ALGEBRA READINESS ASSESSMENT

by

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CHAPTER 1

Introduction

Background

To facilitate learning in high school, students are placed in courses based on their academic ability. Students with adequate academic ability will be enrolled in classes that are intended to prepare them for college, often referred to as college preparatory courses (Spade, Columba & Vanfossen, 1997). Students who are less academically prepared are enrolled in general education courses or remedial level coursework if additional preparation is necessary.

As students transition from middle school to high school, it is often difficult to determine with precision their appropriate classes for enrollment purposes. Algebra is the first mathematics course freshman take to prepare for college and is often looked at as the backbone of mathematics curriculum (Chambers; Moses & Cobb's, cited in Kortering, deBettencourt & Braziel, 2005; Risher, 2003, p. 103). Therefore, the placement process usually begins with determining whether a student is ready to enroll in Algebra.

There are many general educational, psycho-social and cultural factors that contribute to academic success (Hagedorn, Siadat, Fogel, Nora & Pascarella, 1999). Some specific examples include students' self-concept (House, 1993; Wilkins, 2004) and motivation (Singh, Granville, & Dika, 2002). Knowledge of these factors, which is often information that is difficult or expensive to obtain, purportedly would assist academic counselors in determining which courses a student should register. Given the difficulty and expense in obtaining this information, it would be essential to first determine which of these factors could be used most efficaciously for mathematics placement.

Furthermore, the question has been raised on the ethics in placing students based on parental variables or students' personality traits (Oakes & Guiton, 1995; Spade, Columba & Vanfossen, 1997; Useem, 1992). The alternative is some objectively measured student variable, such as middle school math grades and standardized mathematics test scores. Unfortunately, there is a paucity of instruments designed for this purpose, specifically at the middle school level.

Significance

The necessity for such an instrument is well-documented in the mathematics education literature, because proper placement has far-reaching ramifications. For example, there is a high correlation between math classes taken in high school and college completion rates. Adelman (1999) found that completing intensive high school mathematics courses had a stronger effect on finishing a college degree than variables such as high school test scores, grade point average, class rank, tracking, socioeconomic status, and ethnicity. Furthermore, finishing a course beyond Algebra 2 more then doubles the chance that a student who started his or her college degree will finish it (U.S. Department of Education, 1997). Data from the National Educational Longitudinal Study (1988) indicated that 83% of students who took Algebra and Geometry in high school enrolled in college within two years of graduation (U.S.

Department of Education, 1997). Therefore, it is important that students complete advanced mathematics courses (Trusty & Niles, 2003) while in high school, beginning with Algebra.

Problem Statement

The goal of this study is to develop and contribute predictive validity evidence for an instrument that will guide counselors in making placement recommendations and decisions with students. Specifically, the goal is to develop a placement test for ninth grade students enrolling in mathematics at the high school level.

Assumptions

Students withdraw from mathematics courses for several reasons. Often times these reasons have little or no relationship to academic success in the classroom. Examples include transferring to a different school, attendance issues or discipline problems. In this study, students who are dropped from an Algebra course to a remedial class due to poor grades before the completion of the course will be counted as failures. Students who withdraw from an Algebra class for other reasons will not be counted as failures because it is not possible to determine whether or not they would have been successful if they had completed the course.

Limitations

The school policy at the piloting school district is to move unsuccessful students from Algebra into a remedial class at the end of first semester. Collecting data only at the end of the year would create a mortality issue because many of the students would be lost from the original sample. Complicating the matter further would be the fact that the lost scores would belong to low achieving students, these are the most important in determining the success of the placement test. In addition, sometimes students are moved because they have poor grades but their final exam grade is acceptable. Capable students who lack motivation to do well in school may earn poor grades but do well on the final exam.

Definitions

Standardized Tests - Tests that are used to compare achievement of students from different schools. Standardized tests can be either aptitude or achievement tests. Standardized tests are uniformly administered and scored.

Placement Tests - Tests that are given to students entering high school to determine what level of classes to enroll them in.

Remedial Classes - Classes that are considered below average. They are usually taken by students that do not plan on attending college and have difficulty in the subject matter.

Letter Grades - A subjective measurement given by teachers to assess a student's academic achievement. Letter grades are assigned numerical values on an 11 point scale 11 = A, 10 = A -, 9 = B+, B = 8, B - = 7, C + = 6, C = 5, C - = 4, D + = 3, D = 2, D - = 1, E = 0.

Final Exam - A test given by the piloting school at the end of each semester. This exam is intended to assess the skills of Algebra students in the content areas set by the State of Michigan as proficiency requirements for all Algebra One students. Test items were created by the McDougal Littell test generator. Items were selected from the generator by Algebra teachers at the school for inclusion on the final exam.

Ability Tracking (Tracks) - grouping students into two or three different sets of classes. The different sets of classes include college preparatory, non-college and vocational tracks (Garet & Delany, 1988). In 1968 the National Education Association reported that 90% of schools track students.

CHAPTER 2

Review of Literature

Predictor Variables

Policies on how students are placed into mathematics classes vary by school district (Useem, 1992). Using subjective placement criteria such as teacher or counselor recommendations require school officials to make judgments about the correct placement for students. Some experts believe that these judgments are not always based on academic ability but rather on social factors. Rosenbaum (1980) even went as far to suggest that students that school officials believe should be enrolled in remedial courses are mislead about the ramifications of taking these types of courses by school counselors. In other words, the effects these types of courses may have on college success or future careers are not explained to students who enroll in remedial courses.

Socioeconomic status (SES) is one of the researched predictors of success in high school mathematics. Researchers do not suggest that socioeconomic status is directly related to classroom achievement. Instead researchers believe there are underlying factors related to SES that create these differences (Alexander, Cook, & McDill, 1978, Gamoran & Mare, 1989). For example, it may be that parents of higher socioeconomic status demand their kids be placed into more challenging classes (Dauber, Alexander & Entwisle, 1996).

Schools have also been criticized for the overrepresentation of African American and Hispanic students in remedial courses (Schafer & Olexa, 1971; Wang & Goldschmidt, 2003). However, The Educational Testing Service (1991) found that as the percentage of minorities in schools increase so does the emphasis of test scores on placement decisions. Allexsaht-Snider & Hart (2001) found that it is not the difference in ethnicity that causes disparities in mathematical achievement but rather the inequalities in the education. This may suggest that the bias again lies in underlying factors.

Although many believe that factors such as socioeconomic status and ethnicity correlate with Algebra success it would be unethical and socially unacceptable to use them to place students into mathematics courses. In addition, using these types of variables to place students into classes may leave students that are capable of passing higher level mathematics course in courses that will not prepare them to attend college. The goal of this study is to create a standardized test that predicts whether students will be successful in Algebra. This placement test is intended to collect data on factors that researches have shown to be predictive of Algebra success, and are also ethical and socially acceptable. The intention is that this placement tests will identify any student that has the ability to pass Algebra and therefore should be allowed to enroll in a college preparatory Algebra class.

The data for the predictor variable will be collected using an original placement test. Three factors that have been found to correlate with academic success in mathematics that will be incorporated to this placement test are: (1) self-concept, (2) previous academic achievement, and (3) basic computational skills. The literature in support of these three factors is reviewed below.

Self-Concept

Bandura's (1995) theory on self-efficacy indicated that the ability to learn new skills and information is influenced by an individual's personal views on her/his abilities in the area. Self-efficacy is different than self-esteem or self-concept because it deals with specific tasks or topics (Lent, R., Brown, S. & Gore, P., 1997; Pietsch, J., Walker, R. & Chapman, E., 2003). Therefore, a person's self-efficacy can differ greatly from one subject to another. For example, someone may have high self-efficacy in mathematics and low self-efficacy in science. Bandura (1995) postulated that the higher a student's self-efficacy, the more likely he or she would be in succeeding in that task (Baron & Byrne, 2004). Considerable research has been conducted on the relationship between self-efficacy and academic achievement. Much of the current research supports Bandura's theory that a student's self-efficacy has a relationship to academic success (Byrne, 1986; Guay, Marsh, & Boivin, 2003; Pajares & Miller, 1994; Randhawa, Beamer & Lundberg, 1993; Shavelson & Bolus, 1982; Skaalvik & Rankin, 1995; Wigfield & Eccles, 2000).

Many researchers use the term self-concept in their research rather than self-efficacy. However, what they are actually measuring is a student's self-concept in a specific content area. Several researchers that investigated the relationship between self-concept and academic achievement found that the association was stronger in mathematics than other academic areas (Marsh, Koller, Trautwein, Ludtke, & Baumert, 2005; Marsh, Seeshing Yeung, 1997). When researchers measure a student's self-concept in a specific academic area they are actually measuring a concept closer to Bandura's self-efficacy theory.

This leaves the issues of how specific the self-concept questions should be on the placement test. Bandura (1997) suggests that the closer the measurement of self-concept is taken to the specified task the more accurate the prediction of achievement will be. Marsh did a lot of research that suggested that using content specific questions to measure self-concept is not necessary; however questions must be specific to the math domain to have a significant relationship to achievement (Marsh, 1984; Marsh & Yeung, 1998). Therefore, the questions on the placement test will be a combination of these two concepts. The items will be written to evaluate students' feelings of their math abilities but will not be ask questions that ask them to asses their ability to do specific task such as adding fractions.

