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Retaking Summative Assessments at the High School Level

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DEDICATION

This thesis is dedicated to my husband Adrian who has always supported and loved me. He has motivated me to complete my thesis and to always do my best.

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ABSTRACT

In 2010, under President Obama, A Blueprint for Reform: The Reauthorization of the Elementary and Secondary Education Act was written to reform the No Child Left Behind Act that was signed into law in 2002 by President George W. Bush. The new goal under the reform was that by 2020 all students will graduate from high school and be college and career ready. With a growing emphasis on all students being successful in the classroom, educators had to explore different methods to implement in the classroom to help all students learn the state standards. Allowing summative assessment retakes was one of the methods that many teachers chose to implement in order to help students succeed in the classroom. The purpose of this study was to determine whether an association exists between whether a student completes summative assessment retakes and retention of content material in high school mathematics classes.

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CHAPTER I

INTRODUCTION

Teachers, administrators, and leaders around the United States have a common goal: to improve education. In 2002, the No Child Left Behind (NCLB) Act was signed into law by President George W. Bush in order to improve the education system. The goal of the NCLB Act was to have all students reach proficiency on standardized state tests by 2014. Another goal was to close achievement gaps between different ethnic and socio-economic groups as well as to improve the performance of students with disabilities and language barriers (Barnes & Thompson, 2007).

In 2007, the Commission on No Child Left Behind was formed to examine the results of the NCLB Act; the commission determined what aspects of the Act were effective and what needed to be improved to ensure that every child benefited from the Act. The article “Beyond NCLB: Fulfilling the Promise to Our Nation’s Children,” written by Secretary Tommy G. Thompson and Governor Roy E. Barnes, discussed the mission of the Commission and the decisions that were reached during the meetings. The members determined that while the NCLB Act was necessary and beneficial for improving education, the Act required revisions. The NCLB Act required students to be tested in both reading and mathematics in grades 3 through 8 and once in high school. According to the Act, test scores had to be broken down based on different demographic groups, and adequate yearly progress had to be shown on the state-mandated tests. The Act also required that teachers be highly qualified (Barnes & Thompson, 2007). To be considered a highly qualified teacher, teachers had to be fully certified, hold a bachelor's degree, and be knowledgeable of the subject being taught (U.S. Department of Education, 2003).

The NCLB Act had some positive effects of improving public schools and closing achievement gaps. However, the Act was not enough. According to Thompson and Barnes (2007), "far too many children are still not achieving to high standards in every state, and we are not yet making improvements in struggling schools as effectively or as rapidly as we had hoped" (p. 9). While test results in 2005 showed achievement gaps were closing due to the NCLB Act, more changes needed to be implemented in order for all students to reach proficiency in both reading and mathematics (Barnes & Thompson, 2007, p.16).

Seven years after President George W. Bush signed the No Child Left Behind Act into law, Barack Obama was inaugurated as the 44th president in January of 2009. Seven months later, the President and the Secretary of Education, Arne Duncan, announced the beginning of the Race to the Top fund. Grants from the fund were to be issued to states that enforced rigorous standards and assessments, placed outstanding teachers in the classroom, and turned around schools that were failing (*Remarks by the President on Education*, 2009). In 2010 under President Obama, "A Blueprint for Reform: The Reauthorization of the Elementary and Secondary Education Act" was written to reform the NCLB Act. The new goal under the reform was that by 2020 all students will graduate from high school and be college and career ready (U.S. Department of Education, 2010). Raymond Simon, Deputy Secretary of Education, stated, "We simply cannot afford to ignore the more than 1 million students who currently drop out of high school each year and the millions more who graduate without the skills needed to obtain good jobs or pursue postsecondary education" (as cited in Barnes & Thompson, 2007, p. 12). In order to address the concern Simon had about students dropping out of high school and not being prepared for life after high school, changes had to take place.

Obama's reform requires changes to the NCLB Act. One of the goals under the NCLB Act is that all students will reach proficiency on standardized state tests by 2014 (Barnes & Thompson, 2007). President Obama's goal is to have 100% of students college and career ready upon graduating from high school. In order to make sure students are learning all content, new state assessments must be created that align with college and career ready standards (U.S. Department of Education, 2010).

According to the NCLB Act, by 2005 all teachers must be highly qualified and effective. Highly qualified teachers possess state certification or licensure, have a bachelor's degree, and demonstrate knowledge of the subject being taught (Barnes & Thompson, 2007). Teachers are evaluated based on student growth on standardized tests (U.S. Department of Education, 2010).

In the 19th century and early 20th century, approximately half of all children between the ages of 6 and 16 were educated in a one-room school house (Gladish, n.d.). By 1918, every state had compulsory attendance laws that mandated the age range during which all children were required to attend school, and it was not until the early to mid-twentieth century that most one-room school houses were abandoned (HSLDA, 2013). While all children were required to attend school after 1918, Bloom (1968) stated the following:

> Each teacher begins a new term (or course) with the expectation that about a third of his students will adequately learn what he has to teach. He expects about a third of his students will fail or to just "get by." Finally, he expects another third to learn a good deal of what he has to teach but not enough to be regarded as "good students." (p.1)

Since 1968, teachers' expectations have been forced to change. In today's classrooms, elementary, middle, and high school teachers are expected to teach every student, and all students are expected to succeed in school and be college and career ready upon graduating from high school.

Today, teachers are expected to use technology, manipulatives, and a variety of interventions in order to have all students proficient according to the state standards. In order for students to be considered proficient in mathematics, the students must have conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive dispositions (Judson, 2007). Teachers are continuously looking for new methods to incorporate into the classroom in order to ensure that all students are proficient, are challenged, and are college and career ready upon graduating from high school. Since teachers are being evaluated based on student progress, many teachers are allowing students to retake summative assessments. Students retake summative assessments for a variety of reasons; some students need to retake tests in order to improve a grade, to please a parent or guardian, or to gain a greater understanding of the content that was covered on the original test. Educators want students to improve test scores, but even more importantly, educators want to have students learn the material in the state standards and retain the content knowledge.

