State University of New York at Fredonia
Department of Mathematical Sciences

CERTIFICATION OF PROJECT WORK

We, the undersigned, certify that this project entitled *Get Your Facts Straight! The Relationship Among Automaticity, Self-Efficacy, and Mathematics Achievement of Adult Learners*, by Joseph R. Jagoda, Candidate for the Degree of Master of Science in Education – Mathematics, is acceptable in form and content and demonstrates a satisfactory knowledge of the field covered by this project.

[redacted] 7/17/12

Master's Project Advisor — Date
Keary J. Howard, Ph. D.
Department of Mathematical Sciences

[redacted] 7/17/12

Department Chair — Date
H. Joseph Straight, Ph. D.
Department of Mathematical Sciences

________________ __________

Kevin P. Kearns, Ph. D. — Date
Associate Vice President for Graduate Studies and Research

GET YOUR FACTS STRAIGHT!
THE RELATIONSHIP AMONG SELF-EFFICACY, AUTOMATICITY, AND MATHEMATICS ACHIEVEMENT OF ADULT LEARNERS

By

Joseph R. Jagoda

A Thesis
Submitted in Partial Fulfillment
Of the Requirements for the Degree of
Master of Science in Education
Mathematics
Department of Mathematical Sciences
State University of New York at Fredonia
Fredonia, New York

June 2012

Abstract

In this experiment, adult learners at an alternative education program were asked to complete a timed multiplication drill and a survey identifying their self-efficacy prior to taking the TABE Mathematics. Upon completion of the three instruments, an analysis was performed to identify the nature of any existing correlations between TABE scores and both the multiplication drill scores and self-efficacy survey scores, respectively. The analysis revealed that a significant positive correlation existed between the TABE and the multiplication drill, and that a significant positive correlation existed between the TABE and the self-efficacy survey.

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Introduction

This research explores the correlation between automaticity in basic multiplication and academic achievement of adult learners, and also the correlation between self-efficacy, and academic achievement of adult learners. The field of mathematics is typically thought of as a subject in which one must master a basic skill before moving on to a more complicated topic. For example, a student who possesses automaticity, or the ability to quickly and accurately recall information, with the multiplication tables will more easily be able to master future concepts, such as long division, fractions, etc. However, in modern times, the educational process has turned into a time crunch. Frequently, if a student does not ever master the basic skill, they are still pushed on to the next topic, and then the student must find ways to cope with the lack of basic understanding in their future educational endeavors. This often leads to lower mathematics self-efficacy, or one's own belief in their ability, among these students because they now spend much of their energy trying to grasp the basic concepts rather than being able to invest themselves in solving the problem at hand.

I was interested in this topic of basic multiplication facts because I had been teaching basic mathematics to adult learners for three years at an alternative education facility in western New York, and without a doubt, the largest component of my curriculum was fractions. Basic operations with fractions as well as equivalent fractions and the ease with which a student could master these skills seemed to be directly related to whether or not they could recall their basic multiplication facts with relative ease. At one point, for a few months, I was administering a five minute multiplication

automaticity - the ability to quickly and accurately recall information

self-efficacy - one's own belief in their ability

Figure 1. Two Key Definitions

drill once or twice a week in an attempt to help my students memorize these facts, but I started to wonder if it was worth the time and energy. I started to wonder if it was possible to actually overcome this hurdle. Many of these students had been presented these same kinds of drills when they were younger, and for many of them, it was pretty easy to see that this strategy was ineffective. I stopped administering the multiplication drill as I was not sure of its worth to my students and their academic achievement.

The topic of self-efficacy in regards to academic achievement had interested me as many of my students can “talk a big game.” I have had countless encounters with students who claim to know certain materials very well and then test horribly on the topic, whereas I have also had students absolutely fear and resent topics in which they performed extremely well. My desire was to obtain students’ true feelings towards the mathematics they would see on their assessments and determine if a connection existed between their feelings and their test performance. Specifically, the statement of the hypothesis is as follows:

> *It is hypothesized that the ability of an adult learner to quickly and accurately recall basic multiplication facts will have a positive correlation with his performance on the Test of Adult Basic Education in Mathematics. Concurrently, an adult learner’s self-efficacy across the mathematical categories of the test will have no bearing on test performance.*

The first part of the hypothesis was tested by administering a five minute multiplication drill to students 24 hours prior to taking a Test of Adult Basic Education (TABE) in mathematics. The drills were graded on a scale with consideration to time and accuracy. The graded drills from each student were paired with the results from their TABEs to check for a correlation between the scores on each. The second part of this hypothesis was tested by having the students complete a survey prior to their TABE in order to gauge their self-efficacy in regards to the diagnostic categories of the test. Completed surveys were paired with test results and diagnostic sheets to check for a correlation between self-efficacy and test performance. In regards to both hypotheses, the results were further analyzed to check if age or gender was a factor in the existing correlations between the instruments used in the experiment.

The following literature review section will examine some of the existing research related to the correlations between the mathematics achievement of adult learners and both automaticity and self-efficacy, respectively.

Literature Review

The purpose of this literature review is to examine the existing research pertaining to teaching mathematics to adult learners as well as self-efficacy and automaticity with basic multiplication facts and their correlation with performance on mathematics assessments. While not all the studies conducted were exactly in these fields, the findings and arguments can certainly be generalized towards the desired field. The review examines existing research in the areas of teaching mathematics to adult learners, self-efficacy and how it correlates with mathematical performance, and also the impact of automaticity in mathematics performance. Some available assessments in the Adult Basic Education field will be examined, as well as a more detailed look at the TABE.

Adult Education in America

Adult education in the United States is a complex topic. Aside from the development of several different Adult Education programs, the tools used to assess the performance of adult students has grown in number and evolved as well. The purpose of this section is to explore the history of Adult Education in America as well as examine existing assessments used in Adult Education.

A brief history

The Adult-Education movement in America has roots that can be traced as far back as 1919 (Smith, 1996). In this year, the Adult Education Committee of the British Ministry of Reconstruction issued a document known as the "1919 Report." It claimed that universal and lifelong education had become permanent national necessities. Following discussion forums, the American Association of Adult Education came into being in March of 1926 (Knowles, 1977).

In the early 1960s, adult basic education was proposed in various antipoverty packages. Education was continually recognized as a factor in improving the economic status of the unemployed and the poor. In 1964, the Adult Basic Education program was passed as part of the Economic Opportunity Act**.** In 1966, when the act was renewed, the program was transferred to the U.S. Office of Education, and the act also provided funding for teacher training and demonstration projects. The act was amended in 1970 to change the definition of adults to those age 16 or older. The 1970s also brought along changes like the creation of the National Advisory Council on Adult Education and a shift away from grade level equivalency to functional literacy. The concern for literacy continued to rise through the 1980s and 1990s as it became a national priority. The National Literacy Act of 1991 still continued to focus on literacy as a means of solving many problems in society (Rose, 1991). Some of the major provisions of the National Literacy Act of 1991 were the increase of authorization for literacy programs and the establishment of a National Institute for Literacy creation national work force demonstrations, as well as the authorization of other new programs (Irwin, 1991). Adult education in America continues to be a national priority as shown by the continued existence of federally funded adult education programs such as Job Corps, where adult students can enroll to earn a GED or a high school diploma as well as a vocational certification in a trade of their choice.

As shown by history, a prevalent goal of adult education is to help solve the problem of poverty in America by helping young men and women get an education and to produce more qualified individuals for the workforce. By helping these individuals earn an education, the programs will also help them get and maintain jobs and hopefully help suppress the poverty level in the country. However, placing these students on assessments such as the GED test can be costly if not done in an efficient manner. Also, presently, a student can only take a GED test three times in one calendar year. The next section will explore some lower risk assessments used to measure the progress of adult learners.

Assessments used in Adult Basic Education (ABE)

There have been a multitude of standardized assessments used in the Adult Basic Education field. One such assessment is the Adult Basic Learning Examination (ABLE). This test first came out in 1967 to measure several basic education skills of adults (Sticht, 1990). The reading passages are mostly about everyday matters, and the mathematics word problems are similar to those one would encounter in everyday life.

The GED Official Practice Tests are another assessment used to evaluate adult learners and determine their readiness to take the GED tests (Sticht). The practice tests are published by the same organization that produces the GED tests, and they are certainly a good predictor of student performance on the GED tests.

The Test of Adult Basic Education (TABE) was first released in 1957, and consisted of seven sections measuring vocabulary, reading comprehension, language mechanics, language expression, spelling, mathematical calculation, and mathematical concepts/application. The full length version takes about 4.5 hours to administer, so most institutions only use one or two sections for assessment purposes. The TABE will be reviewed in more detail in upcoming sections.

Currently, the main focus in adult education is to teach in a manner in which adult students can draw from life experience. One subject in which this notion is particularly important is mathematics. Many adult students have initially failed in their attempts to master basic mathematics in the past, and very often, the best way to motivate them to succeed is to show how the work they are completing in the classroom is important in their daily lives as well.

Mathematics and the Adult Learner

Teaching the adult learner has long been a popular topic among educational researchers. A variety of articles have been written with the purpose of finding the best way to educate these adult learners (Angiama, 1998; Comings & Mullinix, 1993; Dorwaldt, 1989; Gal, 1993; Lawrence, 1988; Markus, 2001; Nesbit, 1995; Steinke, 2001; Wedege, 2004). While their focus is on a variety of specific mathematical topics, most of these articles mention the need for the mathematics involved to be practical and applicable to the students' lives.

One of the more specific articles regarding this topic argued that the most important thing that we can teach adult students is the topic of measurement (Markus, 2001). In this article, Markus identifies measurement as "an essential life skill, one that adults use in many different but familiar contexts." Markus argues that while the adult learner may not see geometry as useful, geometry can be related to all aspects of life. She maintains throughout that it is necessary to focus largely on hands-on problems solving.