Several researchers have found that, in general, female students have lower self-concept than male students (Marsh, Koller, Trautwein, Ludtke & Baumert, 2005; Marsh & Yeung, 1998; Pajares & Miller, 1994; Simpkins & Davis-Kean, 2005). However, self-concept has the same effect on achievement in both boys and girls (Marsh, Koller, Trautwein, Ludtke & Baumert, 2005). In addition, Hanna & Sonnenschein (1985) found that although girls did better in first-year Algebra they predicted slightly lower Algebra grades for themselves than did boys. This may be something to think about when analyzing the predictability of the placement test. A score adjustment may need to be made to compensate for the inferior view of self-concept in girls.

Self-concept is a good choice for inclusion on the placement because of its high correlation with mathematics achievement. In addition, it is easily measured with a few survey questions. A positive self-concept is important for all students to succeed in mathematics courses at all levels. This section of the test could not only work as a placement tool but also as a diagnostic tool for teachers to determine which students need help raising their self-concept in the are of mathematics.

Previous Academic Achievement

Middle school grades are usually easily obtained by academic counselors. However, there are few studies that investigated the predictive validity of middle school grades to high school success. Much of the research that investigates the predictive validity of grades is conducted on high school GPA and college success. When grades are used in research between 8th grade mathematics marks and ninth grade Algebra success, they are found to be the highest predictor of academic success (Barnes & Asher, 1962; Holly, 1972; Siglin & Edeburn, 1978).

The question arises as to why not just use middle school grades to predict Algebra achievement? Using grade as sole criteria for Algebra enrollment would eliminate time and cost for school districts to administer a placement test. While grades may be a great predictor for highly motivated students this is not necessarily true for the unmotivated student. Many teachers believe that grades are more than a measure of achievement; they are combination of attributes such as attitude, effort and improvement (Brookhart, 1991; Friedman & Frisbie, 1995). Authors of measurement textbooks suggested that for grades to be valid they should only be a measure of achievement and that separate grades should be given for factors such as effort (Allen, 2005; Friedman & Frisbie, 1995). Brookhart (1993) found that teachers assign grades that considered more than academic achievement whether they had measurement training or not. Therefore, due to the subjectivity in assigning grades, it would not be bias to use grades as the sole predictor of achievement in Algebra.

The question also arises as to if it necessary to look up the grades included on the test, or would the students self-report be valid? Hanna (1970) found that using self reported grades only sacrificed a small amount of predictive validity for Algebra success. The placement test will include a question that asks students to report the grade they received in their 8th grade mathematics class. The pilot school also has the actual 8th grade math grades easily accessible for all 9th grade students. This will make it easy to compare the correlation coefficients of self reported and actual grades. If the correlation coefficients are not significantly different schools could be given an option to use actual grades or include the self-reported grades reported on the test in placement decisions.

Computational Skills

Experts associate computational skills with success in Algebra. However standardized testing alone does not always predict how well a student will perform in Algebra. Standardized testing is another area that has limited research examining the relationship to high school mathematics. Most of the literature that investigates the predictive validity of standardized tests is limited to the effects on college success. When researchers use standardized test scores as predictors they are found to be better indicators of high school mathematics success when they are used in addition to previous grades (Asher & Barnes, 1962; Bloand & Michael, 1984; Flexner, 1984; Hanna, 1969; Kovaly, 1979). Flexner (1984) found that computation items used in combination with a student predicted grade for Algebra was the best predictor of whether or not a student would complete an Algebra course. Marwick (2002) found that using just grades to place students into classes denied some students access to courses that they could successfully complete. Marwick also suggested that when students are placed into classes using a single measure they are put into lower level classes and when multiple measures are used students are placed in higher level classes without sacrificing success rates. By using grades in addition to testing computational skills you are rewarding students that do poorly on standardized tests but try hard in the classroom (Dauber, Alexander & Entwisle, 1996).

The next consideration pertains to the type of content that should be included on the computational section of the placement test. Much of the research involving Algebra success suggests students need basic computational skills to be successful in Algebra. The specific skills that encompass computational skills (outlined below in Chapter 3) are usually found in most pre-algebra courses. In addition to computational skills some experts suggest that students should understand mathematical vocabulary (Abraham,1983; Kovaly, 1979; Miles, 1997; Rotman, 1986). This includes not only the definitions of mathematical words but also symbolic representation of numbers, signs and abbreviations (Abraham, 1983; Rotman, 1991).

Other Issues

A typical classroom setting creates a testing environment that is confined to a 55 minute classroom period. Unfortunately, this limits the number of computational questions that could appear on the test. Regarding the notion that giving a timed test might skew results, consider the study conducted by Elliott & Marquart (2004) involving eighth grades students from four different middle schools. They found that extended time did not significantly change the performance of students with and without disabilities on a standardized math test. Some researchers have found that leaving the test un-timed is likely to reduce reliability of the test (Alster, 1997; Attali, 2005).

This leaves the question of how many items should be included on the test to maximize the reliability. Nunnally & Bernstein (1994) found that including more test items will raise the reliability of a test (Nunnally & Bernstein, 1994, p. 11). Therefore, it is necessary to determine the maximum number of questions students can finish comfortably in the 55 minute class period. Morante (1987) suggested that to determine an appropriate time limit 100% of the students should complete 75% of the test, and 90% should attempt all of the items. This method also supports Nunnally's claim that "Unless the time limit is severely restrictive, it will not influence the underlying traits measured by the tests" (Nunnally & Bernstein, 1994, p. 348). The test will be written to assess all of the computational skills experts suggest to be important for students to be successful in Algebra. Test administrators will need to monitor how many students are unable to finish the test in the allotted time period. Adjustments may need to be made after the pilot test.

Another issue that is often debated in mathematics is whether students may use calculators on exams. In 1986 the National Council Teachers of Mathematics emphasized the importance of using calculators at all grade levels and have expanded this position each year (Bridgeman, Harvey, Braswell, 1995; Dion, Harvey, Jackson, Klag, Liu & Wright 2000). In addition they encouraged publishers, test writers and teachers to integrate the use of calculators into their materials. As the use of calculators has grown in the classroom it has also grown in testing situations. Assessments should model the curriculum. Therefore, if students are allowed to use calculators in the classroom then should also be allowed to use them in testing situations.

Dion, Harvey, Jackson, Klag, Liu & Wright (2000) administered a survey to accredited schools that gave the SAT. They found that only 6% of Algebra students reported that they were not allowed to use calculators on tests. In 1996 the National Center for Educational Statistics reported that 80% of eighth graders had access to calculators at school. When calculators were first introduced it may have been unfair to use them on standardized tests because not all students had the same access to calculators. Now that the availability of calculators has become widespread this type of bias is not a problem.

Different types of questions are affected differently by calculator use. In a study conducted by Bridgeman, Harvey, & Braswell (1995) it was found that there was only a moderate increase in scores for the reasoning portion of the SAT mathematics questions when calculators were used. Mathematical placement tests that are testing reasoning should allow students to use calculators (National Council of Teachers of Mathematics, 1989). Reasoning questions reduce the routine calculation errors and get at the main focus of what the question is asking. However, the opposite may be true for problems that require routine calculations. These types of problems turn into assessments of calculator skills. To assess whether or not the use of a calculator affects that predictive validity of the computational section of the placement test it would be ideal to only allow some of the sample to use calculators. Then the predictive validity of both groups could be compared.

The next consideration pertains to the types of calculators that should be permitted? Hanson, Brown, Levine and Garcia (2001) found standardized test givers do not have standard policy, some issue a calculator and some allow students to bring their own. Does the type of calculator a student uses on a standardized test make a difference on her or his score? Hanson, Brown, Levine and Garcia (2001) found that the type of calculators 8th grade students used on a standardized test did not affect problem accuracy or time taken to complete the test. Student's performance on standardized tests increases when they were allowed to use a calculator model that they are familiar with (Bridgeman, Harvey, and Braswell, 1995; Graham, 2003)

Algebra teachers at the piloting school have access to TI-83 graphing calculators for all Algebra students. Unfortunately, ninth grade students may have had limited exposure to this type of calculator. Forster (2001) found that AP calculus students were hesitant to use their graphing calculators on the AP exam, even when it would save time students did not take advantage of the technology. If AP calculus students have a hard time using graphing calculators it may not be the best calculator to offer Algebra students for use during the placement test.

Reading ability is presumed to be a viable covariate in explaining and predicting student achievement in mathematics. However, Newman (1994) did not find reading skill to be a predictor of basic Algebra grades for college students. Miles (1999) found that reading comprehension did not predict college Algebra achievement, although understanding mathematical vocabulary was predictive. Bloland & Michael (1984) found that reading and vocabulary scores from a standardized test did not have a strong relationship with high school algebra success. Abedi & Lord (2001) found that English language learners (ELL) scored lower on the word problems on the *National Assessment of Educational Progress* mathematics assessment than proficient English speakers. Despite these findings, reading ability's potential link to high school Algebra achievement will be pursued as an ancillary objective, and thus, information will be collected on this variable.