Since teachers are being held responsible for student achievement on standardized state tests, teachers need to find ways to help all students. Every student needs to be given the opportunity to learn the material in the state standards, even if some students need more time than what is allotted for a given unit. When students are allowed to retake summative assessments, students who do not learn the content at the same pace as the other students are given a second chance to learn the material.

There can be many reasons why a student might need to improve a test grade. A student who found the content difficult might have to take the test a second time because the pace of the class was too fast and the student needed more time to learn the content. Another student might know the content but not perform well on the test due to personal reasons. Some students might abuse the retake option by not studying for the test the first time in order to see the types of questions on the test. Other students choose not to use the retake option either because the first attempt grade was satisfactory or because the student simply does not want to take the time to retake the test.

The strategy of offering retakes on summative assessments in order for students to learn the state standards is controversial. Some teachers and administrators argue that retakes do not help students prepare for the real world. However, this concept is applicable to multiple situations. Often workplace environments utilize corrective action plans for employees who are not doing a job correctly, many credit cards offer one no hassle late payment, and many professional tests such as the MCAT exam may be taken multiple times.

CHAPTER II

LITERATURE REVIEW

Teachers across the United States create bell ringers, homework assignments, quizzes, and tests to assess which state standards students have mastered and which standards students still need to learn. Bell ringers, homework, and quizzes are typically used to help teachers determine which standards students need to keep practicing, and lessons are adapted to help meet the needs of the students. Tests are typically used to determine what the students know or do not know at the end of the unit or series of lessons. However, sometimes students do not perform well on tests due to test anxiety, problems at home, lack of studying, or because the students have not absorbed all of the content material. Having students master the course standards should be a goal for all teachers, and when students have not mastered the content on the test, teachers need to figure out ways to allow the students the opportunity to continue learning old material.

There are several advantages to implementing retakes; these include reducing test anxiety, clarifying standards, and assisting with guiding students to review the material. Having students master the material on a test is critical when the course builds on previously covered content (Friedman, 1987). When retakes are not offered, students tend to learn the standards for the test but then forget the material soon after taking the exam (Cates, 1982). Friedman (1987) stated:

> Upon receiving a poor examination grade, the mythical ideal student rushes to the privacy of a dorm room to use the exam as a basis for concentrated review and

study. In contrast, the typical student finds that a low grade makes the exam material repellent and that the final examination is too distant a threat to lead to current studying. (p. 20)

While high school students cannot rush to a dorm room, high school students who do not see rewards for mastering content that has already been tested often do not try to learn the material. As Figure 1 shows, both students who originally have mastered the standards and those who have not need to review the material over and over again in order to be able to retain what has been taught (Gentile & Lalley, 2009, p. 30).

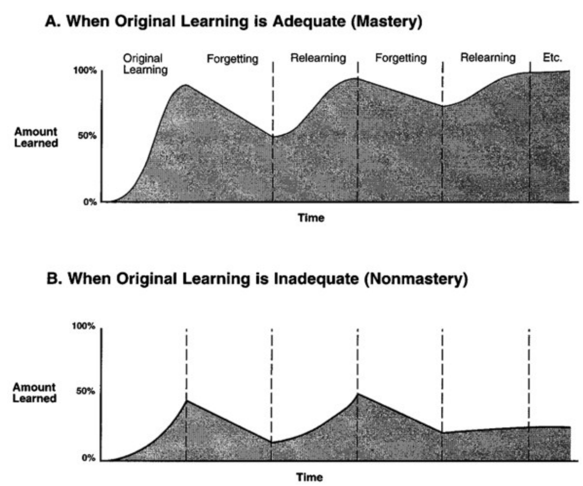

Figure 1: Mastery Versus Nonmastery

Source(s): Gentile, J., & Lalley, J. P. (2009). Classroom assessment and grading to assure mastery. *Theory into Practice*, *48*(1), 28-35. doi:10.1080/00405840802577577

Retention of content knowledge is very important due to the growing importance of cumulative state exams, so students need to be able to retain what they learn. In order for students to retain the material, students must continue to learn material that has been previously taught and misconceptions must be addressed. With many standards being prerequisites for other standards, students must be given the chance to master the content before moving on to new material. When teachers offer retakes, students who choose to retake the test continue to see the material over and over again. This practice may help students retain the information over a period of time and learn prerequisite standards.

Students in many fields depend on retakes in order to learn how to perform procedures correctly. In school, surgeons use cadavers multiple times before performing surgery on humans, and architecture students edit blueprints over and over until the building is up to code. People also have the opportunity to retake exams such as the SAT, MCAT, and Driver's licensure (Wormeli, 2011). When teachers offer retakes to students who will one day be professionals, improved test scores reward the students' efforts to continue to gain a better understanding of the material (Brogan, From, Juhler & Rech, 1998). In the end, grades should represent what the students have learned in the course; the route the students have taken to learn the material should not matter. As Rick Wormeli (2011), a 30-year teaching veteran, states:

> The goal is that all students learn the content, not just the ones who can learn on the uniform time line. Curriculum goals don't require that every individual reaches the same level of proficiency on the same day, only that every student achieves the goal. (p. 23)

Retaining core material as dictated by state standards should be the primary focus of the educator. Teachers need to realize that everyone makes mistakes and learns at a different pace. If students are not given the opportunity to try a second time, the students are less likely to learn the material.

Offering retakes on summative assessments is a controversial topic in education. While teachers want students to succeed and master the content, not all teachers are in agreement about whether retakes are beneficial to students. Many studies have been conducted at the post-secondary level. However, few have been done at the secondary level to analyze the effectiveness of teachers offering retakes on summative assessments. Researchers have analyzed how different retake policies affect student success.

During the years of 1978-1980, Ward Cates (1982), a professor of Pittsburg State University, designed a study to test the hypothesis that offering fewer retakes than the original number of tests offered in a course could "produce significant gains in mean highest test/retest scores" (p. 200). The study consisted of 142 students in five different sections, four of which had five tests and one of which had four tests due to scheduling constraints. Of the four sections that had five tests during the course, one section of the class was allowed to retake two tests, two sections were allowed to retake three tests, and one section was allowed to retake four tests. Students in the section that only had four tests were allowed to retake two tests. During the class period following the original test, the professor returned the test and discussed how to arrive at the correct answer for each question before recollecting the original test. Students could then choose to retake the test once during any of the pre-scheduled retake days outlined in the syllabus during the semester. The retakes were equivalent in difficulty to the original test but were not identical, and the higher of the two test scores was recorded (Cates, 1984).