Dorothea Anne Steinke (2001) used the TABE as an evaluative instrument to examine whether students who possessed a better "part-whole" understanding would perform better in a mathematics course than those who lacked this understanding. The part-whole concept of which Steinke writes can be seen in Figure 2.

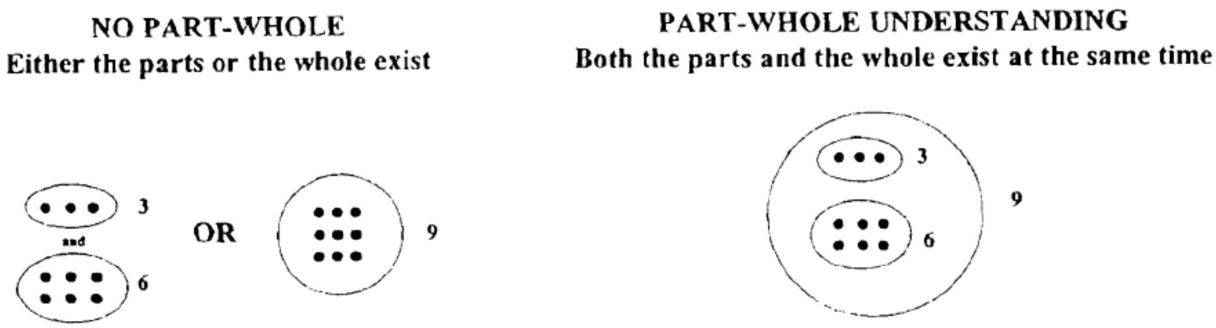

Figure 2. The part-whole concept. Adapted from “Does "part-whole concept" understanding correlate with success in basic math classes?” by D. Steinke, 2001, Paper presented at the Annual Adults learning mathematics Conference, Roskilde, Denmark.

Steinke does note that there could be a number of factors involved in the final grades for the courses, but insists that the results of the study show a trend that would support that a lack of part-whole concept as a “hidden cause of innumeracy.” She states that there are no “confidence values” tied to these numbers, however, the data shows a “trend of a higher final grade corresponding to better part-whole understanding” (p. 151). Steinke concludes her article by stating that the study should indicate that a direct instruction of the part-whole understanding should be part of adult basic mathematics courses, and that an effort should be made to start including this concept in adult mathematics textbooks.

The Part-Whole concept is only one topic that is examined in correlation with mathematics achievement. Louis Dorwaldt, Jr. (1989) reported on reaching “underachievers” in mathematics when it comes to teaching them multiplication. Dorwaldt notes that one of the first evaluations a teacher makes about a student who is underachieving in arithmetic is that they do not know the multiplication tables. The teacher then uses repetitive strategies and activities in order to help the student memorize multiplication facts that he does not know. Dorwaldt states that while the strategies will probably work for the majority of students, it is essential that teachers of adult learners do not give up on those who have failed to master their multiplication facts using the repetition method. Dorwaldt then lists and explains a number of strategies to use with an adult student who has difficulty recalling his basic multiplication facts. These strategies are used to make multiplication less difficult for the student. Dorwaldt also gives a couple of strategies to use to help the student be more certain that an answer makes sense. For example, Dorwaldt notes that explaining to a student when a product is supposed to be even or odd based on the factors involved in the problem could help the student find the correct answer. Dorwaldt concludes his article by restating that teaching mathematical properties and concepts could indeed be more valuable than memorizing the multiplication tables, and that multiplication should be "observable (patterns and finger math), fun (puzzles and games), and practical (using everyday problems related to the student's life)" (p. 69).

Regardless of the topic, a main idea presented in many articles examined suggest using an approach that relates the mathematics being taught to applicable situations for the students and also to reinforce the understandings that lie beneath the basic concepts of mathematics. Without a solid foundation in the basic concepts, it is especially difficult for an adult student, or any student, to progress through the more complex topics of mathematics while lacking a sense of self-confidence in their basic mathematical skills.

Self-efficacy and Mathematics

There is little debate in current research about self-efficacy and its positive correlation with academic achievement. Much research has been conducted in this area, and the general consensus among the majority of the studies is that self-efficacy can be a good predictor of academic achievement and typically has a positive correlation on achievement scores or that self-efficacy is a very good predictor of mathematics achievement (Fast, Lewis, Bryant, Bocian, Cardullo, Rettig & Hammond, 2010; Kitsantas, Ware, & Cheema, 2010; Kitsantas, Cheema, & Ware, 2011; Özgen & Bindak, 2011; Pietsch, Walker, & Chapman, 2003; Semmar, 2006; Skaalvik & Skaalvik, 2009; Zientek & Thompson, 2010).

A study conducted by Pietsch et al. (2003) examined the relationship between self-concept, self-efficacy, and performance in mathematics among high school students. Self-concept refers to “self-perceptions formed though experience with the environment” (p. 589). The study examined the responses of 416 high school students on a questionnaire assessing mathematics self-efficacy and self-concept. Pertaining to self-efficacy, the authors used five items to measure mathematics self-efficacy, using general items such as “I am able to achieve at least OK grades in mathematics,” (p. 591) and also using more specific items like, “I am able to achieve at least 90% in my mathematics course this year” (p. 591). They also used items such as these to measure math self-concept, such as, “I hate mathematics” (p. 591), or, “I enjoy studying for mathematics” (p. 591). A social comparison element was also used to determine where the students placed themselves in relation to their peers. It was hypothesized, among other theories, that self-efficacy would be a more predictive measure of performance than self-concept. The authors took the students’ performance on the end of term examination and compared these scores to the students’ responses on the self-concept and self-efficacy questionnaires as well as the social comparison questionnaire. The authors discovered that they were indeed correct with their hypothesis as they found that self-efficacy was indeed the more indicative measure of student achievement on the mathematics examination.

Homework is one tool a teacher can use to help students build self-efficacy. Kitsantas et al. (2011) performed a study with the purpose of identifying “the extent to which mathematics self-efficacy beliefs, time spent on mathematics homework, and homework support resources predicted high school student mathematics achievement" (p. 315), while also examining the role of race and gender in those relationships. The study involved 5,200 students, mostly from the United States. The authors examined family structure as well as parental education level. The self-efficacy scale included eight questions that measured a student's self-confidence in performing varying mathematical calculations. The authors also asked the students the relative time each student spent on their homework, which is defined as the ratio between time spent on mathematics homework to time spent on total homework. The authors also asked the students what kind of homework support sources they had, such as a desk at which to study, a quiet place to study, computer, Internet access, etc. The results of the study showed that "mathematics self-efficacy and mathematics achievement were highly correlated" (p. 321). The data also showed that there was a "moderately positive correlation" between homework support resources and mathematics achievement and self-efficacy. Interestingly, the study also showed that African-American and Hispanic students spent significantly more time on mathematics homework than their Caucasian counterparts, and also that the Caucasian students had more homework support resources than the African-American and Hispanic students. The study was able to tie self-efficacy in with homework and homework support resources, showing that the latter two certainly help improve a student's self-efficacy when homework is assigned in a proper way and when adequate homework support resources are available for use by the students. As evidenced by this study and many others, self-efficacy is a solid predictor of mathematics performance, and efforts should be made by teachers, schools, and parents to help create this feeling of confidence in the students.

Self-efficacy is only one of many factors that should be considered when predicting student achievement. Skaalvik and Skaalvik (2009) examined whether mathematics selfperception (self-concept and self-efficacy) predicted subsequent achievement over the prediction that could be made by prior achievement. The study was conducted with Norwegian students in grades ten and eleven. The authors measured self-concept, self-efficacy, intrinsic motivation, goal orientation, and self-esteem by means of a questionnaire administered at the schools by trained research assistants. They paired these questionnaires with the end-of-year grades for grades nine, ten, and eleven, respectively. The authors concluded after the study that self-concept and self-efficacy are very important essentials for learning and achievement.

While these studies are not directed in the field of adult learners, the overwhelming consensus regarding the importance of self-efficacy can undoubtedly be extended to the population adult students. As can be assumed for learners of all ages, an adult student's self-efficacy is likely very telling about his ability to succeed in mathematics and any other academic subject.

Test of Adult Basic Education

The Test of Adult Basic Education (TABE) is a standardized assessment used by many institutions to help place students in their academic programs. The TABE was first developed to measure reading, writing, and mathematics achievement, and is now often used to gauge a student's readiness for the GED. The TABE is also used to monitor student progress throughout the educational program and is a low cost assessment for these institutions to administer.

The TABE Mathematics is split into two assessments: mathematics computation and applied mathematics. The computation section consists of 40 multiple choice questions to be completed in 24 minutes (TABE, 2003). The problems on the test cover whole numbers, decimals, fractions, percents, and integers. For all 40 of these questions, one of the multiple choice responses is “none of these.” This choice being offered on all questions seems to be an attempt to measure the student’s self-confidence in their work. Aside from offering “none of these,” it also seems that the test is written in a fashion that the more popular incorrect answers are also listed as choices. For example, in a problem such as “15 – 0.87”, one of the choices listed would most likely be “15.87,” which would be a choice popular among those students who are unaware of the infinite number of available zeroes to the right of the decimal. Another likely choice would be “0.72”. In this case, the student would not know where the decimal should be placed in 15 in order to solve the problem, and would then naturally reverse the numbers in somewhat of a panic move to avoid trying to subtract 87 from 15.

Test of Adult Basic Education (TABE) Forms 9D and 10D	
Two parts – Computation, Applied Math	
Maximum Score – 12.9	
Computation	**Applied Math**
• 40 computation questions • 24 minutes • Covers the following topics: multiplication and division of whole numbers, decimals, fractions, integers, percents • Use of calculator prohibited	• 50 applied math questions • 50 minutes • Covers the following topics: computation in context, numbers and number operations, estimation, algebra, geometry, measurement, data analysis, statistics and probability, problem solving • Use of calculator permitted

Figure 3. Structure of the TABE Mathematics. Note: Adapted from “Test of Adult Basic Education: Complete Battery Test Directions,” by CTB/McGraw Hill, 2003. Copyright 2003 CTB/McGraw Hill LLC.