Predictive Validity: Criterion Variable

The criterion variable for this study is defined by whether a student succeeds in Algebra. Academic success is typically defined in general educational literature in one of two ways. Some researchers define success with a grade that a student receives in the Algebra course (Berry, 2003, p. 898; College Board, 2004; Cooney & Bottoms, 2002, p. 2; Hoyt & Sorensen, 2001, p. 27; Kovaly, 1979; Sworder, 1990). Another measurement used to define academic success is the score a student receives on an administered test at the conclusion of the research (Gamoran, 1992; Hagedorn, Siadat, Fogel, Nora & Pascarella, 1999, p. 269; Whenland, Konet, & Butler, 2003, p. 19). Grades that are a measure of more than just academic ability can also create a problem in the criterion variable. Students may be able to achieve a certain grade by turning in assignments or showing effort, this does not necessarily mean that they know the "Algebra material". Part of doing well in Algebra is passing the final exam. The final exam grade in many schools makes up a portion of a student's final grade in the course. However, just using the final exam to evaluate a student's success would also be unfair because there are students who are poor test takers. A combination of these two measurements would appear to be a more accurate assessment of the variable success.

CHAPTER 3

Methodology

Development of the Placement Test

The placement test will be comprised of three parts or subscales. Students will be given a score for (1) their previous academic achievement, (2) their self-concept, and (3) computational skills. The pilot test will be used to determine the weight each section will have on the final test score.

In part one student's will be assigned a point value for the grade they received in their middle school math courses based on the eleven point scale. The eleven point scale assigns numerical values to the student grades. A = 11, A - = 10, B+ = 9, B = 8, B - = 7, C + = 6, C = 5, C - = 4, D + = 3, D = 2, D - = 1, E = 0. Students will also be asked to report the grade they received in their 8th grade mathematics course to determine if it is necessary to use actual grades for this section. Officials at the pilot school have agreed to provide the Algebra students' middle school grades to assist in collecting data for part one of the placement test. Part two will consist of a series of questions that evaluate the student's self-concept in mathematics. The questions will ask them to assess previous experiences in mathematics courses and the perception of her or his ability to succeed in Algebra.

Part three will be a multiple choice test designed to assess student's pre-algebra skills. There is a very large list of experts' opinions on what basic math skills students should have to be successful in Algebra. From this list a survey will be created and sent to teachers, administrators and curriculum specialist in the piloting school district to assess what they believe the most important test topics will be. After the surveys are returned they will be used to pick the topics for the questions to be included on the pilot placement test. The multiple choice questions for the computation section will be written by the researcher with the help of two curriculum directors from the piloting school district. After the questions are completed they will be evaluated by other teachers and any necessary changes will be made. All of the questions in part three will be weighted equally to compute a student's score for the computation section.

Ninth grade students are required to take the Explore test in early October in preparation for the ACT. This test includes a reading score. The scores from this test will also be collected and used as a covariate to determine if a students reading ability is predictive of their success in Algebra.

Topics and literature citations for inclusion on the Placement Test

1. Conversions (California State Dept. of Education, 1989)
2. Decimals (Kennedy, 1980; Morante, 1987; Louisiana State Dept. of Education, 1987; Richardson & Williams, 1997)
    a. Basic Operations with Decimals (Carter, 1987; Kovaly, 1979)
    b. Converting to Fractions (Carter, 1987)
    c. Place Value (University of the State of New York, 1970)
    d. Rounding (Carter, 1987)
3. Estimation (Morante, 1987)

4. Exponents (Coxford & Shulte, 1988; Kaye, 1997; Kennedy, 1980; Louisiana State Dept. of Education, 1987; Richardson & Williams, 1997)
    a. $n^0 = 1$ (University of the State of New York, 1970)
5. Expressions
    a. Evaluating
    b. Writing Variable Expressions (Abraham, 1983; California State Dept. of Education, 1989; Kovaly, 1979; Richardson & Williams, 1997)
6. Flow Charts (Baker, 1970; University of the State of New York, 1970)
7. Fractions (Kaye, 1997; Kennedy, 1980; Louisiana State Dept. of Education, 1987; Morante, 1987; Richardson & Williams, 1997; Rotman, 1991)
    a. Basic Operations
    b. Converting to decimals (Carter, 1987)
    c. Equivalent Fractions (Kovaly, 1979)
    d. Fraction Bar as division (Coxford & Shulte, 1988)
    e. Picture representation (Carter, 1987)
    f. Reducing (Kovaly, 1979)
8. Fundamental Properties (California State Dept. of Education, 1989; Coxford & Shulte, 1988; Kaye, 1997; Kennedy, 1980; Louisiana State Dept. of Education, 1987)

9. Geometry (Baker, 1970; California State Dept. of Education, 1989 Louisiana State Dept. of Education, 1987; Richardson & Williams, 1997 University of the State of New York, 1970)
    a. Basic Formulas (California State Dept. of Education, 1989)
10. Graphing Points (Louisiana State Dept. of Education, 1987; University of the State of New York, 1970)
    a. Graphing Equations (Richardson & Williams, 1997)
11. Inequalities (Louisiana State Dept. of Education, 1987; Richardson & Williams,1997)
    a. Solving
    b. Understanding the equal sign (Coxford & Shulte, 1988; Kaye, 1997)
    c. Understanding symbols
12. Like Terms (Kennedy, 1980)
13. Number Line
    a. Absolute Value
    b. Integers
    c. Opposites
    d. Ordering Decimals and Fractions (Carter, 1987)
14. Number Theory (California State Dept. of Education, 1989; Louisiana State Dept. of Education, 1987)

15. Operations with Integers (Baker, 1970; Coxford & Shulte, 1988; Kaye, 1997; Kennedy, 1980; Kovaly, 1979; Louisiana State Dept. of Education, 1987; University of the State of New York, 1970)
16. Order of Operations (California State Dept. of Education, 1989; Coxford & Shulte, 1988; Kaye, 1997; Kennedy, 1980; Louisiana State Dept. of Education, 1987; Rotman, 1991)
17. Pattern Problems (Kaye, 1997)
18. Percents (Baker, 1970; California State Dept. of Education, 1989 Kennedy, 1980; Morante, 1987; Louisiana State Dept. of Education,1987; Richardson & Williams, 1997; University of the State of New York, 1970)
19. Probability and Statistics (Baker, 1970; California State Dept. of Education, 1989 Louisiana State Dept. of Education, 1987; Richardson & Williams, 1997; University of the State of New York, 1970)
20. Problem Solving (California State Dept. of Education, 1989; Coxford & Shulte,1988; Morante, 1987; Rotman, 1991; University of the State of New York, 1970)
21. Proportions (Baker, 1970; California State Dept. of Education, 1989; Kennedy, 1980; Louisiana State Dept. of Education, 1987; Richardson & Williams, 1997; University of the State of New York, 1970)
22. Ratios (Baker, 1970; Louisiana State Dept. of Education, 1987; Richardson & Williams, 1997; University of the State of New York, 1970)

23. Relationships of Whole Numbers (Kaye, 1997; Kennedy, 1980; Louisiana State Dept. of Education, 1987)
    a. Basic Operations
    b. Divisibility Tests
    c. Division by zero (Coxford & Shulte, 1988)
    d. Prime vs. Composite Numbers (Kovaly, 1979; University of the State of New York, 1970)
    e. Greatest Common Factors (University of the State of New York, 1970)
    f. Least Common Multiples (Kovaly, 1979; University of the State of New York, 1970)
24. Scientific Notation (Coxford & Shulte, 1988; Kennedy, 1980)
25. Solving Linear Equations (Louisiana State Dept. of Education, 1987; Richardson & Williams, 1997)
26. Square Roots (Coxford & Shulte, 1988; Kennedy, 1980; Louisiana State Dept. of Education, 1987)
27. Tables and Graphs (California State Dept. of Education, 1989)
28. Understanding how to use Calculators (Baker, 1970; Colloby, 1998; Coxford & Shulte, 1988)
29. Understanding of Mathematical Vocabulary Terms (Abraham,1983; Kovaly, 1979; Miles, 1997; Rotman, 1986)

30. Understanding the meaning of symbols (Abraham, 1983; Coxford & Shulte, 1988; Rotman, 1991)
31. Understanding how to use Measurement Tools (University of the State of New York, 1970)
    a. Ruler
    b. Compass
    c. Protractor
32. Understanding Rational Numbers (Baker, 1970; California State Dept. of Education, 1989Kaye, 1997; Louisiana State Dept. of Education, 1987; Richardson & Williams, 1997; University of the State of New York, 1970)
33. Understanding Real Numbers (Louisiana State Dept. of Education, 1987)
34. Unit Rate (Kovaly, 1979)

The weight each section will have on the final score will be determined from the relationships each section has with Algebra grades at the end of the school year.

Design

The study intends to develop and validate a mathematics placement test. After the placement test is completed it will be piloted at a Metro Detroit high school that has agreed to administer the test at the beginning of the 2006-2007 school year. The cooperating high school has approximately three hundred students enrolled in Algebra. The researcher administered the test to all Algebra students on the same day during a 55 minute class period. The school has also approved a second class period for the test if necessary for some students to finish the test. Using an organized testing date will help to give a real life testing situation and ensure that Algebra material is not taught before the test is taken.