Of the 142 students in the five sections of the class, 109 of the students in Cates's study took advantage of the retakes for a total of 220 retakes being given, 18 of which were students taking the test for the first time due to being absent on the original test day.

Of the 202 tests that students took to improve test grades, 139 retakes were better grades than the original test. On average, students increased test scores from 1.2 percentage points to 6.3 percentage points. While students' test scores improved, only 47% of those students who retook any tests saw improved course grades. Of the 33 students who opted not to retake any test, 91.8% received an A or B in the class (Cates, 1982). Cates (1982) determined from the study the following:

> Any program of retesting could benefit a course section as a whole in proportion to the individual talents of the students therein. The further findings that all sections made significant gains in mean test performance as a result of retesting suggests that retesting is an effective way to increase student mastery of the material. (p. 236)

Retakes did not guarantee that the students received higher end-of-course grades. However, the students were forced to learn and retain the old information since many students took the test two to four weeks after the original test day (Cates, 1982). Professor Cates found that students complained less about grades and tests throughout the course when retakes were offered. On the end of the year evaluation when students were asked to rate the use of retakes, 88% of the students marked "good" or "excellent" (Cates, 1984).

While the study found that retakes helped students, offering retakes required the teacher to spend more time writing retakes that were equivalent in difficulty to the original test. Also, more time was spent grading tests and instructional time was lost due to retakes being offered during class time. Cates wrote four pieces of advice for teachers wanting to implement retakes. The first piece of advice Cates offered was based on research by Elrink in 1973: do not allow students to retake every test; doing so reduces student achievement. Second, match the difficulty of the original and retake. Third, collect the original test after reviewing the answers in order to save time in future years. Finally, always go over the problems on the original test with the class so that misunderstandings can be corrected (as cited in Cates, 1984).

In a study at the University of South Carolina, three professors offered retakes to students in the hopes of reducing students' test anxiety, helping students show what standards have been mastered, and guiding students to relearn material that had already been taught (Boyd, Davidson & House, 1984). Boyd, Davidson, and House wanted to reduce student anxiety by offering retakes but wanted students to study for the initial test. In order to encourage students to study for the original test, the researchers calculated students' exam grades by counting the lower of the two test scores, the initial test or the retake, for 25% of the grade and the higher test grade as 75% of the grade (Boyd, Davidson & House, 1984).

In Boyd, Davidson, and House's study, 254 students took two tests and one final exam. Both tests had a retest a week following the original test, but the final exam had no retake option. Students had the choice of whether or not to retake the tests; on the first exam 60% of the students opted to retake the exam, and 43% of the students chose to retake the second exam. Of the students who retook exam one, 54% of the students' grades went up, 34% stayed the same, and 12% went down. On the retake for exam two, 49% of the students' grades went up, 36% stayed the same, and 15% went down (Boyd, Davidson & House, 1984). At the end of the semester the students completed a seven-question yes/no evaluation. The results of the evaluation showed that 80% of the students reported being less anxious about tests due to the retake policy. Eighty-five percent of the students who retook at least one test and 92% of those students who never retook a test said the retake policy did not influence the students to study less on the initial test. Since there was a risk factor of the lower test grade counting for 25% of the exam grade, students were given an incentive to study for the initial test and the retake helped alleviate some students' test anxiety (Boyd, Davidson & House, 1984).

Herbert Friedman completed a study in 1987 that had two objectives: to determine whether allowing students the opportunity to retake exams would improve learning and to determine whether the students would find retakes favorable. To begin the study, on the first day of class, 177 students in three statistics classes were presented with six testing procedures. All three exams for the semester, excluding the final, were open notes/textbook/workbook. During the lecture following the exam, all problems were worked, and during the class following the review session students had the option to retake the test. The retake exam scores and original scores were averaged together, but only if the retake grade was higher than the original test grade; otherwise the retake did not count. The retake and the original exam were similar; both exams had multiple-choice sections that were almost exactly the same but the multiple-choice questions on the retake were closed book. The non-multiple-choice problems were still open notes but new values were used in the problems. Students were also informed that the final exam at the end of the course, which was worth half of the course grade, did not have a retake option but students could reference their notes during the exam. Since retakes were not offered on the final, the students needed to know the material by the end of the course but were allowed to struggle along the way and retake exams (Friedman, 1987).

At the end of the semester, Friedman analyzed 109 of the 177 students who completed the course and responded to a questionnaire. Friedman found that 28 students earned a final course grade of an A, 51 earned a B, 28 earned a C, and 2 earned a D or F. The mean number of retakes students took, with three being the maximum, during the course was 1.42, 2.12, 2.42, 2.00, and 2.02 for students who ended up with an A, B, C, D and F, respectively. Of the students who earned an A in the course, 82% retook at least one exam and 96% of B students, 100% of C students, and 100% of D and F students retook at least one exam. The study also analyzed the 35 students who earned a B on at least two of the exams to determine whether a possible relationship exists between the number of retakes taken and the final exam score. The results showed that of the 16 students who retook zero or one exam, the students had a mean score of 85.31% on exam grades and a final exam mean of an 86.06%, a difference of 0.75 percentage points. Nineteen of the students who earned B's on at least two of the exams retook either two or three exams. The mean exam score was 85.26% and the mean final exam grade was an 89.32% with a difference of 4.06 percentage points (Friedman, 1987).

Friedman's study also involved a yes/no student questionnaire that asked the students five questions, one of which had eight parts. Questionnaire results indicated that 82% of the students in the class felt as if the retake policy led to a decrease in test anxiety for the course, 78% did not feel as if the retake policy led to less studying taking place for the initial exam, 100% of the students recommended that retakes continue in future courses, and 100% of the students found that the original exam was a helpful study guide for the repeat exam. Even though the study did not determine whether retakes led directly to higher end of course exam grades, retakes did offer motivated students support in mastering the content standards (Friedman, 1987).

