Survey- Revised, Math Resilience and the Grit Scale.

Pajares and Miller (1995), using the Mathematics Self-Efficacy Scale Revised (MSES-R), concluded that math problems self-efficacy was the most appropriate measure when problem solving performance was the dependent variable, $F = (3, 387) = 120.89$, $p = < .0001$, adjusted $R^2 = .48$. Even though both problems, self-efficacy and courses self-efficacy, were significant in the prediction of problem solving performance, problem solving self-efficacy had a much stronger influence. Likewise, when choice of math-related majors was the dependent variable, courses self-efficacy had the only significant association in the prediction, $F = (3, 387) = 47.66$, $p = < .001$, adjusted $R^2 = .26$. This study may have value to North Central State College in that

assessment of math self-efficacy using an instrument like MSES-R might be embedded within the course and used as secondary assessment post placement so that faculty members and advisors might respond appropriately.

Johnston-Wilder and Lee (2010) described the math resilience construct as "…that quality by which some learners approach mathematics with confidence, persistence and a willingness to discuss, reflect and research" (p. 2). While their research was primarily focused in the secondary school system in England, Johnston-Wilder and Lee concluded that "…by naming and defining the construct of mathematical resilience the school had something that they could discuss and decide how they could develop" (p. 11) They also noted that the assessment tool needs to be further refined for global use. North Central State College could contact the authors and request permission to be included in their continuing study and development of the tool.

Angela Duckworth, in an interview with Hanford (2013) explained the concept of 'grit' among college students. Duckworth suggested that grit may be as essential to achievement as is intelligence. Duckworth's test, called the "Grit Scale" is a self-assessment tool which allows students to answer such questions as "Setbacks don't discourage me" and "I have overcome setbacks to conquer an important challenge." While Duckworth's research is continuing as related to college students, she believes that "…grit is likely a significant factor when it comes to college completion…" (p. 3) among the students in her sample. The research sounds promising and it may have application to students enrolled in developmental mathematics at community colleges.

**Review of the Mathway**

Findings from Research Question 3: What association exists between the number of levels below college math and the course grade in Pre-Algebra showed the correlation was

significant and negative, which meant that students who placed more levels below college math tended to have lower grades in Pre-Algebra and vice-versa. If North Central State College has not done so already, this finding implies the need for a review of the Mathway by major. For example, what are the required courses for the Public Service Mathway and might the Mathway be accelerated or the developmental course eliminated?

Bryk and Treisman (2010) stated "It's time to decide what these students really need to know to succeed. For these reasons, we think that it's time to revisit both the structure and goals of remedial math" (p. B19-B20). They believed …"students in the social sciences, arts, and humanities, and those seeking careers in business, applied technologies, health sciences, and other fields could be served just as well by another pathway" (p. B19-B20). Faculty members, Hern and Snell (2013) from the California Acceleration Project, reported higher levels of achievement using acceleration strategies. Perhaps it is time for North Central State College to begin to use acceleration strategies in the delivery of Pre-Algebra.

Even with promising statistical values such as an $R^2$ of 12% and overall accuracy of 62% for the success prediction, more research is needed in order to better understand the relationships to course grade. This study used previous academic performance, depth and breadth of developmental education needs, recency of math education, and motivational scores from the College Student Inventory Form B™ (CSI-B). The next section, implications for future research, will provide a discussion of additional analysis which may benefit practitioners and add to the body of literature which describes the factors which impact course success in developmental mathematics.

## Implications for Future Research

This section will describe three areas for additional research which were indicated from the findings and discussion in Chapters Four and Five. The first suggestion, as was made by many other researchers, is the need for additional variables to be used to make the course success prediction. The second implication is for the continuing study of males and the variables which matter most to the prediction of course grade. Finally, other instruments like MSES-R, math resilience assessments, and the Grit Scale show promise to educators that they may provide some value to the prediction of course grade.

### Additional variables

This study and many of the studies presented in the Chapters One and Two, (Edwards, 1972, Long, 2003, Stephens, 2005, Lynch-Newberg, 2010, and Rambish, 2011) used independent variables which were usually representative of previous academic performance, demographic indicators, placement scores or delivery methods. As the researchers themselves (Long, 2003 and Stephens, 2005) pointed out, their studies paid little attention to other factors such as attendance, attitude, effort, anxiety levels, learning styles, actual number of hours worked, number of credit hours carried in the semester, income, marital status, or personal issues.. Additional research adding a greater number of variables and variable types is needed.