Students will be given a hundred question answer sheet on which to record the answers to parts one and two. No students will be allowed to use calculators on the test. After the students complete the test, the teachers will collect them to be picked up at the end of the day. The test will be scored by the researcher.

Data for the criterion variable will be collected at the end of both semesters using two predictors of academic success final exam scores and final grades. The school where the pilot test will be administered gives the same final exam to all Algebra students at the conclusion of each semester. At the end of the both semesters, students' scores on the departmental final exam as well as their final grade will be collected. This data will then be matched with the scores each student received on the placement test at the beginning of the year. The student's final grades as well as their final exam score will be collected to determine if the placement test is more accurate at predicting one of the two measurements of success.

Potential Extraneous Variables

There are two threats to internal validity, as outlined by Campbell and Stanley (1963) that may create a problem in this study. First, mortality, losing students throughout the study, may become a problem if students are absent when the placement test is initially given. Students will be unaware that they will be taking a standardized test until they arrive for class this will make it highly unlikely that a student's absent is related to the test.

Mortality may also become an issue if students drop Algebra before the end of the semester and therefore do not take the final exam. Any student that took the placement test that does not take the final exam will be tracked. If the student was dropped to a lower math class he or she will be counted as a failure. Students that were dropped for any other reason will not be counted as failures.

According to the school's policy students that fail first semester Algebra are moved to remedial math for second semester. If the data for the criterion variable is not collected at the end of first semester it will bias the results because the majority of students that are unsuccessful in Algebra will be lost from the study. To control for the possibility of a large number of students dropping Algebra at the semester break, data for the criterion variable will also be collected at the end of first semester.

Throughout the semester students will be exposed to different teachers, teaching methods, and tutoring. This is the natural progression for students in an Algebra course. This will assist in generalizing to other Algebra students who typically are exposed to different variables throughout the course. Regardless of what support students receive or neglect to receive throughout an Algebra course, they are all expected to know the same material at the end. Therefore, differential exposure to support systems among students should not create a problem in this study.

Sample

The sample for the pilot study will be all Algebra students at the participating high school. The piloting school district currently uses the Stanford OLSAT to track students into math classes. Ethical considerations impact the decision of having students participate in a mathematics curriculum that school educators felt they would not pass. Therefore, this study will not include individual student data on those that were tracked into lower level math classes using the OLSAT. Students in the lower level mathematics course will also take the computation section of the test. Class averages will be collected to use as a covariate.

Statistical Analysis and Hypothesis Tests

Cronbach's alpha will be used to evaluate the internal reliability of the test. To assess the predictive validity of the placement test a Pearson correlation (*r*) will be conducted between the student's scores on the placement test and the four dependent variables.

Discriminant Function Analysis will be used to determine how well the items on the test discriminate between students who are successful in Algebra and those who are not. Students who receive a B+ or better will be classified as successful (coded as 1). Students who receive a B or lower will be classified as not successful (coded as 0). Two separate analyses will be conducted where the outcome variables will be: (1) the final exam, and (2) final grades.

The large sample size (n > 300) permits the use of cross-validation techniques. Thus, a random sample of ½ N will be selected to derive the discriminate function. In turn, that function will be used to predict the remaining ½ N of the sample. This will permit the determination of how successful the discriminate function predicts group membership (0 or 1). Subsequent to the cross-validation, the final discriminant function will be determined based on the entire sample.

A second approach will be used to assess the instrument's ability to differentiate between high and low performing students. Cohen's d, a standard measure of Euclidian distance, will be used to compute the effect size of the outcome variable as a measure of distance between high and low performing students. The formula is

$$\text{Cohen's d} = \frac{\bar{x}_1 - \bar{x}_0}{s_p} ,$$

where $\bar{X}_1$ is the mean of the group designated as high performing, $\bar{X}_0$ is the mean of the group designated as low performing, and s_p is the pooled sample standard deviation.

The performance of individual test items will be evaluated using classical measurement the item difficulty index

$$\frac{U + L}{N} ,$$

where U is the number of examinees obtaining the item correct whose score is in the top 27 ½%, L is the number of examines obtaining the item correct whose score was in the lower 27 ½%, and N is 55%.

In addition, item discrimination will be assessed using the classical measurement theory discrimination index

$$\frac{U-L}{N},$$

Distracter analysis will also be used to analyze the plausible but incorrect choices in the multiple choice computation section of the test. After the field test a chart such as the one below will be used to record the frequency of each response.

# 1	
a	**28%**
b	19%
c	30%
d	23%

Note: * bold denotes the correct answer

This table will be used to identify distracters that need to be reviewed. For example if a distracter is chosen more frequently than the correct answer, this may identify a problem with the question. Distracter analysis will also identify wrong answers that are chosen infrequently and therefore may not be plausible. These types of distracters will be identified as responses that should be reviewed and possibly changed in revising the field test into the final version of the test.

Item-by-item deletion will be used to evaluate the test items given on the computation section of the assessment. First, a visual inspection will be done to see if the deletion of any one item will increase the overall reliability of the test. If the deletion of any one item greatly increases the overall reliability of the test it will be examined and possibly removed from the test.

Exploratory Factor Analysis will be used as a possible means of data reduction. This technique is sometimes helpful in reducing a pool of test items into a smaller subset, and in so doing generate factors that capture the construct being tested. The variables will be coded as dummy variables to create the correlation matrix.

Principal components analysis will be used to extract the factors. The Kaiser-Guttman rule will be used to determine the number of factors to be extracted. Any factor that has an eigenvalue less than 1 will be removed. A scree plot will be used to determine if the Kaiser rule can be supported. After the unrotated factor matrix is computed the factor loading will be examined to see if the factor solution should be rotated, and if so, a varimax orthogonal rotation will be applied to the factor solution if necessary. The factor loadings will be sorted by size. A loading will be retained if it has an absolute value equal to or greater than .4. Items that have factor loading less than .4 and low communalities will be evaluated for deletion from the assessment.

Computational Methods

A Microsoft Excel spreadsheet will be used to compute the Pearson's correlation coefficients. SPSS will be used to compute Cronbach Alphas indices and the Discriminant Analysis Function. The test will be scored using a scantron machine. Using a scantron will help score the tests quickly and tally information needed for an item analysis.

Presentation of Results

Correlation coefficients will be compared between the subscales and total score of the placement test and both the final grades and the final exam. Pearson's correlation coefficients will be displayed in two tables such as the one given below.

	Computation	Actual Grade (8th)	Self-Concept
Final Grade 1st Semester			
Final Exam 1st Semester			
Final Grade 2nd Semester			
Final Exam 2nd Semester		.	

CHAPTER 4

Results

Two hundred and ninety students were enrolled in Algebra at the school where the pilot study was conducted. From this sampling frame seven students were classified as non-ninth grade students and were not eligible for the study. Six students were absent on the day the test was administered and thirty-three students did not agree to sign the consent form. The final sample consisted of 244 ninth grade Algebra students. The test was also administered to 120 remedial algebra students. The data from the remedial group was only used to compare how students from the both groups scored on individual test questions.

Exploratory Factor Analysis

Exploratory Factor Analysis was used to reduce the number of items used on the 85 question computation section. This technique split the computation section into two factors. The first factor referred to as "fractions" consists of seven questions. All of the questions in this factor required students to work with fractions except for question 85. However, this question required that student used divisibility and multiple rules that are commonly used when finding common denominators and reducing fractions. The second factor referred to as "operations with integers" consisted of eight questions. The questions from the two factors were combined to create a new variable Math. This variable replaced the 85 question computation variable. All of the 15 items were retained in the new variable math because the loading had an absolute value equal to or greater than .4 and the deletion of any of the items did not significantly increase the reliability of the test.

Figure 1: Questions Retained from the Factor Analysis

Factor 1: Fractions

19. Which of the following decimals is equivalent to $\frac{3}{5}$?
   a) 0.35
   b) 0.6
   c) $1.\overline{6}$
   d) 5.3

85. What two digit number is divisible by 2, 3, and 6. The sum of its digits is 9 and it is a perfect square?
   a) 12
   b) 18
   c) 36
   d) 81

20. Evaluate $\frac{2}{3} + \frac{3}{5}$
   a) $\frac{6}{15}$
   b) $\frac{5}{8}$
   c) $\frac{6}{8}$
   d) $\frac{19}{15}$

21. Evaluate $\frac{7}{9} - \frac{2}{3}$
   a) $\frac{1}{9}$
   b) $\frac{3}{4}$
   c) $\frac{5}{6}$
   d) $\frac{6}{7}$

(Figure 1 continued)

22. Evaluate $\frac{2}{3} \cdot 3$

a) $\frac{2}{9}$

b) $\frac{2}{3}$

c) 2

d) $\frac{9}{2}$

26. Which of the following four fractions is not equivalent to the others?

$\frac{4}{16}$ $\frac{6}{18}$ $\frac{3}{12}$ $\frac{5}{20}$

a) $\frac{4}{16}$

b) $\frac{6}{18}$

c) $\frac{3}{12}$

d) $\frac{5}{20}$

27. Evaluate $3\frac{1}{2} - 1\frac{2}{3}$

a) $1\frac{2}{3}$

b) $1\frac{5}{6}$

c) $2\frac{1}{6}$

d) $2\frac{1}{2}$

<u>Factor 2: Operations with Integers</u>

8. Evaluate 3^2

a) 6

b) 9

c) 23

d) 32

29. The formula for the volume of a cylinder is $V = \pi r^2 h$. What is the volume of a cylinder with a radius of 3 and a height of 2?

a) 6π

b) 12π

c) 18π

d) 36π

(Figure 1 continued)

45. Evaluate -3 + -6 =

a) 3

b) - 3

c) 9

d) - 9

46. Evaluate 9 + -5

a) 4

b) - 4

c) 14

d) -14

47. Evaluate 4 - (-2)

a) -2

b) 2

c) - 6

d) 6

48. Evaluate -7 - (-3)

a) - 4

b) 4

c) 10

d) -10

51. Evaluate -2 - 2

a) - 4

b) 4

c) 0

d) undefined

55. Evaluate $(5w)^2$, $w = 2$:

a) 20

b) 54

c) 100

d) 104

The Blom Transformation was used on the raw scores for both factors to create z scores. Then, T scores were created using the formula T = 10z + 50. The combined T scores of both factors were then submitted to the Blom Transformation to obtain a total z score, which were subsequently transformed into T scores using the same formula above. The T scores for both factors and the total score were used to create a chart of percentile ranks to classify students who may take the test in the future.