The instructors in Friedman's study found many advantages to offering retakes. For example, no longer did lagging students need to be pushed as much as in previous years due to the retake policy. Weaker students who often did not even realize that conceptual understandings were missing until receiving the test back were able to study the test and get a better understanding of the material. Offering retakes did not require the instructors to reorganize the whole course, and little effort had to go into implementing the retake policy. On the down side, the instructors felt as if valuable lecture time was taken away due to retakes being offered during the class period (Friedman, 1987).

The three studies conducted by Cates, Friedman, and Davidson, House, and Boyd found retakes to be successful and explored different aspects that made the retakes successful. Cates found that even though retakes did not guarantee a higher cumulative grade at the end of the course, the retake motivated students to learn the course material. Davidson, House and Boyd found that approximately half of the students who took advantage of the retakes improved test grades, and Friedman found that retakes motivated students and were favored by the students. All three studies involved different retake policies concerning grades. In Cates's study the higher of the original test and retake was recorded. In Davidson, House, and Boyd's study the lower of the two grades counted as 25% of the cumulative test grade while the higher grade counted for 75% of the grade. Friedman averaged the two test scores together if the retake was higher than the original test; otherwise the original test grade was recorded.

Other studies have also supported the results of these three studies, indicating that retakes benefit students. Covington and Omelich (1984) carried out a study that found that retesting increased student performance, which in turn led to student motivation and learning gains. Results from Smith's (1987) study showed that students who were offered retakes in both traditional lecture classes and Socratic style classes scored higher on final exams than those students who were not allowed to retake exams during the semester. In the traditional lecture classes, the mean final exam grade in classes that offered retakes and did not offer retakes differed by 14.3 percentage points In the class that offered no retakes, the final exam mean was 66%, but in the class that offered retakes the mean grade on the final exam was 80.3%. In the Socratic style classes, the mean final exam grade was 78.1% for those students who were not allowed to retake tests during the semester and an 84.8% for those students who were given the opportunity to retake semester tests (Smith, 1987). In 1998, a study was published in the *Journal of Experimental Education* that analyzed the proximate and distal effects of offering students optional retakes on academic achievement. Students who scored below a B on the test were given the opportunity to retake the test with the highest obtainable grade on the retake being a B. The retake and original test were considered equal in difficulty, and the retake score was recorded regardless of whether or not the score was higher or lower than the initial test (Brogan, From, Juhler & Rech, 1998). The results of the study showed that approximately 90% of students who retook an exam had an improved test grade but that retakes did not lead to improved final exam scores (Brogan, From, Juhler & Rech, 1998).

While many studies have concluded that retakes help those students who take advantage of the policy, not all studies have found that implementing a retake was worth the effort. At Northwestern State College in 1973, students in Psychology of Learning were allowed to retake each exam a maximum of three times with the last test being the score that was recorded. Only 27% of the students utilized the retake policy, and of those students who did retake at least one exam 55% of the students' final course grades improved by a letter grade (White, 1974). Starting in 1971, Ohio State University allowed freshman students in Calculus the opportunity to retake tests in order to show mastery of the content. In 1973, Elbrink reported that students did not study for the test until the last retake was given. At the end of the 1975-76 school year, the university quit allowing students to retake tests over and over again (as cited in Cates, 1982). Three years later, at the Mansfield campus of Ohio State, an experiment was conducted by Deatsman to confirm the lack of retest efficacy. In the study, students who scored less than an 80% on the original test were allowed to retake the test once but the highest score that could be earned was an 80% on the retake. Deatsman found from the study that students put off studying for the first test which negated the value of the retest (as cited in Cates, 1982). In 1973 Glucksman also completed a study to determine the benefits of retesting. Retests in the study were created to be more difficult than the original test in order to help eliminate procrastination of studying. However, students still delayed studying and relied on the retake. Glucksman came to the conclusion that the effort that goes in to offering retakes was "not warranted by their usefulness" (as cited in Cates, 1982, p. 231).

There have been extensive studies on retakes being offered at the post-secondary level. However, research on the effects that summative assessment retakes have on high school students is limited. Based on the published post-secondary studies found, it can be argued that retakes could also help motivate high school students to learn previously taught standards that have not been mastered. As observed by Gentile and Lalley (2009), "achieving learning standards is at the forefront of current educational philosophy, and is the goal of sound educational practice" (p. 28). Even though students learn in different ways and at different paces, teachers should strive to help all students learn the course content.

CHAPTER III

RESEARCH DESIGN

Research Question

Is there an association between whether a student completes summative assessment retakes and retention of content material in high school mathematics classes?

Hypothesis

The researcher believes that students who retake summative assessments retain more content knowledge after a period of time than those students who choose not to retake summative assessments.

Population and Sample

West Jessamine High School (WJHS) is one of two traditional public high schools located in Nicholasville, Kentucky. Based on the most recent data from the 2011-2012 school report card, the WJHS population presents as follows:

- 1048 Students
- 51% Males, 49% Females

- 91.4% White, 4% Black, 4.6% Other
- 30.2% free lunch, 8% reduced lunch
- 11th Grade Average ACT Composite Score: 20.5
- 11th Grade Average ACT Mathematics Score: 20.2
- 74% Graduation Rate

Sample demographics were expected to model the population of WJHS. Students in the researcher's second block accelerated algebra II class during the fall 2013 school year participated in the study. The class period ran from 10:10-11:25 Monday through Friday. The accelerated algebra II class had 37 students, 18 males and 19 females. The class had 13 freshman, 15 sophomores, and 9 juniors.

A mathematics department policy at WJHS states that all students are allowed to retake any summative assessment within two weeks of receiving the graded test. In order to be allowed to retake a test, students must go over the original test with any teacher in the mathematics department before or after school hours. Students who receive a score less than 65% must have a conference with the teacher and legal guardian prior to retaking the test. During the conference, the student, legal guardian, and teacher discuss why the student did not do well on the original test. The group also discusses what needs to change or what interventions need to be put into place in order for the student to be successful on the test retake as well as future tests.