The applied math section consists of 50 multiple choice questions on the following areas: number and number operations, computation in context, estimation, measurement, geometry, algebra, problem solving, and probability, data, and statistics. The student has 50 minutes to complete this section and is allowed to use a calculator if desired (TABE). These questions usually show a figure (chart, graph, etc.), and then asks the student to answer two to four questions about the figure. Both the computation and applied sections of the test allow for the students to navigate forwards or backwards through the problems as long as time permits.

The results of the test are broken down into diagnostic categories so that, not only does the instructor know how each student is performing mathematically, they also know what exact areas each student needs to work on in order to improve upon their performance on the test. The TABE also comes in different forms and levels of difficulty in order to provide the best assessment available for each student. Various articles have cited the TABE as the preferred test in Adult Basic Education classrooms (Nagel, 1999; Piccone, 2006).

An article by Piccone (2006) discussed the use of the TABE test to accurately place newly incarcerated adults in an educational program while they are in prison. Piccone argues that the offenders have increased sensations of depression and anxiety, and that these heightened feelings impair the individuals' ability to accurately finish their tests. To complete this study, Piccone obtained data from the past 15 years from the Virginia Department of Correctional Education database. Piccone took data from offenders who took the TABE at intake and took a follow-up TABE within a year of the initial test while receiving no educational programming in between. The author found that, as he had predicted, the "offenders scored significantly lower on the TABE during intake than at follow-up testing" (p. 245), and that this notion was evident across all of the sub-portions of the test. He concluded that TABE scores at intake are not indicative of an offender's true ability, which creates an issue as long as the initial TABE remains an essential part of the offender's educational program.

Piccone's work, while not specifically linked to the present study, can certainly be paralleled to the situation in which my study could be performed. At the institution at which I am employed, students are taken from the inner-city and housed in an extremely rural environment, which is most likely hundreds of miles away from their homes. The students are then asked to take a TABE in reading and mathematics to determine their academic schedule on the third day at the institution in which this study took place. Piccone's article brings to light some issues that should absolutely be considered in the initial TABE scores of the students.

The TABE is not the only adult learner assessment available, however, it seems to be preferred over the other tools used to measure adult learner achievement. A monograph written by Nagel (1999) compared the TABE and another standardized assessment, the Comprehensive Adult Student Assessment System (CASAS). The TABE had been the primary standardized assessment instrument utilized by the adult education program of an institution run by the Pennsylvania Department of Education Bureau of Adult Basic and Literacy Education. The institution's program improvement team needed to make a choice between the TABE, and an "up and coming" assessment instrument, the CASAS. The institution used the TABE to establish baseline data from September through December of that year, and then use the CASAS from January through June. The results were compared using these criteria: usefulness in planning individual instruction, impact on student test anxiety, impact on student retention, length of time to administer, ease of scoring, acceptability of use for required PDE information, and predictability to the GED test. The study showed that the students had marginally more test anxiety with the TABE, and also that teachers preferred the TABE for its "diagnostic and prescriptive information" (p. 3). At the conclusion of the study, the institution decided to continue using the TABE test in order to place their adult education students as they found it to be a better assessment in preparing their students for a GED exam.

The TABE certainly tests a variety of mathematical topics. Because of the topics covered in the computation section of the test, a student that has mastered basic numeracy skills could certainly prove to be advantageous for the student. These skills would likely allow the student to move more quickly through the assessment, while also limiting the number of basic computation errors that would lead to an incorrect response. Automaticity indeed seems like a positive asset when it comes to being successful on the TABE or any other assessment.

The Impact of Automaticity

A known theory of mathematics educators is that mathematics is a subject in which one needs a solid foundation in order to advance to more complicated topics. Many articles have cited the notion that a student's basic numerical ability will impact them later in life (Brookhart, Andolina, Zuza, & Furman, 2004; Bynner & Parsons, 1997; Djemil, 2010; Roark, 1998; Su, 1990; Wittman, Marcinkiewicz, & Hamodey-Douglas, 1998; Woodward, 2006).

Basic numeracy can affect more than just high school performance. Bynner and Parsons (1997) conducted a study that showed that students with weak numeracy skills not only left school early and without qualifications, but had more difficulty getting and maintaining full-time employment. The jobs they were able to get generally had little room for growth and low pay.

The mastery of basic mathematical concepts can allow students to focus on solving more difficult problems rather than struggle with how to actually do the work required to solve the more complex problems. A lack of these basic skills could result in higher math anxiety and limit student achievement. A study by Wittman, Marcinkiewicz, & Hamodey-Douglas (1998) actually showed that memorization and improved automaticity in basic multiplication facts indeed lowered the level of math anxiety among a group of fourth grade students.

One of the most basic skills that all mathematics students are asked to achieve is memorization of the basic multiplication facts. Abdelhafid Djemil (2010) conducted a study to examine the effect of memorization of multiplication tables on students' performance in high school level mathematics. To conduct the study, Djemil had the students take a diagnostic multiplication test and a comprehensive assessment on varying mathematical topics. Djemil used two methods of testing in the study. The first test required the students to use memorization, while on the second assessment, the students were allowed to use calculators. The results of the study indicated that students who had memorized the basic multiplication facts performed at a higher level with and without calculators than those who had not memorized the times tables.

Memorization of the basic multiplication facts is essentially a visual process. Most people at one point in their lives use a flashcard or a times table to take a mental image. The study conducted by Roark (1998) attempted to show that students who are classified as visual learners will score higher on standardized tests than those who are deemed non-visual. The study used 33 visual learners and 33 non-visual learners from the adult education program at Putnamville Correctional Facility. The author used the TABE as a means of assessing the students' performance, and separated the parts of the test into four categories: vocabulary, reading comprehension, mathematics concepts, and mathematics computation. The study indicated that visual learners outperformed the non-visual learners in all four categories. Also, the two largest differences in average scores between the two groups appeared in reading comprehension and mathematics computation.

It is an extremely common theme through current research that students who have a strong foundation with fundamental mathematics will achieve at a higher rate than those who do not possess these basic skills. Also, while there is an abundance of research within the topic of self-efficacy and mathematics, little of this research is directed in the area of adult students. Adult education programs and alternative education programs are becoming more and more popular as time goes on, and more research needs to be conducted in these areas in order to best suit the needs of these adult students. Within these programs, an emphasis must be placed on educating these students on the basic skills needed in order to grow in the area of mathematics. Students who possess a higher level of automaticity with basic arithmetic will be able to spend more of their energy actually solving a mathematical equation rather than struggling with how to perform the required arithmetic to solve the problem.

By mastering the basic arithmetic, the students will have a heightened sense of self-efficacy resulting in less anxiety. This lowered sense of anxiety would possibly allow a student to perform better on standardized assessments, and because of the basic skill mastery, the student would be more confident in his or her abilities. He or she would also be able to focus on the problems at hand instead of struggling with the basic skills necessary to solve them. These combined factors would lead one to believe that a positive correlation exists between self-efficacy, basic numeracy mastery, and student performance on assessments. A more detailed explanation of how self-efficacy and mastery of basic multiplication skills can be connected with performance on a standardized test is offered in the following design section.

Experimental Design

This experiment was designed to test the hypothesis that adult students who can recall basic multiplication facts quickly and accurately will score higher on the Test of Adult Basic Education (TABE) in Mathematics, and that an adult student's self-efficacy will have little to no bearing on that student's achievement on the TABE. The students were given a five minute multiplication drill, as well as a self-efficacy survey prior to taking the TABE. The results of all three were analyzed to determine what correlation, if any, existed between the three instruments.

Participants

This study was conducted at an alternative education program in northeast United States. The institution is located in a small village set in a rural environment.

The institution is an educational and vocational training program, in which the students are between ages 16 through 24. There were 271 students enrolled at this program when this study began. New students are enrolled every week, but the number of students is consistently around 270. The racial breakdown of the students enrolled in the program was very different than that of the surrounding community, with only about 15 percent of the student population being regarded as white. The complete racial breakdown of the student population can be seen in Figure 4. The number of students that participated in the study was 49. From these 49, data from 35 participants was analyzed for results. This was done in order to simplify the process of obtaining meaningful results. Also, students under the age of 18 were omitted from the data collection process.

The contrast between the population of the institution and the surrounding community can be explained in the arrangement of the institution. The students enrolled at the institution

Race	**Number of Students**	**Approximate Percentage of Total Population**
Asian	3	1%
Asian & Black/African American	1	< 1%
Black or African American	175	65%
Black/African American & Hispanic or Latino	1	< 1%
Hispanic or Latino	45	17%
White	42	16%
White & American Indian/Alaska Native	1	< 1%
White & Black/African American	1	< 1%
White & Hispanic/Latino	1	< 1%
White & Native Hawaiian/Other Pacific Islander	1	< 1%

Figure 4. Racial Composition of Students at the Site of the Study

were primarily from some of the larger cities in the state of New York, such as Buffalo, Rochester, Syracuse, and New York City, and these students lived on campus in gender specific dormitories. While some students were residents of the local area, and some students were from different states, about 85% of the students at the time of this study were from the four aforementioned cities. Of these students, about 56% were male.

As explained previously, all of the students involved in this study were between the ages of 16 and 24 when they enrolled in the program. At the time that the study was conducted, some of them had turned 25 after they had enrolled. About 75% of the students enrolled in the program at the time of the study were between 17 and 21 years of age.