Table 1. Percentile Rank Statistics

Factor 1 Raw Score	Factor 1 T Score	Percentile	Factor 2 Raw Score	Factor 2 T Score	Percentile
0	34.1	5.5	0	22.1	0.3
1	41.6	19.8	1	27.1	1.1
2	46.7	36.3	2	32.5	4
3	50.6	52	3	37.3	10.6
4	54.3	67.4	4	42.3	22.7
5	58.3	80.2	5	46.5	36.3
6	63	90.3	6	50.3	52
7	69.8	97.7	7	54.7	67.4
			8	62.1	88.5

Math Raw Score	Math T Score	Percentile
1	22.2	0.3
2	25.4	0.7
3	28.5-31.9	1.6-3.6
4	34-37	5.5-9.7
5	37.6-40.7	10.6-17.1
6	41.1-44	18.4-27.4
7	43.4-46.4	25.8-36.3
8	46.6-48.9	36.3-46
9	49.4-52.2	48-57.9
10	53-55.9	61.8-72.6
11	55.1-57.9	69.2-78.8
12	58.9-60.3	81.6-85.3
13	61-62.6	86.4-89.4
14	64.2-66.7	91.9-95
15	72.8	98.9

Item Analysis

Students that were enrolled in what would be considered a remedial Algebra course were also asked to take the exam for comparative purposes. Table 2 gives the percentage of students in each group that correctly completed the questions included in the variable Math.

Table 2. Item Percentages

Factor 1	Fractions		Factor 2	Operations	
Question #	Remedial	Algebra	Question #	Remedial	Algebra
19	31%	59%	8	79%	93%
20	22%	39%	29	30%	51%
21	19%	42%	45	61%	76%
22	18%	32%	46	74%	81%
26	28%	50%	47	26%	52%
27	22%	34%	48	33%	54%
85	13%	35%	51	38%	58%
			55	38%	82%

The item difficulty and item discrimination for each of the 15 questions retained in the factors are listed in Table 3.

Table 3. Item Analysis Statistics

Factor 1	item difficulty	item discrimination
19	.60	.56
20	.42	.72
21	.43	.78
22	.32	.47
26	.52	.44
27	.34	.59
85	.37	.56
Factor 2		
8	.94	.17
29	.56	.48
45	.78	.42
46	.84	.17
47	.56	.72
48	.57	.59
51	.61	.70
55	.82	.36

Distracter analysis for each of the 15 items retained in the Math variable were computed and recorded in the following tables. Note that bold type denotes the correct answer.

#8

a	85%
b	**94%**
c	0.5%
d	0.5%

#19

a	19%
b	**61%**
c	16%
d	4%

#20

a	9%
b	43%
c	8%
d	**41%**

#21

a	**43%**
b	2%
c	53%
d	2%

#22

a	33%
b	18%
c	**32%**
d	16%

#26

a	4%
b	**51%**
c	16%
d	29%

#27

a	4%
b	**35%**
c	36%
d	19%

#29

a	16%
b	15%
c	**55%**
d	14%

#45

a	4%
b	51%
c	16%
d	**29%**

#46

a	**84%**
b	5%
c	2%
d	8%

#47

a	6%
b	31%
c	7%
d	**56%**

#48

a	**56%**
b	9%
c	10%
d	24%

#51

a	**61%**
b	7%
c	29%
d	3%

#55

a	10%
b	6%
c	**82%**
d	2%

#85

a	19%	d	4%
b	**61%**		
c	16%		

For the 15 remaining items, Cronbach's alpha showed the internal consistency reliability estimate to be .726. Table 4 shows that Cronbach's alpha does not significantly increase by deleting any of the 15 items. The Spearman Brown Prophecy reliability estimate was calculated for both factors. The reliability estimate for factor 1 (fractions) was .850. The estimate for factor 2 (operations with integers) was calculated to be .832.

Table 4. Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
q47	8.14224138	8.434	.382	.464	.706
q48	8.12500000	8.586	.329	.387	.713
q51	8.08620690	8.278	.453	.323	.698
q45	7.92672414	8.761	.344	.292	.711
q46	7.86206897	9.323	.146	.211	.729
q8	7.75862069	9.370	.257	.157	.721
q29	8.15086207	8.709	.282	.132	.718
q55	7.87931034	9.024	.268	.167	.718
q19	8.09913793	8.523	.357	.191	.709
q20	8.28448276	8.326	.426	.613	.701
q21	8.27155172	8.216	.465	.617	.696
q22	8.38362069	8.731	.303	.181	.715
q26	8.18534483	9.000	.178	.129	.730
q27	8.35344828	8.481	.387	.231	.706
q85	8.32758621	8.602	.333	.170	.712

Predictive Validity

The Pearson's correlation (r) was used to determine the predictive validity of the placement test. Table 5 shows the correlation of the four dependent variables with each of the independent variables. Cells that are left blank indicate they were not retained in the correlation. The subscripts indicate the rank order of the independent variables with the highest correlation to the given dependent variable.

Table 5. Pearson Product Correlation Coefficients

	Math	Actual Grade (8th)	Self-Concept	Self-Concept w/o grade	Gender
Final Grade 1st Semester	$.710_2$	$.558_1$	$.729_3$	$.750_5$	$.744_4$
Final Exam 1st Semester	$.540_1$	$.670_2$	$.695_3$		
Final Grade 2nd Semester	$.674_2$	$.540_1$	$.689_3$	$.706_4$	
Final Exam 2nd Semester	$.467_1$	$.566_2$	$.592_3$		$.610_4$

*a p-value of <.05 was required for statistical significance

Discriminate Function Analysis

Discriminate Function Analysis was used to determine how well the items on the test discriminated betweens students who were successful in Algebra and those who were not. A median split was used based on those who received a 9 (B+) or higher in Algebra for their 2nd semester grade. They received a code of 2 and are labeled "successful". Those who received a grade lower than a B were considered unsuccessful and coded as a 1. Based on the unstandardized canonical discriminate function coefficients, all of the independent variables contributed to the prediction of Algebra success. The coefficients for the equation are listed in Table 6. This equation correctly classified 78.7% of the original cases.

Table 6. Canonical Discriminant Function Coefficients

	Function
	1
Gender	-.549
Self-Concept	.499
Self-Concept w/o grade	-.413
Actual 8th Grade Math Grade	.276
Student Predicted 9th Grade Algebra Grade	-.297
Explore Reading Score for incoming 9th graders	.027
Math	.237
(Constant)	-7.961

Note: Unstandardized coefficients

To determine how successfully the discriminate function predicted group membership a cross-validation technique was used. Half of the cases were randomly selected to produce an equation that would be used to cross validate the 2nd half of the sample. The coefficients used in the equation are listed in Table 7. This equation correctly classified 76% of the students that received a final grade of a B+ or higher in Algebra.

Table 7. Canonical Discriminant Function Coefficients

	Function
	1
Gender	-1.045
Self-Concept	.406
Self-Concept w/o grade	-.322
Actual 8th Grade Math Grade	.205
Student Predicted 9th Grade Algebra Grade	-.400
Explore Reading Score for incoming 9th graders	-.021
Math	.277
(Constant)	-4.333

Note: Unstandardized coefficients

Cohen's d was used to determine the effect size of the differentiation between high and low performing students for the variable math. The effect size was found to be extremely large, d = 2.88. One way to understand this value is to note that ceteris paribus, if no differentiation was defined as both groups performing equally at the 50th percentile (e.g., an effect size of 0) the percentile equivalent for the high performing group would be at the 99.8^{th} percentile.

CHAPTER 5

Conclusion

Discussion

The purpose of this study was to determine predictive factors for a student to succeed in an Algebra Course. Each student participating in the study was asked to fill out a self-concept questionnaire and take an 85 question exam. In addition, 8th grade math grades, 9th grade reading scores and a student's gender were also collected for use in the study.