After a student has fulfilled the required actions that must take place in order to be allowed to retake a test, the student must come before or after school hours to complete the assessment a second time. Students are given 75 minutes to complete the retake which is equivalent in length to one class period. The summative assessment retake resembles the original test. Each question is presented in the same format as seen on the original test but different values are used in the problem. Students can choose to take the whole test or certain sections of the test. When a student retakes only portions of the test, those sections that were omitted from the retake still affect the student's score on the retake. For example, if the student omits the multiple-choice section of the retake and missed two points on this section on the original test then the student would once again be docked two points on the multiple-choice section of the retake. After the teacher grades the retake, the score on the retake replaces the original test grade regardless of whether the retake score was higher or lower than the original test.

Procedures

In order to determine whether students who retake summative assessments retain more content knowledge after a period of time than those students who choose not to retake a summative assessment, the researcher conducted a study. Students in the class took summative assessments every two to three weeks. This study looked at two units: Basic Trigonometry and Factoring. The Basic Trigonometry unit lasted nine days and the Factoring unit lasted twelve days. At the end of the Basic Trigonometry unit the students were given one class period, 75 minutes, to complete the original summative assessment (Appendix A). Students were also given one class period to complete the original Factoring summative assessment (Appendix D) at the end of the unit. The students had two weeks to retake the Basic Trigonometry (Appendix B) and Factoring (Appendix E) summative assessments as long as the students followed the procedures outlined by the retake policy. Six weeks after the original Basic Trigonometry summative assessment, students were given a post-assessment (Appendix C) in order for the researcher to determine whether those students who retook the test retained more information than those students who did not retake the test. In the same way, students were given a post-assessment (Appendix F) six weeks after the original Factoring summative assessment.

All students in the class were required to take the original unit assessments. Those students who were absent on the day of the test took the test upon returning to school. Graded original summative assessments were returned to the students two school days after taking the test, and students were reminded of the retake policy and the procedures that must be followed in order to retake the test.

Each test question corresponded with one of the learning targets from the unit. The Basic Trigonometry unit had the following ten learning targets:

LT 1: I can determine the exact values of sine, cosine, and tangent using the unit circle.

LT 2: I can determine positive and negative coterminal angles.

LT 3: When given a quadrant I can determine the sign (positive or negative) of sine, cosine, and tangent.

LT 4: I can find the reference angle for angles in degrees and radians.

LT 5: When given sine, cosine, or tangent of theta as a fraction, I can determine the other two trigonometry values of the angle.

LT 6: I can convert an angle from degrees to radians and radians to degrees.

LT 7: I can sketch an angle that is in radians or degrees.

LT 8: When given a coordinate that is on the terminal side of an angle in standard position, I can determine the six trig values of the angle.

LT 9: I can determine the arc length of a circle subtended by a given angle.

LT 10: I can use Soh-Cah-Toa to solve for missing side lengths and angle measures of right triangles.

The Factoring unit had the following five learning targets:

LT 1: I can factor trinomials that have and don't have greatest common factors.

LT 2: I can determine when a polynomial cannot be factored and when I can only factor out a greatest common factor.

LT 3: I can factor the difference of two perfect squares.

LT 4: I can factor the sum and difference of two perfect cubes.

LT 5: I can factor trinomials that lead to me having to factor the difference of two perfect squares or the sum/difference of two perfect cubes.

An Excel spreadsheet was used to record the number of questions each student got incorrect on the original test for each learning target. In order to separate the two units, two worksheets were used within the spreadsheet. The number of questions that the students missed on the retake for each learning target was also recorded for those students who opted to retake the test.

Four weeks after the last day to retake the unit summative assessment, the students were given a post-assessment. The post-assessment was similar to the original summative assessment, but the values in the problems were changed. The students were informed of the post-assessment one day in advance. Students were told that the post-assessment would be analyzing what the students remembered from the first unit and would count as a quiz grade. Students were unaware that the post-assessment would be similar to the original summative assessment. The same grading rubric was used to grade the post-assessment and original summative assessment. For accountability purposes, students who received an A on the post-assessment received 5/5 as a quiz grade. Students who received a B, C, D, and F on the post-assessment earned a quiz grade of 4/5, 3/5, 2/5, and 1/5 respectively. The number of questions each student got incorrect for each learning target on the post-assessment was then recorded on the Excel spreadsheet in a column next to the number of questions missed on the original and the retake. The researcher then sorted each spreadsheet into those students who retook the summative assessment and those who did not for each unit.

CHAPTER IV

RESULTS

The unit Basic Trigonometry lasted nine days and covered ten learning targets. On the last day of the unit, the students had 75 minutes to complete the summative assessment. The class average on the summative assessment was 85.79%. The breakdowns of the grades were as follows: four F's, two D's, six C's, ten B's, and sixteen A's. A student had to score 92% or higher to earn an A, 83%-91% to earn a B, 74%-82% to earn a C, 65%-73% to earn D, and less than 64% to earn an F.

After the tests were returned to the students, the teacher reiterated the retake policy. During the two weeks that followed the original assessment, eight students opted to retake the Basic Trigonometry summative assessment. In order to ensure that students did not share retake questions or answers, all retakes were graded at the end of the two-week retake window. Of the students who retook the exam, one originally had a B, three originally had a C, one originally had a D, and three originally had an F. After the retakes had been entered into the gradebook the class mean increased from 85.79% to 88.79%.

The second unit used in the research lasted twelve days and was titled Factoring. The unit covered five learning targets. The test required students to factor out greatest common factors, factor trinomials, factor difference of squares, and factor the sum and difference of cubes. The class average for the test was a 75.65%. Four students received an A, six a B, thirteen a C, four a D, and ten an F. Of the thirty-seven students, nineteen students retook the test, zero of whom received an A, one received a B, nine received a C, two received a D, and seven received an F on the original test. After the retake scores were recorded, the class average increased to an 80.05%.

Four weeks after the last day to retake the original summative assessment, students were given a post-assessment. The post-assessment was similar to both the original test and the retake, but different values were used. In order to analyze the data the researcher had to determine whether students improved from the original summative assessment to the post-assessment. The researcher looked at the results of one student at a time and totaled the number of questions missed on the original assessment and the number of questions missed on the post-assessment for each learning target. Minitab was then utilized to create dotplots of the data.