All students enrolled at the institution were administered a TABE in reading and mathematics within the first week of their arrival. A student's training program was then determined based upon TABE scores and whether or not that student needed a diploma or entered the program having already earned one. If a student had a diploma prior to entry, they could still be enrolled in basic mathematics and reading courses if their TABE scores were not satisfactory. They would then be retested every 90 days, or could earn their way on to a follow-up TABE 30 days following their initial test. If a student had a diploma upon arrival, and had high enough TABE scores, they would be scheduled in the vocational program on a full time basis.

For those students in need of a diploma, their academic schedules were determined using their TABE results. If the scores were high enough in reading and mathematics, they would be enrolled in a GED class. Otherwise, the students were enrolled in basic reading or math until they were able to raise their TABE scores at which point they would earn entry into the GED course or one of the offered High School Diploma programs.

Design

This experiment involved a dual hypothesis, but each

- Student completes timed multiplication drill (50 questions) and self-efficacy survey prior to TABE
- Multiplication drill was scored using rubric
- Self-efficacy ratings (computational, applied math, overall) were computed
- Results from drill and survey were paired with TABE results to identify any existing correlations.

Figure 5. An overview of the experimental design.

		t = time in minutes					
		$t \leq 1$	$1 < t \leq 2$	$2 < t \leq 3$	$3 < t \leq 4$	$4 < t \leq 5$	$t > 5$
Questions answered correctly	**50**	10	9	8	7	6	5
	49	9	8	7	6	5	4
	48	8	7	6	5	4	3
	47	7	6	5	4	3	2
	46	6	5	4	3	2	1
	45	5	4	3	2	1	0
	44	4	3	2	1	0	0
	43	3	2	1	0	0	0

Figure 6. Rubric used to score the multiplication drill.

part was tested at the same time. The first hypothesis was that a positive correlation existed between TABE scores and a student's ability to recall basic multiplication facts quickly and accurately. This hypothesis was tested by administering a timed multiplication drill to students within 48 hours of those students taking a follow-up TABE Mathematics. The multiplication drills consisted of 50 multiplication problems involving the numbers one through ten; these drills were graded using the rubric in Figure 6. The rubric uses the number of questions answered correctly from 43 through 50. Any drill that had less than 43 correct responses earned a score of zero. Time was measured up through five minutes. Once a student reached five minutes, he or she was not timed additionally past five minutes. A sample of a

Name:____________________		ID:____________________
2 x 3 =	5 x 4 =	6 x 6 =
8 x 4 =	4 x 10 =	7 x 4 =
2 x 8 =	3 x 1 =	8 x 3 =
4 x 4 =	2 x 2 =	2 x 6 =
3 x 6 =	8 x 6 =	9 x 9 =
6 x 10 =	8 x 11 =	4 x 7 =
2 x 7 =	5 x 8 =	9 x 4 =
1 x 8 =	2 x 9 =	1 x 7 =
10 x 9 =	3 x 7 =	4 x 3 =
1 x 10 =	8 x 7 =	3 x 6 =
5 x 2 =	4 x 9 =	2 x 10 =
5 x 4 =	10 x 3 =	7 x 9 =
7 x 2 =	3 x 9 =	3 x 3 =
6 x 4 =	3 x 4 =	2 x 10 =
3 x 8 =	9 x 1 =	4 x 8 =
1 x 1 =	8 x 2 =	

Figure 7. Sample multiplication drill.

speed drill can be seen in Figure 7. Clearly, the order in which the problems appear on the speed drill is completely random, and thus can be used to test a student's true automaticity in this area. The types of problems were decided on due to the nature of the problems the students would be exposed to on the TABE. Time and accuracy were considered in the scoring rubric as it is part of the nature of the TABE as well.

The second part of the hypothesis was that a student's self-efficacy in the diagnostic categories of the TABE mathematics would have little to no bearing or correlation with performance on the TABE itself. The diagnostic categories refer to the areas listed on the diagnostic results sheet for each student's TABE results. This sheet is typically used to drive instruction and to allow the teacher and student to focus on particular weaknesses to improve upon before the student takes another TABE.

To measure this relationship, students completed a short survey rating their confidence in the categories on the TABE. For each category, a brief description of the topic was given, and the student rated their confidence on a scale from one to four, with four being "extremely confident" and one being "not at all confident." The survey given to each student prior to the TABE can be seen in Appendix B. The first six categories listed on the survey pertain to the computation section of the TABE, while the remaining categories are from the applied math portion of the assessment. Each student's TABE results were paired with that student's corresponding survey to analyze if any correlation existed between the two.

Data Collection

The data from both the multiplication drill and the self-efficacy survey were collected and paired with a print-out of the student's TABE results. This sheet contained the student's overall TABE score as well as the separate scores of the computation test and the applied test, respectively, thus it was a good resource to use in analyzing the results from both student-completed instruments. The data from all three instruments were entered into a spreadsheet to organize and analyze the data collected.

The results from the self-efficacy survey were analyzed in three ways. First, ratings from all categories listed were averaged together to compute an overall self-efficacy rating. This rating was paired with the overall TABE score and analyzed to determine if any correlation existed. Also, the self-efficacy survey contained two sections: a computation section and an applied math section. The computation sections included whole numbers, decimals, fractions, percents, and integers. The ratings from these categories were averaged together to compute a computational self-efficacy rating. The computational self-efficacy rating from each student was paired with that student's score on the computation section from his or her TABE and analyzed to determine if any correlation was present. The ratings from the remaining categories were averaged together to compute an applied self-efficacy rating. Each student's applied self-efficacy rating was paired with the corresponding score from the applied math section of his or her TABE. They also were analyzed to determine if any correlation existed. A timeline of events that took place for each student that participated in the study can be seen in Figure 8.

1.) Student completes timed multiplication drill (50 questions, typically less than 5 minutes)
2.) Student completes self-efficacy survey (15 categories, approximately 2 minutes)
3.) Student completes TABE Mathematics Computation (40 questions, 24 minutes)
4.) Student complete TABE Applied Math (50 questions, 50 minutes)

Figure 8. Sequence of Events for the Experiment

While several steps were used to collect data for this study, analyzing the results was fairly simple. The methods in which the data was analyzed will be explained in the next section.

Methods of Data Analysis

The first part of this study was quantitative in nature since it compared scores from the TABE as well as scores from the timed multiplication drills. Results were grouped by score on the multiplication drill, and then averages in TABE scores from each performance group were computed to find any possible correlation between the drill score and the TABE score.

The self-efficacy portion of this study was analyzed both qualitatively and quantitatively. While the students' opinions of their own abilities were qualitative, analyzing those surveys together with the TABE results were quantitative. Based on the results collected, inferential and descriptive statistics were calculated and discussed.

Analysis of the Timed Drill Results

The timed multiplication drills were administered to each student prior to taking the TABE. The drills were collected upon completion. Each drill score was plotted with its associated TABE Computation GLE, TABE Applied Math GLE, and Overall TABE GLE, respectively. An analysis was performed to determine the nature of any existing correlations within the data.

Analysis of Self-Efficacy Results

The self-efficacy surveys were administered to each student prior to taking the TABE. For each survey, three separate averages were calculated to utilize as a self-efficacy rating. The ratings from multiplication and division of whole numbers, decimal, fraction, and integer operations, and percents were used to obtain a computational self-efficacy rating. The remaining categories were used to compute an applied self-efficacy rating, and finally, ratings from all categories were used to compute an overall self-efficacy rating. Each rating was analyzed with its corresponding TABE GLE, as follows: computation self-efficacy rating versus TABE Computation GLE, applied self-efficacy rating versus TABE Applied Math GLE, and overall self-efficacy rating versus Overall TABE GLE. The data was analyzed to determine the nature of any existing correlations. Figure 9 shows a list of items that were paired and analyzed to determine the nature of any existing correlations.

The data collected was also separated by age and gender to find out if the correlations between each respective group were significantly different. The findings of each data plot are discussed in the following results section.

Multiplication Drill ⇔ TABE Computation GLE
Multiplication Drill ⇔ TABE Applied Math GLE
Multiplication Drill ⇔ Overall TABE GLE
Self-Efficacy Survey ⇔ TABE Computation GLE
Self-Efficacy Survey ⇔ TABE Applied Math GLE
Self-Efficacy Survey ⇔ Overall TABE GLE

*Figure 9***.** Instruments Analyzed to Find Existing Correlations

Results

Four primary results were evident following the collection and analysis of the TABE results, multiplication drills, and self-efficacy surveys.

- ***A significant positive correlation (r = .580) exists between the multiplication drill scores and the Overall TABE GLE scores.***

- ***A significant positive correlation (r = .579) exists between the overall self-efficacy survey scores and the Overall TABE GLE scores.***

- ***The correlation between multiplication drill scores and TABE GLE scores was significantly higher for older students (r = .705) than younger students (r = .311).***

- ***The correlation between self-efficacy and TABE results was significantly stronger for male students (r = .745) as opposed to female students (r = .354).***

There is not significant evidence to reject the hypothesis that a positive correlation exists between TABE performance and the multiplication drill scores. However, the hypothesis of no correlation between self-efficacy and the TABE results must be rejected, as it is clear that there is an existing positive correlation between the two.

Result 1: A significant positive correlation (r = .580) exists between the multiplication drill scores and the Overall TABE GLE scores.

The multiplication drill and the Overall TABE GLE score were analyzed to find if any correlation existed between the two items. A correlation analysis was performed using the data collected from each instrument. The analysis produced a correlation coefficient of .580 between the drill scores and the TABE results. A regression plot of the data collected can be seen in Figure 10.