Exploratory Factor Analysis

After the 85 items in the pool of questions were administered to the students a data reduction technique, Exploratory Factor Analysis was used to create a core set of items. The initial 85 items were reduced to 15. Results from the Exploratory Factor Analysis classified them into two factors. The questions that were retained by each factor were analyzed to determine how to name the factors. Factor one is described as "fractions", and Factor 2 is described as "operations of integers". All of the items retained by the factor analysis pertained to pre-Algebra topics. The most likely reason that so many items were dropped from the assessment is that they were highly correlated with each other.

Many researchers found that fractions are essential to success in Algebra (Kaye, 1997; Kennedy, 1980; Louisiana State Dept. of Education, 1987; Morante, 1987; Richardson & Williams, 1997; Rotman, 1991). However, the factor "fractions" goes beyond basic operations of fractions, such as addition and subtraction. This factor also includes skills that have been discussed in the literature, such as converting fractions to decimals (Carter, 1987) identifying equivalent fractions (Kovaly, 1979) and reducing fractions (Kovaly, 1979). In addition, question 85 was not classified as a traditional fraction problem, but contains some of the properties used to solve fraction problems such as finding common denominators and reducing fractions using divisibility rules.

Many students are used to working with only positive whole numbers. Algebra requires students to be able to work with numbers beyond positive whole numbers involving manipulations and calculations of numbers that can not always be written as a whole number or even as a rational number. Examples would include manipulating equations that involve fractions, solving proportions and square roots.

The second factor, "operations with integers", included topics which have also been shown to have a relationship to Algebra success, such as adding and subtracting Integers (Baker, 1970; Coxford & Shulte, 1988; Kaye, 1997; Kennedy, 1980; Kovaly, 1979; Louisiana State Dept. of Education, 1987; University of the State of New York, 1970), order of operations (California State Dept. of Education, 1989; Coxford & Shulte, 1988; Kaye, 1997; Kennedy, 1980; Louisiana State Dept. of Education, 1987; Rotman, 1991), basic formulas (California State Dept. of Education, 1989) and exponents (Coxford & Shulte, 1988; Kaye, 1997; Kennedy, 1980; Louisiana State Dept. of Education, 1987; Richardson & Williams, 1997).

If students are not fluent with these types of basic skills or rely on the calculator to perform them it may cut down on their confidence (Wu, 2001) and in turn their ability to perform in mathematics. The problems included in the second factor use many mathematical symbols. Fluency in symbolic notation has also been connected to Algebra proficiency (Abraham, 1983; Coxford & Shulte, 1988; Rotman, 1991, Wu, 2001). This also includes the symbolic notations included in fractions (Coxford & Shulte, 1988).

Item Analysis

Table 2 compares the number of students enrolled in remedial math that answered the selected 15 questions correctly verses the number of students enrolled in Algebra. Although the Algebra students did better on every question the average difference between the two groups for factor 1 was approximately 10%. The difference between the two groups for factor 2 was close to 20%. This may suggest that how a student performs on questions involving operation with integers is a telling feature between the two groups of students. However, these two sets of students were grouped by the Stanford OLSAT, not the computation test that was administered in this study.

The average item difficulty for factor 2 was .71, which was much higher than the average difficulty for factor 1 at .43. The average item discrimination for factor 1 was .59 while the average item discrimination for factor 2 was only .45. It appears that although the operation with integer problems were more difficult for the students, the fraction problems did a better job at measuring students who had mastered the material.

The distracter analysis reveled that except for question 29, the question distracters were not endorsed in equal proportions. This suggests that revisions are necessary for the incorrect, alternative responses to each question.

Cronbach's Alpha

Cronbach's Alpha is a coefficient used to assess the internal consistency reliability of an instrument. In this study, the coefficient was calculated to be .726. This meets the expectations that a test should have a minimum internal consistency of at least .70, which is a rule of thumb adopted by some text book authors (Fraenkel & Wallen, 2003, p. 168; Nunnally & Bernstein, 1994, p. 265). However it falls short of the .90 that are obtained with most commercially available tests in mathematics. Cronbach's alpha is based on the Pearson correlation, which is a measure of internal consistency. After the Exploratory Factor analysis the test was reduced from 85 to 15 items. In addition, the factor analysis demonstrated that there were two factors that were not homogeneous. Therefore, the reliability calculated by Cronbach's Alpha for the 15 items would be lower than the Spearman's Brown for each of the two factors. The Spearman's Brown Prophecy predicted the reliability of factor 1 to be .850 and the reliability of factor 2 to be .832. These reliability coefficients are acceptable estimates for such small sample subscales.

Predictive Validity

In this study, four dependent variables were collected to define success, final grades and final exam scores for 1st and 2nd semesters. The Pearson Product Moment Correlation reveled that the predictor of Algebra success depended on what was used to define success. If final exam scores were used to predict Algebra success then the variable math which consisted of the 15 computation items was the number one predictor. If the final grade a student received in the course (which encompasses the final exam scores) is used to predict Algebra success than the number one predictor was a student's grade that he or she received in his or her eighth grade mathematics course. A student's self-concept, although not the primary predictor in any of the Algebra success measures, was present as a factor in all four dependent variables.

Assuming school districts use final grades to determine whether or not a student was successful in a course than a student's previous math grades would be the most predictive item. This would imply that it is not necessary for school districts to spend a lot of money on testing students to place them in mathematical courses. Using the coefficients given in Table 5, a school district should be able to predict what grade a student will receive in an Algebra course. The regression equation created for first semester grades explains 75% of the variation in a student's first semester Algebra grade. The equation created for second semester explains only 71% of their final grade.

Discriminate Function Analysis

The Discriminate Function Analysis was used to create an equation to predict whether or not a student would be successful in Algebra. Unlike the multiple regression equation, all of the hypothesized factors were retained for the equation created by the Discriminate Function Analysis. A two-group discriminate analysis with a median split in the dependent variable was used to determine how accurate the equation was in predicting whether or not a student would succeed in Algebra.

Because the students were divided evenly into two groups the expected hit ratio was 50%, meaning that 50% of the cases would have been correctly classified by chance alone. It is suggested that classification accuracy should be at least one-fourth greater than that achieved by chance. For 50% chance accuracy this would be 62.5%. The equation created in this study was 76% accurate in predicting those students that would score higher than a B in Algebra. To determine whether or not this method would be a more accurate and cost effective way for a school district to place students into mathematical courses they should analyze the hit ratios of their current placement procedures verses the cost to buy and administer the test.

Cohen's d

Cohen's d was used to determine the effect size of the 15 question computation test. The effect size was found to be extremely large at 2.88 (a value of .8 is usually classified as a large effect size). Therefore, the 15 questions do provide strong evidence of discriminate and predictive validity in properly categorizing students who will be successful in Algebra verses those who will not.

Implications for further research

Further research could be conducted with a school district that does not track students. This would allow a researcher to further assess the predictive validity for all levels of students. In addition, the 15 question computation section may have increased predictive validity and reliability by replacing incorrect answers that were not chosen by students with more viable answers. If the 15 question commutation test was to be marketed work would need to be done to improve the internal reliability to bring it to commercial standards. In addition, further research could incorporate how the use of calculators would affect the predictive validity of the assessment.

It was determined in this study that math achievement, as expected, was a good predictor of Algebra success. The predictive validity of the test may be increased with work on the individual retained items and the addition of the students classified into a remedial Algebra course. Whether a school district uses final exam scores or final grades to define success, they should be able to get a good indication of whether a student will be successful based on 8^{th} grade math scores, administering the mathematical questions retained in the variable math, and asking a few questions about students' self-concept.

School districts could give greater consideration to purchasing tests that emphasize work with fractions and integers in order to better place students into high school math courses. In this study, student's 8th grade math grades accounted for 58% of the variation in their first semester Algebra final grade.

Appendix A: Algebra Readiness Exam

Student Survey

Name: ____ **ID**: ____________
(leave blank)

Teacher: ____

Directions: Your responses will be kept confidential. Read each question carefully and draw a circle around your response.

1. Your gender is male female

2. What was the grade you received in math at the end of second semester last year?

E D- D D+ C- C C+ B - B B+ A- A A+

3. On a scale from 1 to 10 (1 = poor, 5 = average, and 10 = excellent) rate your mathematical ability.

Poor				Average					Excellent
|				|					|
1	2	3	4	5	6	7	8	9	10

4. On a scale from 1 to 10 (1 = poor, 5 = average, and 10 = excellent) rate your mathematical ability in comparison with other students in your mathematics classes.

Poor				Average					Excellent
|				|					|
1	2	3	4	5	6	7	8	9	10

5. Please rate your ability to learn new mathematics material (1 = poor, 5 = average, and 10 = excellent).

Poor				Average					Excellent
|				|					|
1	2	3	4	5	6	7	8	9	10

6. What grade do you expect to receive in Algebra this year?

E D- D D+ C- C C+ B - B B+ A- A

Computation Section

Directions: Read each question carefully. Use a #2 pencil to record your answer on the scantron.