In order to replicate this study and attempt to develop a more robust regression equation, North Central State College and other community colleges that use CSI and COMPASS should begin to collect data at the student level which represent the students' experience, in addition to grades, while in the course. Community colleges should begin to collect other variables like life circumstances (family, work, etc.) attendance, engagement and interest, program, student employment or other affiliations and other variables known by the instructor in order to better

inform the prediction of course grade. As was discussed in the implications for practice section, if additional instruments to assess math self-efficacy, math resilience, and grit are used, these measures should be added to the mix for analysis.

**Males**

The findings of this study certainly point to development of a better understanding of which variables matter most to the prediction of course grade for males. This suggestion is substantiated by the significantly lower course means which males achieved and the regression equation where being male provided a significant contribution to the prediction of course grade. In order to better describe the need for additional research, males within this sample were isolated and a cursory multiple regression analysis was run using the same variables as were used in Research Question 10. As might be expected the results were different. Math placement score was still a factor, however study habits did not have a role in the prediction for males. In fact, the combination of variables could not produce an equation that could significantly predict course grade for males.

What was interesting was that by loading other variables not included in Research Question 10, reading placement scores provided a significant contribution to the prediction of course grade for males but when females were included it did not. Similarly, a Logistic regression review, defining success as C or greater, also produced odds ratios showing males with higher reading placement scores would have higher grades in pre-algebra. This raises the question that if all the same research questions in this study were applied to males only would the same results be found? More research on males only using different variables needs to be undertaken. It might means that the prediction is truly grounded in the reading needs of the male.

**MSES-R, Grit Scale, Math Resilience**

Lastly, more research needs to be conducted on the value of tools like the GRIT Scale, Math Resilience Assessments and MSES-R for course placement and or prediction of course success. A better understanding of the associations between the MSES-R subscales, math resilience measures, and Grit Scores and course grade would benefit practitioners and add to the body of literature which describes the factors which impact student success in developmental mathematics. The current research for Grit sounds promising and it would be interesting to determine if any relationships existed between the Grit score, course placement, and course success. Additional research might determine if the score could be used to supplement other instruments like ACT Compass® as students are advised and placed into courses.

## Summary and Conclusion

The purpose of this study was to assist North Central State College with the identification of students who are not likely to receive a grade of A, B, or C in their Pre-Algebra course via the development of a regression equation. A secondary purpose was to provide advising and student success recommendations which may assist the faculty and staff as they attempt to best situate and affiliate students who are not likely to receive a grade of A, B, or C.

One Way ANOVA, Pearson r, Spearman Rho, multiple regression, and Chi Square analyses were used to answer ten research questions outlined in Chapters One and Three and three additional items of interest which were developed as the study evolved. Ultimately, by employing six of the sixteen independent variables, an equation that predicted a student's grade in Pre-Algebra was developed. The variables were representative of previous academic performance, depth and breadth of developmental education needs, recency of math education, motivational scores from the College Student Inventory Form B™ (CSI-B) such as math skills

self-assessment and desire to finish to college, and self-reported demographic data such as the number of hours planned to work.

Chapter Five provides a discussion in four sections. The first section explained how the results of the study related to Chapter Two, Review of the Literature. Four of the seven factors which impact student success, placement testing, breadth and depth of skill deficiency, student beliefs, attitudes, and motivation, and academic and demographic variables, had relevance to this study. Section two provided a model analysis showing the relationship between predicted versus actual results had the model been used and described possible explanations of why students did not perform as predicted. The overall accuracy of the success prediction, both yes and no, would have been 62% had the model been used with the students in the historical sample. This was supported by a logistic regression model which produced similar results. Thirty–eight percent of students did not perform as predicted and possible explanations concluded this section.

Section three provided a discussion of three implications for advising and student success practices which were indicated by the findings of this study. The development of student success plans at the individual and section level, implementation of other assessments to learn more about the relationships between self-efficacy, resilience and grit, and a review of the Mathway, for each major, were suggested. Implications for future research concluded the discussion suggesting that additional variables, variables that matter most to the success prediction for males, and other motivational assessments, like Grit Scales, should be studied to determine if any associations exist to course grade.

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