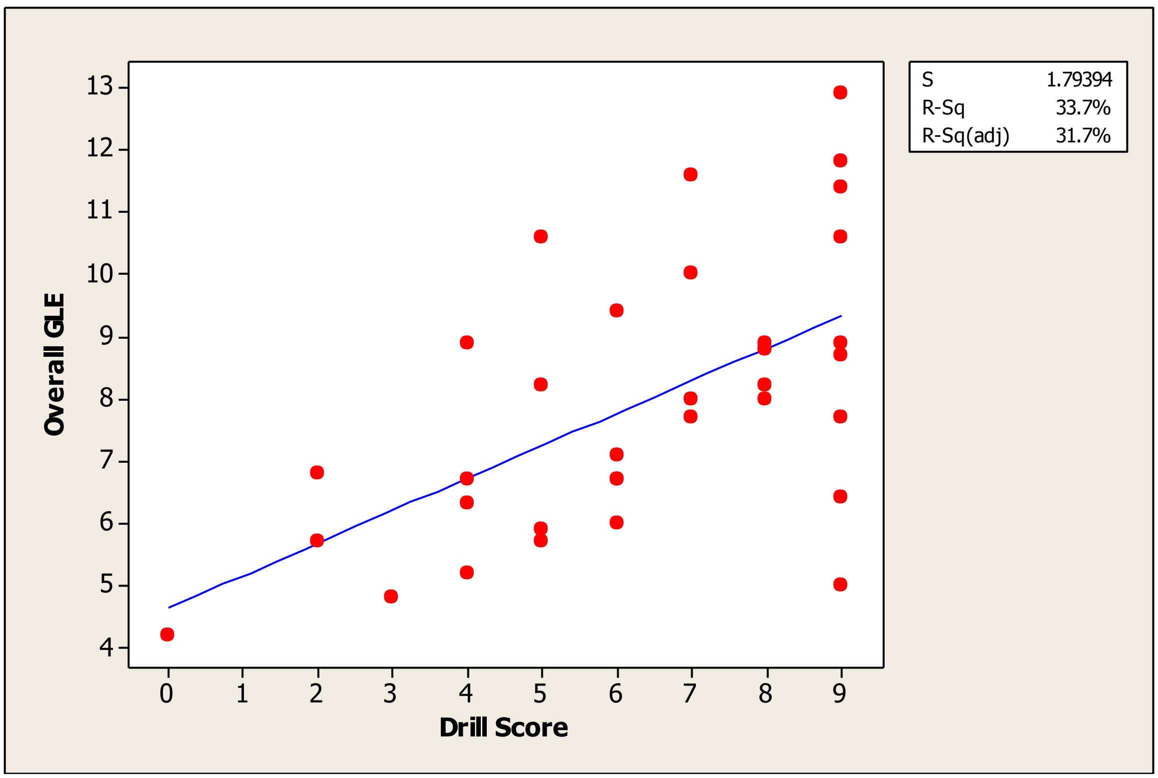

Figure 10. Regression plot of the multiplication drill score versus Overall GLE score.

This data essentially answers the first part of the hypothesis. It is clear from the data that a positive correlation exists, and thus, a student that possessed a higher level of automaticity with basic multiplication facts typically performed at a higher level on the TABE. However, while this positive correlation exists, it is clear from looking at Figure 10 that it is by no means a perfect correlation. The data points are very spread out, meaning that while the multiplication drill score could be a good predictor of general TABE performance, it is by no means a guarantee that a student with a higher level of automaticity with basic multiplication facts will outperform his or her peers on the TABE.

Additionally, the multiplication drill scores were compared to the TABE Computation GLE scores and the TABE Applied Math GLE scores, respectively. Upon analysis of the multiplication drill scores and the TABE Computation scores, a significant positive correlation was found between the two instruments. Figure 11 shows a regression plot of the scores from the computation section of the TABE as compared to the score on the multiplication drill for

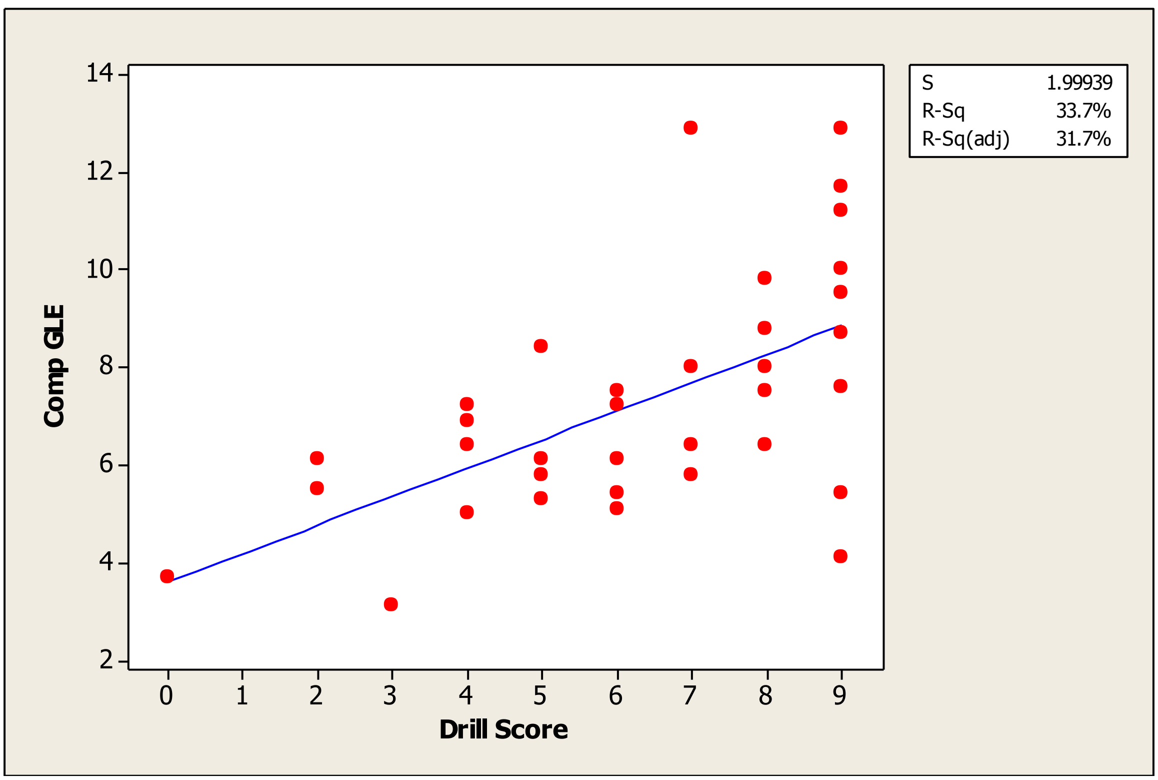

Figure 11. Regression of the multiplication drill score versus the Computation GLE score.

each student. The multiplication drill had a significant positive correlation with the computation GLE, having a correlation value of .581. This result is less than surprising. The topics evaluated on the computation section of the TABE can easily be rooted in the multiplication tables. Multiplication and division of whole numbers, decimal, fraction, and integer operations, and basic percent problems can certainly be thought of as "easier to solve" if a student is confident and proficient in his or her multiplication facts. Because of the knowledge of these facts, the student can focus on solving the problem at hand, rather than struggling to compute basic multiplication problems. This basic multiplication ease can allow for a student to complete the test within the time allotted (40 questions in 24 minutes) as now they only need to spend time completing the procedural mathematics associated with each topic covered on the test.

There was one student in particular who could be viewed as an outlier in the data set used in Figure 11. This student was identified as student 15 in the data sheets used to configure the statistics of importance for this study. Student 15 received a 7 on the multiplication drill, which is a relatively mediocre to high score on the rubric, yet he scored a 12.9 on the computation section of the TABE, which is regarded as the highest possible GLE score. A 12.9 can be obtained by answering 36 or more questions correctly out of the 40 total questions on the test. The reason why a high score on the TABE is surprising with only a 7 on the drill (as opposed to an 8 through 10) is that this student clearly took longer to figure out the multiplication facts. The student answered 49 of 50 multiplication drill questions correctly, but took almost 2.5 minutes to do so. This student stands out more than those who scored higher on the drill but not as high on the TABE for good reason: one can expect that even though students are proficient with basic multiplication facts, they may not know the procedures behind fraction, decimal, and integer operations nor how to solve a basic percent problem.

Student 15 was accurate in answering the drill questions, but the time it took to complete the drill would lead one to think that this student may not have had time to answer all 40 questions on the TABE Computation, and therefore, would not be able to obtain a 12.9 GLE score on the test. The data from student 15 seems to stand alone and disagree with this logic. A correlation coefficient of .614 was calculated for the data set not including student 15. Figure 12 identifies student 15 and configures a regression plot not including that student. As can be seen from comparing Figure 11 and Figure 12, the removal of student 15 has a substantial impact on the R-Squared values, and has a substantial impact on the aforementioned correlation values as well.