1. In the number 35.486, what digit is listed in the tenths place?

    a) 3

    b) 4

    c) 5

    d) 8

2. Round the number 249.657 to the hundredths place.

    a) 200

    b) 249.65

    c) 249.66

    d) 249.700

3. Write .3 as a fraction.

    a) $\frac{3}{1000}$

    b) $\frac{3}{100}$

    c) $\frac{3}{10}$

    d) $\frac{1}{3}$

4. Evaluate $13.5 + 4.36$

    a) 5.71

    b) 15.11

    c) 17.86

    d) 19.39

5. Evaluate 2.3×1.4

    a) 0.92

    b) 2.30

    c) 3.22

    d) 4.2

6. Evaluate $21.08 \div 3.1$

    a) .147

    b) 1.86

    c) 2.48

    d) 6.80

7. Evaluate 32.45 - 4.6

a) 26.45

b) 27.85

c) 31.99

d) 32.25

8. Evaluate 3^2

a) 6

b) 9

c) 23

d) 32

9. Which of the following expressions written below means "five squared"?

a) $\sqrt{5}$

b) 5^2

c) 2(5)

d) 5 + 5

10. Write $(3x)(3x)(3x)(3x)$ in exponential form.

a) $3^4 x$

b) $3x^4$

c) $(3x)^4$

d) $(3^4)x$

11. If $x = 3$ and $y = 6$ what is the value of xy?

a) 9

b) 18

c) 36

d) 63

12. Which variable expression represents the sum of x and 8?

a) $8x$

b) $x8$

c) $x + 8$

d) $x - 8$

13. If the top of a house is y feet from the ground and a ladder is seven feet tall, what expression represents the distance from the top of the roof to the top of the ladder?

a) $7 - y$

b) $y - 7$

c) $7y$

d) $\frac{7}{y}$

14. What operation is indicated by the expression $6x$?

a) difference

b) multiplication

c) quotient

d) sum

15. Which of the following fractions expresses $\frac{6}{8}$ in lowest terms?

a) $\frac{1}{4}$

b) $\frac{2}{3}$

c) $\frac{3}{4}$

d) $\frac{4}{5}$

16. Given $x = 15$, what is the value of the expression x - 5?

a) 5

b) 10

c) 15

d) 20

17. Which fraction is equivalent to $\frac{2}{3}$?

a) $\frac{7}{12}$

b) $\frac{4}{6}$

c) $\frac{6}{8}$

d) $\frac{3}{2}$

18. Which of the following fractions expresses $\frac{4}{8}$ in lowest terms?

a) $\frac{1}{2}$

b) $\frac{1}{4}$

c) 2

d) 4

19. Which of the following decimals is equivalent to $\frac{3}{5}$?

a) 0.35

b) 0.6

c) $1.\overline{6}$

d) 5.3

20. Evaluate $\frac{2}{3} + \frac{3}{5}$

a) $\frac{6}{15}$

b) $\frac{5}{8}$

c) $\frac{6}{8}$

d) $\frac{19}{15}$

21. Evaluate $\frac{7}{9} - \frac{2}{3}$

a) $\frac{1}{9}$

b) $\frac{3}{4}$

c) $\frac{5}{6}$

d) $\frac{6}{7}$

22. Evaluate $\frac{2}{3} \cdot 3$

a) $\frac{2}{9}$

b) $\frac{2}{3}$

c) 2

d) $\frac{9}{2}$

23. Evaluate $\frac{4}{5} \div \frac{2}{3}$

a) $\frac{1}{5}$

b) $\frac{6}{5}$

c) $\frac{2}{15}$

d) $\frac{8}{15}$

24. Evaluate $2\frac{1}{4} \div \frac{2}{3}$

a) $1\frac{1}{8}$

b) $1\frac{1}{2}$

c) $2\frac{1}{6}$

d) $3\frac{3}{8}$

25. Which of the following four fractions is not equivalent to the others?

$1\frac{1}{5}$ $\quad \frac{6}{5}$ $\quad \frac{20}{24}$ $\quad \frac{12}{10}$

a) $1\frac{1}{5}$

b) $\frac{6}{5}$

c) $\frac{20}{24}$

d) $\frac{12}{10}$

26. Which of the following fractions is not equivalent to the others?

$\frac{4}{16}$ $\quad \frac{6}{18}$ $\quad \frac{3}{12}$ $\quad \frac{5}{20}$

a) $\frac{4}{16}$

b) $\frac{6}{18}$

c) $\frac{3}{12}$

d) $\frac{5}{20}$

27. Evaluate $3\frac{1}{2} - 1\frac{2}{3}$

a) $1\frac{2}{3}$

b) $1\frac{5}{6}$

c) $2\frac{1}{6}$

d) $2\frac{1}{2}$

28. Express $\frac{12}{6}$ in lowest terms.

a) $\frac{1}{2}$

b) $\frac{3}{4}$

c) 2

d) 3

29. The formula for the volume of a cylinder is $V = \pi r^2 h$. What is the volume of a cylinder with a radius of 3 and a height of 2?

a) 6π

b) 12π

c) 18π

d) 36π

30. The formula to find the area of a trapezoid is $A = \frac{1}{2}h(b_1 + b_2)$.
What is the area of a trapezoid with a height of 8 and bases of 4 and 6?

a) 22

b) 36

c) 40

d) 80

31. What is the perimeter of a square that
has a side length of 3?

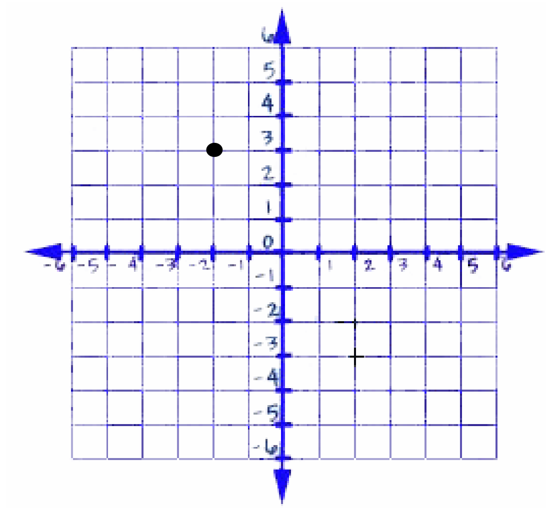
a) 6

b) 9

c) 12

d) 2

32. What are the coordinates of the point on the coordinate plane below?



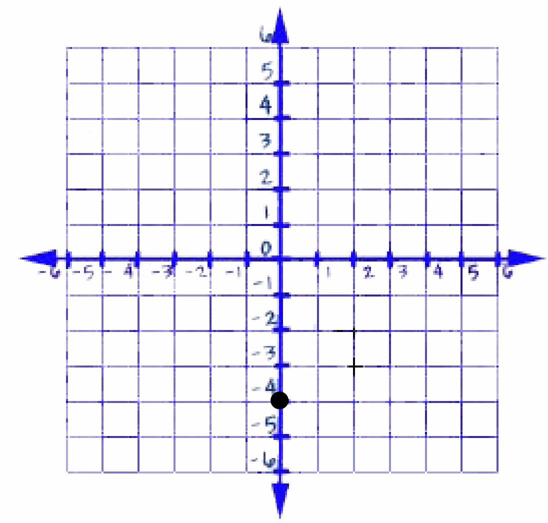
a) (2,-3)

b) (-2, 3)

c) (3, 2)

d) (3,-2)

33. What are the coordinates of the point on the coordinate plane below?



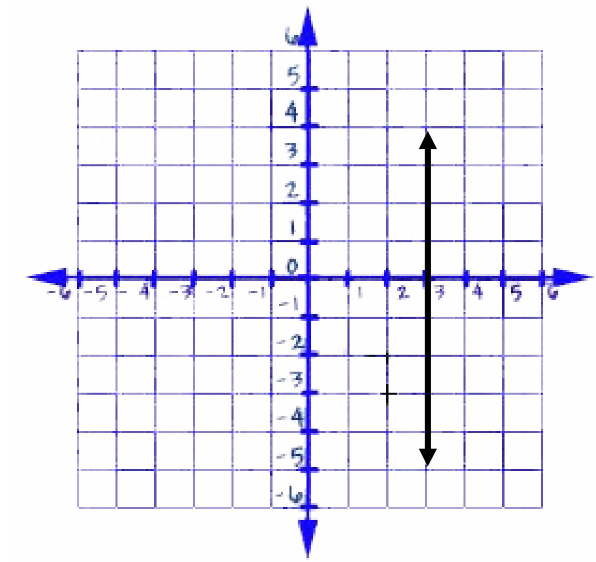
a) (0, 4)

b) (0, -4)

c) (4, 0)

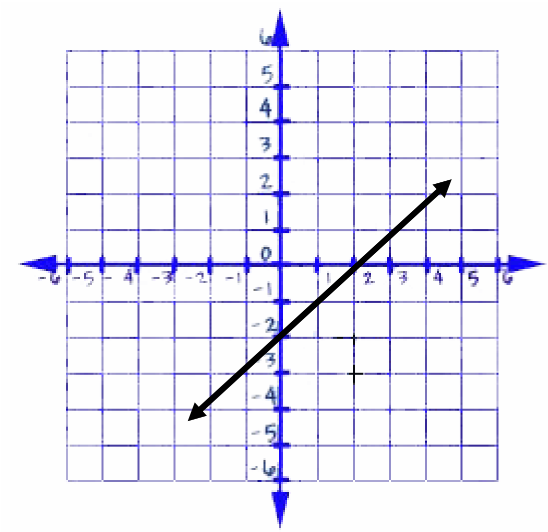
d) (- 4, 0)