There were 49 questions on the Basic Trigonometry test. The dotplot in Figure 2, Appendix G, shows the number of questions students from the no retake group (28 students total) missed on the original assessment and the post-assessment. Students missed between 0 and 23 questions on the original assessment, with a majority of the students missing between 4 and 9 questions. There were extreme values at 19 and 23. On the post-assessment, students missed between 2 to 33 questions, with the majority of students missing between 3 and 18 questions. There were extreme values at 29 and 33. The spread for the post-assessment was larger than the spread for the original assessment.

The dotplot in Figure 3, Appendix H, displays the number of questions students from the retake group (8 students total) missed on the original and post-assessments for the Basic Trigonometry unit. Students missed between 7 and 28 questions on the original assessment and between 4 and 19 on the post-assessment.

Next, the difference of the number of questions missed on the original and the number of questions missed on the post-assessment was calculated for each student for both the retake group and the no retake group. If the difference was negative, then the student missed more questions on the post-assessment than the original assessment. Figure 4, Appendix I, is a dotplot of the differences. The differences for students in the no retake group were between −21 and 9, with a majority of the differences between −10 and 2, and an outlier at −21. The differences for students in the retake group were between 0 and 16, with a majority of the students having a difference between 6 and 10, with outliers at 0 and 16. The dotplot shows that the distribution for the retake group was shifted farther right than the distribution for the no retake group, meaning that overall the retake group improved more from the original to the post-assessment than the no retake group.

Minitab was used to create Table 1, Appendix J[1], which included the sample size, mean, standard deviation, minimum, first quartile, median, third quartile, and maximum for the number of questions missed on the original Basic Trigonometry assessment and post-assessment for both the retake group and no retake group. Minitab also created a boxplot of the differences of the number of questions missed on the original and the number of questions missed on the post-assessment for both the retake group (8 students) and the no retake group (28 students) for the Basic Trigonometry Unit. The boxplot in Figure 5, Appendix K, shows that the mean difference for the no retake group was −3.25 and the median was −3, which was lower than the retake group which had a mean of 8.13 and a median of 8.5. It appears that on average, the test scores improved for the retake

[1] All tables are located in the appendices.

group from the original to the post-test. However, there appears, on average, to be a decrease in the original to post-test scores for the group that did not retake.

There were 18 questions on the Factoring test. The dotplot in Figure 6, Appendix L, displays the number of questions students from the no retake group (18 students total) missed on the original assessment and the post-assessment. Students missed between 1 and 14 questions on the original assessment. On the post-assessment, students missed anywhere from 2 to 17 questions, with a majority of students missing between 2 and 11 questions. There were extreme values at 14 and 17.

The dotplot in Figure 7, Appendix M, displays the number of questions students from the retake group (19 students total) missed on the original assessment and the post-assessment for the Factoring unit. Students missed between 4 and 12 questions on the original assessment and between 0 and 13 on the post-assessment. There was more variability in the post-assessment scores.

Next, the difference of the number of questions missed on the original and the number of questions missed on the post-assessment was calculated for each student for both the retake group and the no retake group for the Factoring unit. Figure 8, Appendix N, is a dotplot of the differences. The differences for students in the no retake group were between −7 and 5, with an outlier at −7. The differences for students in the retake group were between −2 and 8.

Minitab was also used to create Table 2, Appendix O. The table includes the sample size, mean, standard deviation, minimum, first quartile, median, third quartile, and maximum for the number of questions missed on the original Factoring assessment and post-assessment for both the retake group and no retake group. Minitab also created a boxplot of the differences of the sum of the original and the sum of the post-assessment for both the retake group (19 students) and the no retake group (18 students) for the Factoring unit. The boxplot in Figure 9, Appendix P, shows that the mean difference for the no retake group was -0.611 and the median was -0.5, which was lower than the retake group which had a mean of 1.947 and a median of 1.0.

The boxplots generated by Minitab indicated that the data for both units were not normally distributed since there were several outliers. Also, for both the Basic Trigonometry unit and the Factoring unit, the sample mean and median of the difference between the number of questions missed on the original and the post-assessment were higher for the retake group than the no retake group. The difference between the sample means of the retake group and no retake group for the Basic Trigonometry unit was 11.38 questions, and the difference of the medians was 11.5 questions. For the Factoring unit the difference between the means of the retake group and no retake group was 2.558 questions, and the difference of the medians was 1.5 questions.

Since the data were not normally distributed, the Wilcoxon Rank Sum test was utilized to analyze the results. The null hypothesis for the two-sided test was that the median difference of the number of questions missed on the original and the number of questions missed on the post-assessment for students who did not retake the summative assessment was equal to the median for students who did retake the summative assessment. The alternative hypothesis was that the median difference of the number of questions missed on the original and the number of questions missed on the post-assessment for students who did not retake the summative assessment was not equal to the median for students who did retake the summative assessment.

Table 3, Appendix Q, and Table 4, Appendix R, present a detailed summary of the total number of questions each student missed on the original and post-assessment for those students who retook the Basic Trigonometry assessment and those who did not. The data in the original minus post-assessment columns were used to compute the value of the Wilcoxon Rank Sum test statistic.

Minitab adjusted for ties and found W, the sum of the ranks of the retake differences, to equal 417.5 with a p-value of 0.0001. Thus the null hypothesis was rejected at the 5% significance level. Also, since the sample median of the original number of questions missed minus the number of questions missed on the post-assessment for the Basic Trigonometry test was −3.0 for the non-retake group and 8.5 for the retake group, the Wilcoxon Rank Sum test indicated that the population median difference is higher for all students who retake than all who do not retake summative assessments. So the retake group showed more improvement, on average.

Table 5, Appendix S, and Table 6, Appendix T, present a detailed summary of the total number of questions each student missed on the original and post-assessment for those students who retook the Factoring assessment and those who did not. The data in the original minus post-assessment columns were used to compute the value of the Wilcoxon Rank Sum test statistic.

Minitab adjusted for ties and found W, the sum of the ranks of the retake differences, to equal 263.0 with a p-value of 0.0158. Thus the null hypothesis was rejected at the 5% significance level. Also, since the sample median of the original number of questions missed minus the number of questions missed on the post-assessment for the Factoring test was –0.5 for the non-retake group and 1.0 for the retake group, the Wilcoxon Rank Sum test indicated that the population median number of questions missed on the original minus the number of questions missed on the post-assessment is higher for all students who retake than for all who do not retake summative assessments. So the retake group showed more improvement, on average.