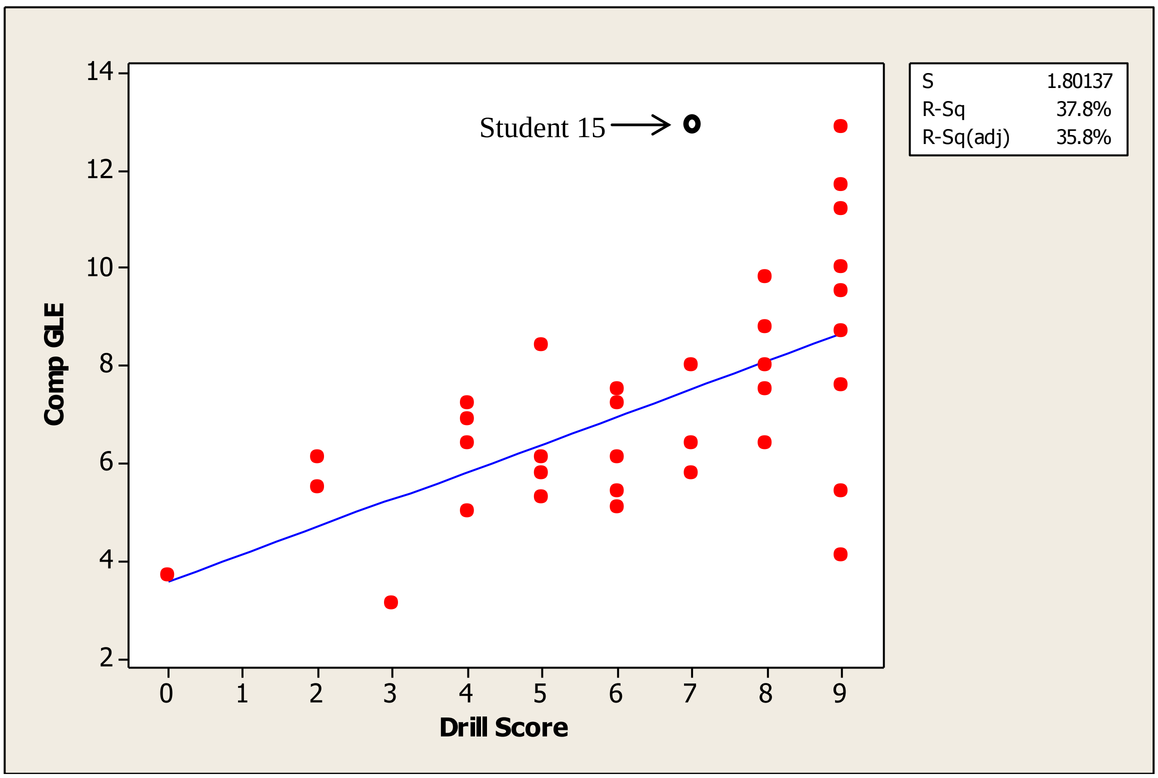

Figure 12. Regression plot of multiplication drill score versus Computation GLE not including Student 15.

The TABE Applied Math GLE scores and multiplication drill scores were also analyzed to find any existing correlation between the two. A regression plot including R-Squared values can be seen in Figure 13. When the data was analyzed, a correlation value of .400 was calculated. This is significantly lower than the correlation between the drill and the computation section of the test. The difference between these values can mostly be attributed to the fact that students can use a calculator on the applied math section of the test. As the instrument is comprised of word problems (applied math), the purpose of the test is to assess the students' problem solving abilities; thus, they are given a calculator to do any calculations needed to solve the problem.

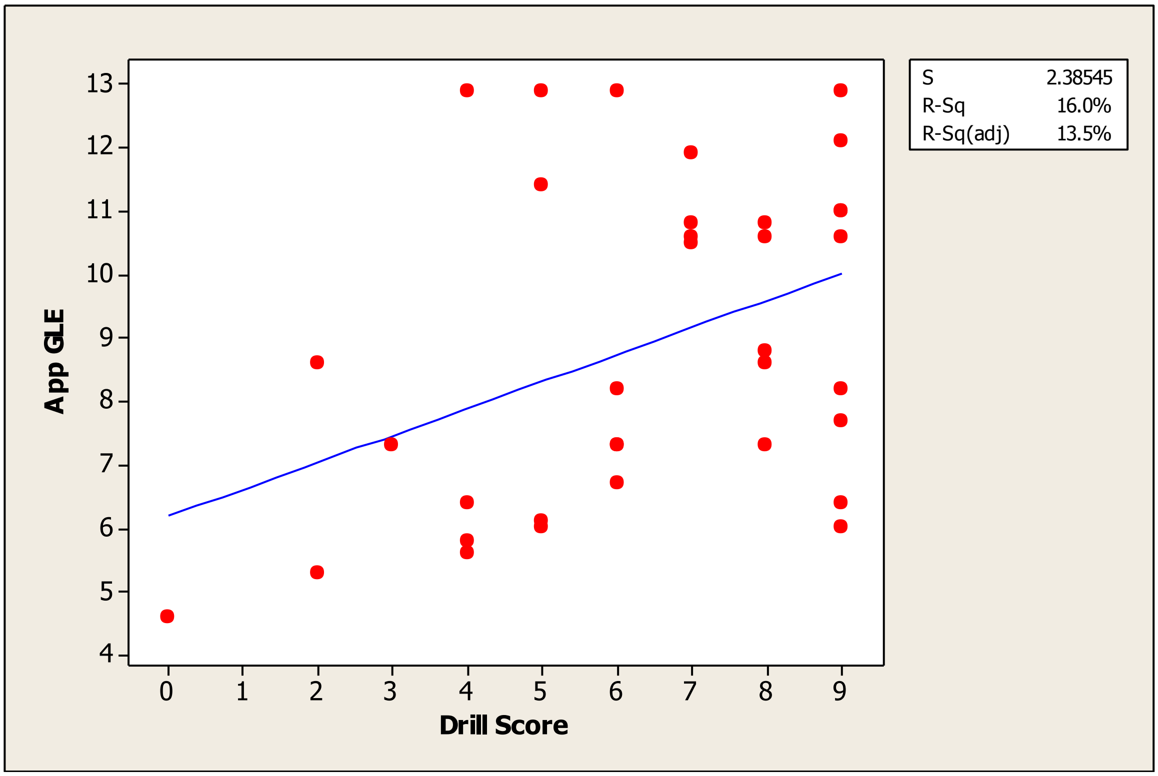

Figure 13. Regression plot of the multiplication drill score versus the Applied Math GLE score.

As can be seen in Figures 11 and 13, the R-Squared values were much lower for the comparison of the multiplication drill and the TABE Applied Math, as was the correlation value, in comparison to the correlation to the TABE Computation. However, the data still yields a significant positive correlation, which is certainly worth noting. Also, while the positive correlation exists, the data points are extremely spread out, and while the fitted line shows the correlation, the data points themselves do not show a strong particular pattern, meaning the multiplication drill is not as strong a predictor for the TABE Applied Math as it is for the TABE Computation.

Essentially, the performance on the multiplication drill is as strong a predictor for the Overall GLE as it is for the Computation GLE. This is interesting to note as the Overall GLE is computed by averaging the performance on each separate part of the test. So, while the drill score was not an extremely effective predictor of TABE Applied Math performance, it seems to offer a much stronger prediction of overall performance on the TABE. A correlation value for the Overall TABE was expected to be in between those for the Computation and Applied Math sections, respectively. This certainly raises the question as to why the correlations for the Computation and Overall GLE were so close to each other, a question to which this author does not have an answer.

Result 2: A significant positive correlation (r = .579) exists between the overall self-efficacy survey scores and the Overall TABE GLE scores.

When analyzed, the overall self-efficacy rating compared to the overall TABE GLE produced significant positive correlation with a correlation value of 0.579. This result caused the hypothesis regarding TABE scores and self-efficacy to be rejected. While this author hypothesized there would be no significant correlation between the two, the correlation analysis performed using data collected from the self-efficacy survey and the TABE proved this notion to be false. A regression plot of this data can be seen in Figure 14 on the following page.

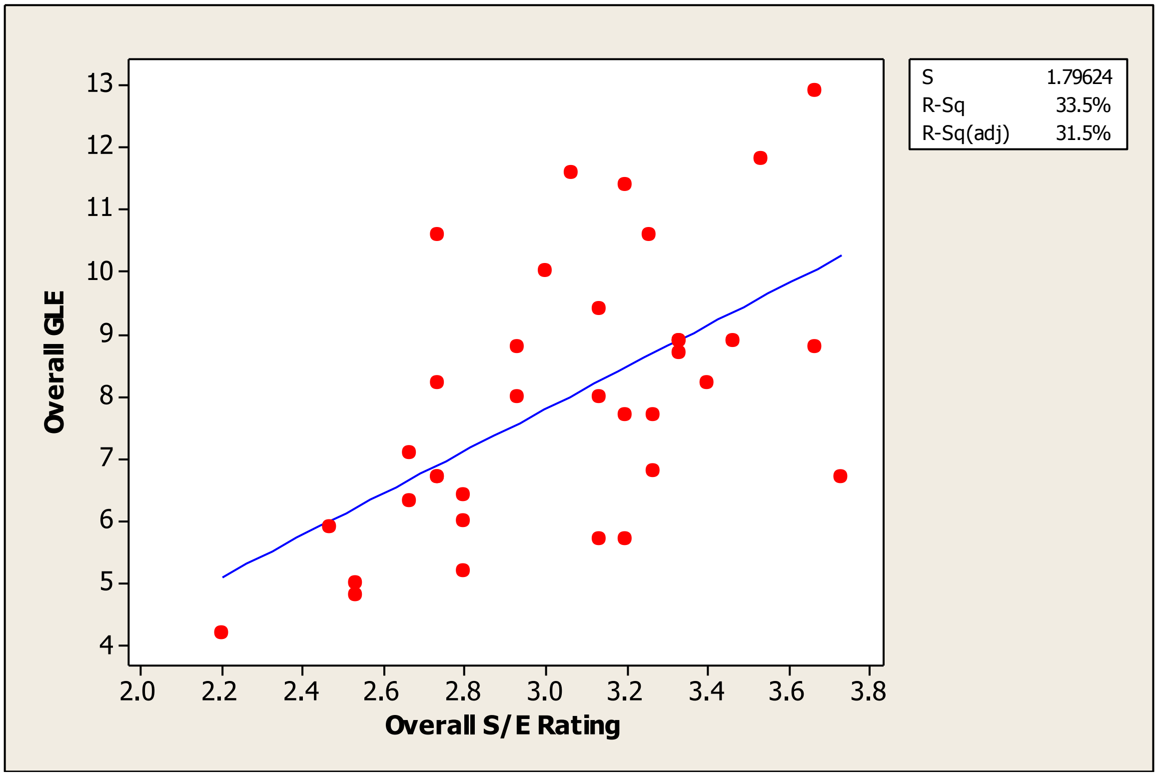

Figure 14. Regression of overall self-efficacy rating versus Overall GLE score.

This result was somewhat surprising to this author, because, as mentioned previously, many students can say they are confident in their mathematical abilities but fail to succeed on the TABE. This matter will be further discussed in the upcoming section discussing the implications that resulted from this experiment.