34. What is the equation of the line graphed on the coordinate plane below?



a) $x = 3$
b) $x = 0$
c) $y = 3$
d) $y = 0$

35. What is the equation of the line graphed on the coordinate plane below?



a) $y = -x + 2$
b) $y = x - 2$
c) $y = -2x + 1$
d) $y = 2x - 1$

36. Simplify the expression $2x + 3x$

a) $5x$

b) $5x^2$

c) $6x$

d) $6x^2$

37. Simplify the expression $3x + 4y$

a) $7xy$

b) $12xy$

c) $12xy^2$

d) cannot be simplified

38. Simplify the expression $6x \cdot 2y$

a) $3xy$

b) $8xy^2$

c) $12xy$

d) cannot be simplified

Further instructions for questions #39 - #43. Compare each set of numbers and determine if they are <, >, =, or not enough information

39. 14.71 14.73

a) <

b) >

c) =

d) not enough information

40. -1 -6

a) <

b) >

c) =

d) not enough information

41. 3 -4

a) <

b) >

c) =

d) not enough information

42. $|-2|$ $|2|$

a) $<$

b) $>$

c) $=$

d) not enough information

43. $-|8|$ $|-8|$

a) $<$

b) $>$

c) $=$

d) not enough information

44. Which fraction is the largest?

$\frac{3}{10}$ $\frac{5}{10}$ $\frac{1}{5}$ $\frac{3}{5}$

a) $\frac{3}{10}$

b) $\frac{5}{10}$

c) $\frac{1}{5}$

d) $\frac{3}{5}$

45. Evaluate $-3 + -6 =$

a) 3

b) - 3

c) 9

d) - 9

46. Evaluate $9 + -5$

a) 4

b) - 4

c) 14

d) -14

47. Evaluate $4 - (-2)$

a) -2

b) 2

c) - 6

d) 6

48. Evaluate $-7 - (-3)$

a) - 4

b) 4

c) 10

d) -10

49. Evaluate $-4 \cdot 3$

a) 7

b) -7

c) 12

d) - 12

50. Evaluate $-9 \div -3$

a) 3

b) -3

c) 27

d) -27

51. Evaluate $-2 - 2$

a) - 4

b) 4

c) 0

d) undefined

52. Evaluate $19 - 20 \div (8 - 3) \cdot 2 + 6$

a) 5

b) 6.4

c) 17

d) 23

53. Evaluate $7 + 3 \cdot 2^3 \div 2$

a) 16

b) 19

c) 34

d) 40

54. Evaluate $\frac{14+6}{7}$

a) 3

b) 8

c) $\frac{20}{7}$

d) $\frac{26}{14}$

55. Evaluate $(5w)^2$, $w = 2$:

a) 20

b) 54

c) 100

d) 104

56. There are 24 people in a mathematics class. There are 6 girls and 18 boys. What is the percentage of girls in the class?

a) 25%

b) 33%

c) 40%

d) 75%

57. On a recent test, a student got 18 out of 30 questions correct. What was the percentage of correct answers?

a.) 1.67%

b) 50%

c) 55%

d) 60%

58. A shirt that normally sells for $25.00 is on sale for 20% off. What is the sale price of the shirt?

a) $5.00

b) $12.50

c) $16.50

d) $20.00

59. Solve the proportion $\frac{x}{4} = \frac{7}{3}$

a) 1.71

b) 5.25

c) $9.\overline{3}$

d) 8.0

60. Solve the proportion $\frac{2}{6} = \frac{x}{9}$

a) 4/3

b) 3

c) 6

d) 27

61. Fifty of 375 students in a school own a cell phone. If 75 were randomly surveyed, how many would be expected to own a cell phone?

a) 5

b) 7.7

c) 10

d) 13.3

62. Solve the following equation for x.

$$x + 7 = 10$$

a) $\frac{10}{7}$

b) 3

c) 17

d) 70

63. Solve the following equation for x.

$$x - 5 = 15$$

a) 3

b) 10

c) 20

d) 75

64. Solve the following equation for x.

$$4x = 12$$

a) 3

b) 8

c) 16

d) 48

65. Solve the following equation for x.

$$\frac{x}{3} = 6$$

a) 2

b) 3

c) 9

d) 18

66. Solve the following equation for x.

$$2x - 4 = 10$$

a) 3

b) 7

c) 9

d) 28

67. Solve the following equation for x.

$$\frac{4}{3}x + 4 = 12$$

a) 5

b) 6

c) $10.\overline{6}$

d) 13.5

68. Solve the following equation for x.

$$2(x+5) = 20$$

a) 5

b) 7.5

c) 12.5

d) 15

69. Solve $4x + 6 = 2x - 6$

a) - 18

b) - 6

c) - 2

d) 0

70. Evaluate $\sqrt{9}$

a) 3

b) 3 or - 3

c) 81

d) 81 or - 81

71. $\sqrt{17}$ lies between which of the following pairs of numbers?

a) 2 and 3

b) 3 and 4

c) 4 and 5

d) none of the above

72. Evaluate $\sqrt{-4}$

a) 2

b) - 2

c) 2 or - 2

d) no real number answer

73. Simplify the expression $2(x+3)$

a) $2x - 3$

b) $2x - 6$

c) $2x + 6$

d) $-6x$

74. Simplify the expression $\frac{4x-6}{2}$

a) $-x$

b) $4x - 3$

c) $2x - 3$

d) $2x - 6$

75. Simplify the expression $4x(x+5)$

a) $4x + 5$

b) $4x + 20$

c) $4x^2 + 20$

d) $4x^2 + 20x$

76. What is the probability that you will roll a 3 on a six-sided number cube?

a) $\frac{1}{3}$

b) $\frac{1}{6}$

c) $\frac{3}{6}$

d) $\frac{5}{6}$

77. Using the data set below find the mean.

{ 10 2 8 10 11 9 4 6 10 0 }

a) 5

b) 7

c) 10

d) 70

78. Find the median of the following data set.

{ 4 5 9 2 3 7 10 4 }

a) 4

b) 5

c) 4.5

d) 5.5

79. Using the table given below, what is the probability that a household that owns a pet chosen at random will own a dog.

U.S. Households with Pets

Type of Pet	Number in millions
Dog	35
Cat	24
Bird	6
Fish	10

a) $\frac{1}{2}$

b) $\frac{40}{35}$

c) $\frac{35}{75}$

d) $\frac{35}{100}$

80. 78,000 written in scientific notation is

a) 780×10^{2}

b) 78×10^{3}

c) 7.8×10^{4}

d) 0.78×10^{5}

81. .0000034 written in scientific notation is

a) 3.4×10^{6}

b) 3.4×10^{-6}

c) 34×10^{7}

d) 34×10^{-7}

82. 5.612×10^6 in expanded form is

a) .000005612

b) .005612

c) 561,200

d) 5,612,000

83. A number of students are standing in a circle. They are evenly spaced and the 6th child is directly opposite the 18th child. How many children are there altogether?

a) 12

b) 24

c) 36

d) 48

84. If the pattern continues, what will be the next number in the sequence?

3 5 9 17 33 ___

a) 39

b) 57

c) 65

d) 73

85. What two digit number is divisible by 2, 3, and 6. The sum of its digits is 9 and it is a perfect square?

a) 12

b) 18

c) 36

d) 81

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ABSTRACT

ALGEBRA READINESS ASSESSMENT

by

LORI ROY

December 2007

Advisor: Dr. Sawilowsky

Major: Educational Evaluation and Research

Degree: Doctor of Philosophy

An 85 question exam made up of topics that research has shown to be related to Algebra success was given to 244 9th grade students from a large suburban high school. Exploratory Factor Analysis was used to reduce the original assessment to a 15 question exam that is used to predict if a student would succeed in Algebra. Next, this study uses a student's gender, previous and predicted math grades, reading score, self-confidence and a score on the newly created computation quiz to determine what factors are predictive of Algebra success.

AUTOBIOGRAPHICAL STATEMENT

LORI ROY

Education

Concordia College Ann Arbor	BA in Education
Wayne State University	MA in Political Science
Wayne State University	Doctorate of Philosophy

Employment

1997-present	Math and Social Studies Teacher *Livonia Public Schools*
2006-present	Social Studies Department Head *Livonia Stevenson High School*
1998-2001	Special Programs Instructor *Schoolcraft College*
2001	Adjunct Professor *Macomb Community College*
2004-2005	Part-Time Staff *Wayne State University*

Special Achievements

Concordia College Division Scholar for Social Studies Department 1996/1997
Concordia College Division Scholar for Mathematics Department 1996
Wayne State University Graduate-Professional Scholarship Recipient
Wayne State University College of Liberal Arts Graduate School Grant Recipient
Livonia Public Schools District Assessment Committee Member
State of Michigan Content Advisory Committee

College Sports Achievements

M.I.A.A. Player of the week for basketball 1994
N.C.C.A.A. All-American Academic team for basketball and softball
W.H.A.C. All-Conference honorable mention basketball 1995, 1996 and 1997
W.H.A.C. Player of the week for basketball 1997