Since the null hypothesis was rejected for both the Basic Trigonometry and Factoring units, and it was concluded that those students who retook tests made more of an improvement from the pre-assessment to the post-assessment than those students who did not retake, the researcher looked at each learning target individually. Excel was used to generate side-by-side bar charts that compared the number of questions missed on the original summative assessment minus the number of questions missed on the post-assessment for those students who retook the summative assessment and those who did not in order to see where the differences were for each learning target.

Nine questions of the Basic Trigonometry summative assessment pertained to the first learning target. For the no retake group, 35.71% of the students did worse on the post-assessment than the original test, 28.57% stayed the same (including 10.71% who had perfect scores on both tests), and 35.71% improved. For the retake group, 25% of the students did worse on the post-assessment, no one stayed the same, and 75% improved (Figure 10, Appendix U).

The second learning target on the Basic Trigonometry summative assessment had 9 questions. For the no retake group, 46.43% of the students did worse on the post-assessment than the original test, 35.71% stayed the same (including 7.14% who had perfect scores on both tests), and 17.86% improved. For the retake group, 25% of the students did worse on the post-assessment, 12.5% stayed the same, and 62.5% improved (Figure 11, Appendix V).

The third learning target on the Basic Trigonometry summative assessment only had 2 questions. For the no retake group, 14.29% of the students did worse on the post-assessment than the original test, 71.43% stayed the same (including 50% who had perfect scores on both tests), and 14.29% improved. For the retake group, 0% of the students did worse on the post-assessment, 50% stayed the same (including 25% who had perfect scores on both tests), and 50% improved (Figure 12, Appendix W).

Five questions of the Basic Trigonometry summative assessment pertained to the fourth learning target. For the no retake group, 17.86% of the students did worse on the post-assessment than the original test, 50% stayed the same (including 42.86% who had perfect scores on both tests), and 32.14% improved. For the retake group, 0% of the students did worse on the post-assessment, 37.5% stayed the same and had perfect scores on both test, and 62.5% improved (Figure 13, Appendix X).

The fifth learning target on the Basic Trigonometry summative assessment only had 1 question. For the no retake group, 25% of the students did worse on the post-assessment than the original test, 71.43% stayed the same (including 53.57% who had perfect scores on both tests), and 3.57% improved. For the retake group, 0% of the students did worse on the post-assessment, 75% stayed the same (including 62.5% who had perfect scores on both tests), and 25% improved (Figure 14, Appendix Y).

The sixth learning target on the Basic Trigonometry summative assessment had 4 questions. For the no retake group, 32.14% of the students did worse on the post-assessment than the original test, 50% stayed the same (including 35.71% who had perfect scores on both tests), and 17.86% improved. For the retake group, 25% of the students did worse on the post-assessment, 37.5% stayed the same (including 12.5% who had perfect scores on both tests), and 37.5% improved (Figure 15, Appendix Z).

The seventh learning target on the Basic Trigonometry summative assessment had 4 questions. For the no retake group, 14.29% of the students did worse on the post-assessment than the original test, 71.43% stayed the same (including 57.14% who had perfect scores on both tests), and 14.29% improved. For the retake group, 0% of the students did worse on the post-assessment, 37.5% stayed the same (including 25% who had perfect scores on both tests), and 62.5% improved (Figure 16, Appendix AA).

The eighth learning target on the Basic Trigonometry summative assessment had 12 questions. For the no retake group, 60.71% of the students did worse on the post-assessment than the original test, 25% stayed the same (including 21.43% who had perfect scores on both tests), and 14.29% improved. For the retake group, 25% of the students did worse on the post-assessment, 12.5% stayed the same and had perfect scores on both tests, and 62.5% improved (Figure 17, Appendix BB).

The ninth learning target on the Basic Trigonometry summative assessment had only 1 question. For the no retake group, 42.86% of the students did worse on the post-assessment than the original test, 53.57% stayed the same (including 25% who had perfect scores on both tests), and 3.57% improved. For the retake group, 12.5% of the students did worse on the post-assessment, 62.5% stayed the same (including 12.5% who had perfect scores on both tests), and 25% improved (Figure 18, Appendix CC).

The tenth learning target on the Basic Trigonometry summative assessment had 2 questions. For the no retake group, 39.29% of the students did worse on the post-assessment than the original test, 46.43% stayed the same (including 39.29% who had perfect scores on both tests), and 14.29% improved. For the retake group, 12.5% of the students did worse on the post-assessment, 37.5% stayed the same and had perfect scores on both tests, and 50% improved (Figure 19, Appendix DD).

The first learning target on the Factoring summative assessment had 5 questions. For the no retake group, 50% of the students did worse on the post-assessment than the original test, 38.89% stayed the same (including 16.67% who had perfect scores on both tests), and 11.11% improved. For the retake group, 36.84% of the students did worse on the post-assessment, 21.05% stayed the same (including 5.26% who had perfect scores on both tests), and 42.11% improved (Figure 20, Appendix EE).

The second learning target on the Factoring summative assessment had 2 questions. For the no retake group, 16.67% of the students did worse on the post-assessment than the original test, 61.11% stayed the same (including 38.89% who had perfect scores on both tests), and 22.22% improved. For the retake group, 31.58% of the students did worse on the post-assessment, 31.58% stayed the same (including 10.53% who had perfect scores on both tests), and 36.84% improved (Figure 21, Appendix FF).

The third learning target on the Factoring summative assessment had 4 questions. For the no retake group, 50% of the students did worse on the post-assessment than the original test, 33.33% stayed the same (including 5.56% who had perfect scores on both tests), and 16.67% improved. For the retake group, 31.58% of the students did worse on the post-assessment, 21.05% stayed the same, and 47.37% improved (Figure 22, Appendix GG).