As explained in the experimental design section, the self-efficacy survey was evaluated as a whole, but it was also separated into two parts, similar to the TABE. Analysis of the computational self-efficacy ratings and the TABE Computation GLE scores revealed a significantly positive correlation value of .542 between the two instruments. Analysis of the applied math self-efficacy ratings and the TABE Applied Math GLE scores showed a positive correlation existed between those two instruments as well, having a correlation of .352. Regression plots for each respective pair of instruments can be seen in Figure 15 and Figure 16, which can be found on the following page.

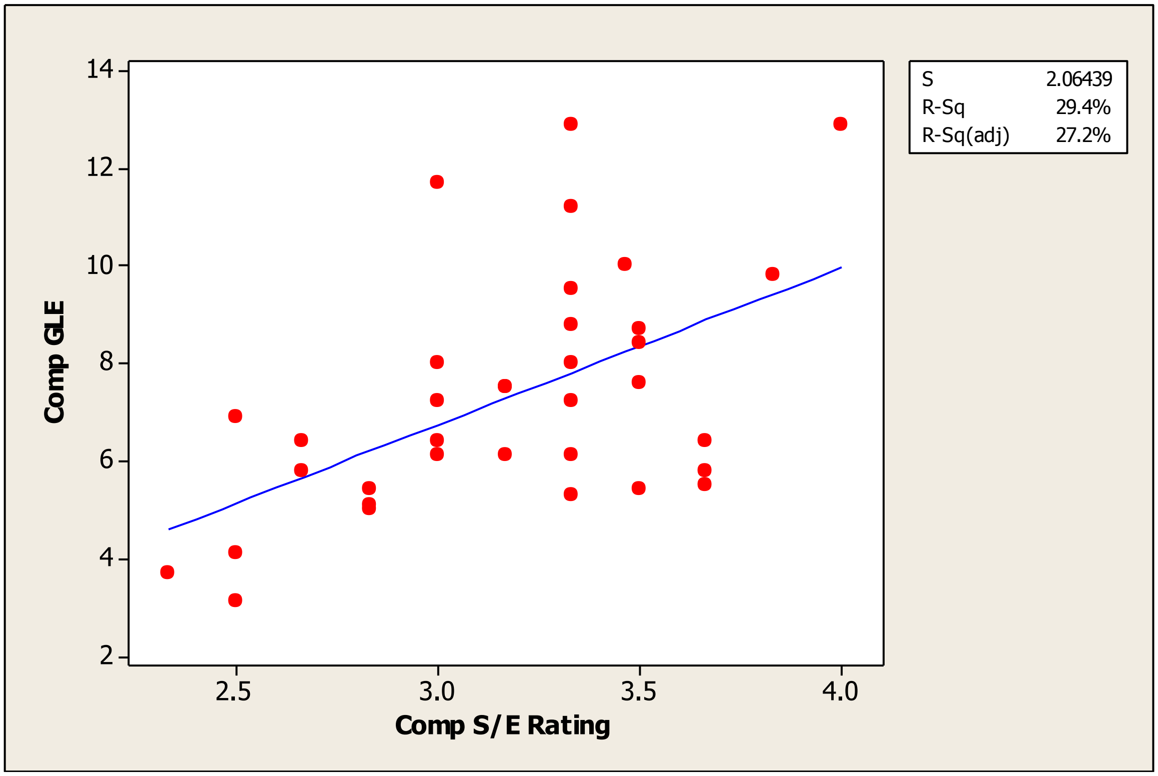

Figure 15. Regression plot of computational self-efficacy rating versus Computation GLE score.

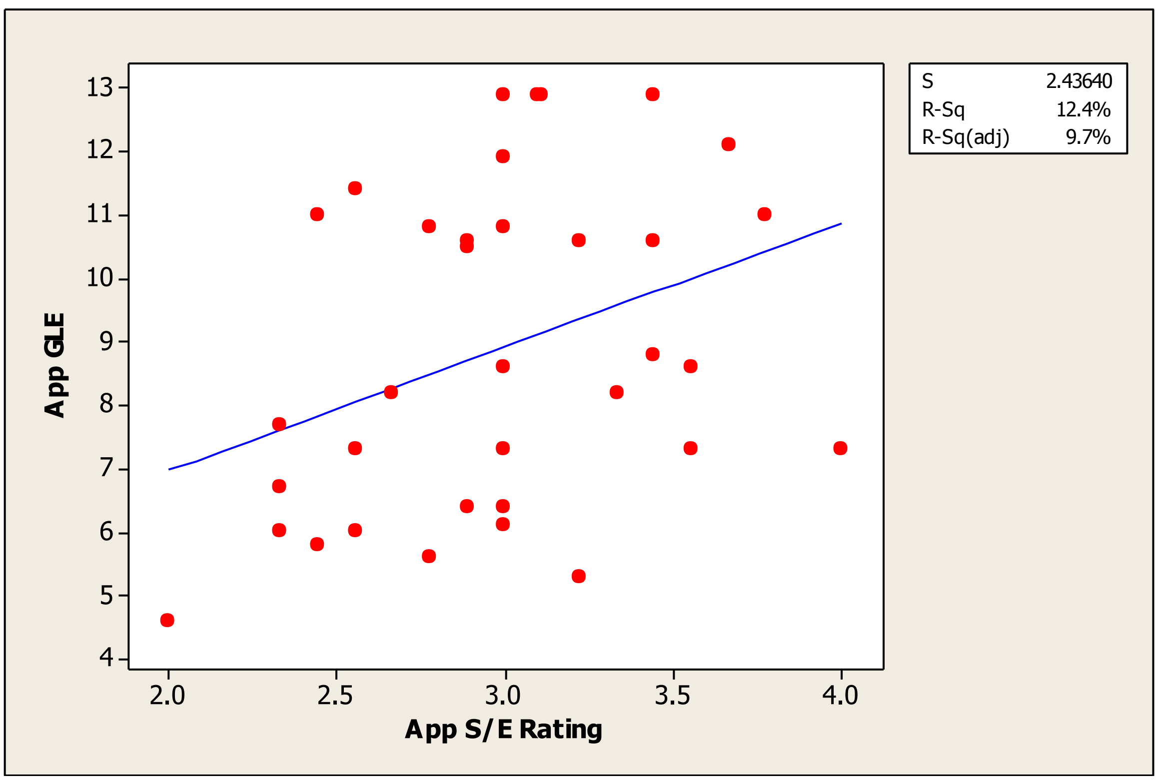

Figure 16. Regression plot of applied self-efficacy rating versus Applied Math GLE.

While each value shows a positive correlation exists for each part of the TABE and its corresponding self-efficacy rating, it is easy to see from the values that the computation instruments had a stronger positive correlation than their applied math counterparts. Also, while the correlation value for the applied math section of the TABE and the self-efficacy survey do show a positive correlation, it should be noted that this value was lower than that of the computation sections. Also, among all of the correlations from this study, this data yielded a p-value of 0.038; this is the only p-value higher than 0.003 produced by the six correlations. One possible reason for this difference can be found on the self-efficacy survey administered to the students. Topics from the computation section, such as operations with fractions and decimals, are much less complex, and more procedural, requiring lower-level thinking skills than topics from the applied math section, such as geometry and algebra. The applied topics can cover a much wider array of questions on the TABE than those of the computation section. Because of this wider variety of questions, students may have believed they were strong in a topic such as algebra because they did not have a clear picture of the types of applied algebra questions they would be required to solve. Despite the brief description of each topic on the survey, “multiplying and dividing whole numbers” is a much more concise topic than algebra.

Instruments	**Correlation Value**
Multiplication Drill Score vs. Overall TABE GLE Score	0.580
Multiplication Drill Score vs. TABE Computation GLE Score	0.581
Multiplication Drill Score vs. TABE Applied Math GLE Score	0.400
Overall Self-Efficacy Rating vs. Overall TABE GLE Score	0.579
Computational Self-Efficacy Rating vs. TABE Computation GLE Score	0.542
Applied Self-Efficacy Rating vs. TABE Applied Math GLE Score	0.352

Figure 17. A Summary of the Existing Correlations between Student-Completed Instruments

Result 3: The correlation between multiplication drill scores and TABE GLE scores was significantly higher for older students (r = .705) than younger students (r = .311).

Following the data collection and the calculation of the initial results, the data was further analyzed to find if age could be a factor in the results of the experiment. The data collected was separated by student age, with the data from students aged 18 and 19 in one group, and the data collected from students ages 20 and older in the other. The decision to separate the data at the student age of 20 was made in order to keep the size of each sample relatively similar. For these groups, a correlational analysis was performed between the multiplication drill scores and Overall TABE GLE scores from each respective group. The analysis showed that the correlation coefficient was significantly higher for the older students (r = .705) than the younger students (r = .311).

Result 4: The correlation between self-efficacy and TABE results was significantly stronger for male students (r = .745) as opposed to female students (r = .354).

Student data was also separated by gender. Analysis of each respective group of students revealed that the correlation coefficient between the self-efficacy of male students and their TABE results (r = .745) was significantly higher than that of their female counterpart (r = .354). While the data from both groups shows a significant correlation exists for each, the correlation found within data from the male group is considerably higher.

While reasons for these last two results are unclear, they do suggest some meaningful implications for future research, which will be discussed in the following section.

Implications for Teaching

The hypothesis for this study was that automaticity pertaining to basic multiplication facts would have a positive correlation with TABE scores, while a student's self-efficacy would have no correlation with his or her TABE performance. During the course of the study, scores from the multiplication drill, self-efficacy surveys, and TABE were collected and analyzed to determine the nature of any existing correlations. After analysis, the evidence failed to reject the first part of the hypothesis, while the second part of the hypothesis was to be rejected. The results of the correlation analysis had certain implications in my classroom; those implications will be discussed in this section, along with the modifications to the design of this experiment that may affect its outcome if it were repeated. Suggestions for how the results of this experiment may lead to further research are also offered.

Classroom Implications

As a result of this experiment, there are some clear implications for classroom instruction.

- ***A continuous review and/or assessment of basic mathematics facts is important at any level.***

Often, as students progress through the education system, they start becoming more and more dependent on the use of a calculator to solve problems. While calculators, especially the high functioning models, are wonderful tools, it is important that they do not become a crutch when only basic computation is needed. While this researcher will always promote higher education and attempt to inspire my students to reach more deeply into mathematics, the abilities to solve basic mathematics computation and application problems are the most relevant life skills with which we can equip young students. By not continually focusing on the importance of these basic skills, it seems that we are only handicapping our students as a calculator might not always be readily available when computation is necessary.

- ***Aside from memorization, the concepts behind basic facts should be taught.***

Clearly, it is not always possible for a student to memorize basic facts such as the multiplication tables; however, it should be relatively simple for a student to remember, in this particular case, that multiplication is merely the repeated addition of a single number, and that adding is merely counting; for instance, $4 \times 5 = 5 + 5 + 5 + 5$ or $4 + 4 + 4 + 4 + 4$. Memorizing this one concept is seemingly much easier than memorizing over 50 answers to varying multiplication questions. If the student can learn this one basic concept, then he or she has at least been equipped with the tools to find the answer, which is a much better alternative than to have him or her be and feel helpless. Many of these basic concepts are essential to understanding ideas presented in higher level mathematics courses, from middle school all the way through college. While this study may have shown that automaticity with basic multiplication yields a high success rate on a standardized assessment, teaching and reinforcing these concepts could allow students incapable of rote memorization to succeed at a higher rate as well.

- ***Efforts to make students comfortable with being honest about their mathematics abilities and shortcomings should be a priority.***

The results of this study indicate a significant positive correlation between self-efficacy and TABE performance. This would suggest that a student's perceptions regarding confidence in mathematics could be a relevant piece of information when predicting comprehension and his or her performance. The problem lies in the teacher's ability to obtain that information from the student. Simply asking a student will not always yield a truthful response; a student may not feel comfortable being honest for fear of embarrassment. One simple solution to this could be administering a private survey, like the survey that was administered as part of this study. From what this author could tell, the responses on the survey seemed to be much more accurate than the responses obtained from publicly asking the students to rate their own abilities. In order to obtain a student's true feelings, the student must feel comfortable responding honestly to such questions, thus, the teacher must create a setting in which this can happen. Furthermore, it is in environments such as these in which student participation and engagement will be maximized.

Suggestions for Future Research

One change that should certainly be implemented if this study were to be conducted again in the future would be an adjustment of the scoring rubric for the multiplication drill; in this researcher's opinion, one minute intervals are not specific enough. The rubric should be adjusted so that the intervals are every 30 seconds, possibly even shorter than that. This would create a more accurate plot and possibly change the associated correlation values.

Future studies may further examine the positive correlation between scores from the multiplication drill and the GLE from the Applied Math section of the TABE. It was mildly surprising that such a correlation existed between the two, so maybe a study regarding the students' history of mathematics performance or opinions of mathematics classes could reveal some telling information as to why such a correlation was found. Also, further studies may explore if students really understand concepts such as multiplication, regardless of whether or not they know the times tables.

One issue that could be examined in future studies is the differences between the correlation coefficients referred to in results 3 and 4. This study only answered an initial question; there are questions that could be answered as to why the existing differences are present between the groups identified. Why would age make a difference? Why would gender make a difference? These are two questions to be examined in the future.

Concluding Remarks

The results of this experiment showed that, generally speaking, TABE achievement had a positive correlation with self-efficacy and basic multiplication automaticity, respectively. While the positive correlations exist, it is clear to see from the regression plots that the data points are very spread out. This simply means that the correlations are not perfect, and that the correlation is different from student to student. This is similar to many aspects of learning and education; students differ from one to another. As many teachers have experienced, one classroom full of students leads to variety and many challenges. For example, rote memorization of all single digit multiplication facts is impossible for some students; this is why adequate time should be spent on explaining the concept of multiplication rather than memorizing a system of associated numbers.

As for self-efficacy, it is easy to understand why higher self-efficacy would lead to better performance. The difficulty lies in obtaining the true measure of a student's self-efficacy and how to encourage students to be honest. Finding the best way to do so may be something that deserves further research. Encouraging this open communication will help students and teachers alike to succeed and help maximize student learning and achievement.

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Appendix A

Consent Form

- You are being asked to participate in a research project.

- The purpose of this project is to determine if your knowledge of the times tables and/or your self-confidence have any relationship to your TABE results.

- To participate, you must do two things:
    - Complete a timed multiplication speed drill. This drill will consist of 50 questions on your multiplication tables using the numbers 0 through 10.
    - Complete a short survey in which you rate your own confidence in varying math subjects

- By signing this consent form, you are allowing Mr. Jagoda to use your drill results, survey answers, and TABE scores in this study. <u>If you do not sign, you will still be required to complete all three of these items.</u>

- This project will take place during the months of February and March 2012.

- Your TABE scores, results from the multiplication drill, and the answers from your surveys will be the focus of this project.

- Your name will only be used to link the three completed items. The results of the study will not identify you personally.

- Once you have completed the three items listed, your participation in the study will end.

- If you choose to withdraw at any point, your multiplication drill and survey will be destroyed.

- Possible benefits of your participation are better and more efficient teaching methods in your classrooms.

- There is no risk to you at all. However, if there is a problem you would like to discuss with someone other than Mr. Jagoda, the Academic Manager and Career Development Director are aware of the study and will be available to you.

- Please remember that this study is an attempt to make learning easier and improve your performance.

- There is <u>no penalty</u> for not participating in the study.

Appendix A (continued)

- You will not be paid or given rewards for participation.

If you have any questions, feel free to ask.

Student Consent Form

Thank you for being a part of this study. Please print and sign your name in the space provided to show that you agree to participate. Remember that signing the form allows Mr. Jagoda to use your data for the research project. All students must complete the items mentioned whether or not they sign this form.

Voluntary Consent: I have read this memo and I am fully aware of all that this study involves. My signature below shows that I freely agree to participate in this study. I understand that there will be no penalty for not participating. I understand that I may withdraw from the study at any time, also without penalty. I understand that my name and any other personal information will be kept out of the results of the study. I understand that if I have any questions about this study, I may contact Mr. Jagoda at extension 1204222 or jagoda.joe@jobcorps.org, or any of the contacts listed at the bottom of this form.

Please return this original, completed consent form as soon as possible. Thank you for your cooperation.

Student Name (please print):____

Student Signature:____

Date:_______________

Appendix B

Self-Efficacy Survey

Name________________________ Student ID________________________

Date ___/___/___ **Level D**

Please read the through the following math topics and their descriptions, and then rate your confidence in them, with "4" being the highest rating, and "1" being the lowest rating.

Please answer honestly. Your responses will be kept confidential.

Topic	Extremely Confident	Confident	Not Very Confident	Not At All Confident
Multiplying Whole Numbers	4	3	2	1
Dividing Whole Numbers	4	3	2	1
Decimals (+, −, ×, ÷)	4	3	2	1
Fractions (+, −, ×, ÷)	4	3	2	1
Integers (positive and negative numbers)	4	3	2	1
Percents	4	3	2	1
Computation in Context – finding answers to real-life problems using addition, subtraction, multiplication and division	4	3	2	1
Number and Number Operations – compare and order numbers, finding fractional parts, finding ratios, and changing forms between fractions, decimals, and percents	4	3	2	1
Estimation – rounding to find an approximate answer instead of an exact answer	4	3	2	1
Algebra – patterns, functions, finding unknown values, solving for a missing number or variable	4	3	2	1
Geometry – symmetry, circles, points, parallel and perpendicular lines, angles, shapes, and 3-D figures	4	3	2	1
Measurement – time, perimeter, area, finding rates, converting units of measurement, finding angle measures	4	3	2	1
Data Analysis – bar, line, and circle graphs, tables, charts, and drawing conclusions from data	4	3	2	1
Statistics and Probability – mean, median, mode, range, and finding probability	4	3	2	1
Problem Solving – solve problems, identify extra or missing information, evaluate and justify solutions	4	3	2	1

Appendix C

Sample Multiplication Drill

Name:_________________________ ID:_________________________

2 x 3 =	5 x 4 =	6 x 6 =
8 x 4 =	4 x 10 =	7 x 4 =
2 x 8 =	3 x 1 =	8 x 3 =
4 x 4 =	2 x 2 =	2 x 6 =
3 x 6 =	8 x 6 =	9 x 9 =
6 x 10 =	8 x 11 =	4 x 7 =
2 x 7 =	5 x 8 =	9 x 4 =
1 x 8 =	2 x 9 =	1 x 7 =
10 x 9 =	3 x 7 =	4 x 3 =
1 x 10 =	8 x 7 =	3 x 6 =
5 x 2 =	4 x 9 =	2 x 10 =
5 x 4 =	10 x 3 =	7 x 9 =
7 x 2 =	3 x 9 =	3 x 3 =
6 x 4 =	3 x 4 =	2 x 10 =
3 x 8 =	9 x 1 =	4 x 8 =
1 x 1 =	8 x 2 =	

Appendix D

Multiplication Dill Grading Rubric

	t = time in minutes						
		$t \leq 1$	$1 < t \leq 2$	$2 < t \leq 3$	$3 < t \leq 4$	$4 < t \leq 5$	$t > 5$
Questions answered correctly	**50**	10	9	8	7	6	5
	49	9	8	7	6	5	4
	48	8	7	6	5	4	3
	47	7	6	5	4	3	2
	46	6	5	4	3	2	1
	45	5	4	3	2	1	0
	44	4	3	2	1	0	0
	43	3	2	1	0	0	0