The fourth learning target on the Factoring summative assessment had 4 questions. For the no retake group, 16.67% of the students did worse on the post-assessment than the original test, 38.89% stayed the same (including 5.56% who had perfect scores on both tests), and 44.44% improved. For the retake group, 21.05% of the students did worse on the post-assessment, 42.11% stayed the same (including 5.26% who had perfect scores on both tests), and 36.84% improved (Figure 23, Appendix HH).

The fifth learning target on the Factoring summative assessment had 2 questions. For the no retake group, 16.67% of the students did worse on the post-assessment than the original test, 66.67% stayed the same, and 16.67% improved. For the retake group, 5.26% of the students did worse on the post-assessment, 52.63% stayed the same (including 5.26% who had perfect scores on both tests), and 16.67% improved (Figure 24, Appendix II).

In conclusion, based on the two units studied, there does appear to be an association between whether a student completes summative assessment retakes and retention of content material, in high school mathematics classes. For both the Basic Trigonometry and Factoring units, the Wilcoxon Rank Sum test indicated that the population median number of questions missed on the original minus the number of questions missed on the post-assessment is higher for all students who retake than for those who do not retake summative assessments. In this sample, for every learning target in the Basic Trigonometry unit, the retake group had a greater percentage of students who improved from the original to the post-assessment than the no retake group. For three out of five learning targets in the Factoring unit, a greater percentage of students in the retake group improved from the original to the post-assessment. The exceptions are the fourth and fifth learning targets. For the fourth learning target, “I can factor the sum and difference of two perfect cubes,” 44.4% improved in the no retake group compare to 36.84% who improved in the retake group. For the fifth learning target, “I can factor trinomials that lead to me having to factor the difference of two perfect squares or the sum/difference of two perfect cubes,” 16.67% improved in both groups. Overall, it appears that students who complete a summative assessment retake benefit more than those students who do not retake with respect to retention of content material.

CHAPTER V

LIMITATIONS

There were many limitations of this study. One of the limitations was that the researcher did not choose the sample of students who would participate in the study. The counselors assigned the students to the class, and the students who were placed in the researcher's second block accelerated algebra II were the students who were used in the study. Also, since the researcher was only assigned one accelerated algebra II class, only one class was used for the study.

Another limitation of the study was that due to the mathematics department's retake policy, all students were given the option to retake the summative assessments. There was not one group that was forced to retake summative assessments and another group that did not have the option to retake. Instead, since the researcher had no control over who retook what tests, it was up to the students whether or not to utilize the retake option.

A third limitation of the study was that some students took the post-assessment seriously, while others saw the post-assessment as only a quiz grade and finished the post-assessment quickly and without much thought. If the post-assessment had counted as a test grade the scores might have been different, but due to school policies the post-assessment could not count as a second test grade.

A fourth limitation was the number of units that this study covered due to time constraints. The study might yield more statistically significant results if the researcher could compare final exam grades of those students who retook summative assessments to those students who did not retake assessments. The time frame of the study was less than one semester and the researcher had no control over the units covered in the study.

It is important to note that while the study only covered two units, the lessons covered in the unit following the Factoring unit reviewed learning targets that had been taught during the first two units. This might have influenced how the students performed on the post-assessment for the Factoring unit.

Further Research

While there are many studies on the effects of retakes being offered at post-secondary schools, more research needs to be conducted on the effects the retakes have on high school students. Studies similar to the researcher's should be carried out with larger sample sizes and the research should be carried out for an entire school year. By conducting the research for a whole school year, a researcher could collect data to determine whether those students who retook tests throughout the semester did better on the final exam. Research should also be carried out to see whether offering retakes hinders students' motivation to do well on the original test. A questionnaire could be used to determine whether students study less due to retakes being offered and whether retakes help with test anxiety.

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APPENDIX A:

Basic Trigonometry—Original Summative Assessment

1st Trig Test ORIGINAL Algebra II Accel   Name;________________________

Choose the correct answer(s).

1. $\cos\frac{31\pi}{6} =$

A. $\frac{1}{2}$ B. $-\frac{1}{2}$ C. $\frac{\sqrt{3}}{2}$ D. $-\frac{\sqrt{3}}{2}$

2. $\tan(-810°) =$

A. Undefined   B. 0   C. 1   D. -1

3. Which of the following is a coterminal to $\frac{16\pi}{7}$. Circle all that apply

A. $-\frac{2\pi}{7}$ B. $\frac{23\pi}{7}$ C. $\frac{2\pi}{7}$ D. $-\frac{12\pi}{7}$

4. Which quadrant has the following characteristics: $\sin\vartheta < 0$ and $\tan\vartheta > 0$?

A. I   B. II   C. III   D. IV

5. What is the reference angle for $280°$?

A. $10°$ B. $80°$ C. $-10°$ D. $-80°$

6. What is $\sin\left(\frac{7\pi}{4}\right)$?

A. $-\frac{1}{2}$ B. $\frac{\sqrt{3}}{2}$ C. $-\frac{\sqrt{2}}{2}$ D. $\frac{\sqrt{2}}{2}$

7. Given $\cos\vartheta = \frac{3}{5}$ and ϑ is in quadrant I, $\tan\vartheta =$ _______

A. $\frac{4}{5}$ B. $\frac{3}{5}$ C. $\frac{4}{3}$ D. $\frac{3}{4}$

8. Which quadrant(s) have a negative value for $\sin\vartheta$?

A. I   B. II   C. III   D. IV

Trig Chapter Algebra II   Name: ______________

<u>Be sure to show ALL WORK to receive any credit!!!!</u>

I. Solve for each of the following. Only give EXACT answers.

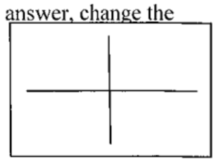
1. $\sin\left(\frac{5\pi}{4}\right) =$ ______   2. $\tan\left(-\frac{5\pi}{2}\right) =$ ______   3. $\cos\frac{11\pi}{6} =$ ______

4. $\cos 6\pi =$ ______   5. $\sin\left(-\frac{5\pi}{3}\right) =$ ______   6. $\tan\left(\frac{2\pi}{3}\right) =$ ____

II. Sketch the angle in the box. Give a negative and positive coterminal angle, and the reference angle. Give the conterminal angles that are as close to zero as possible. ***Give all answers in radians***. For the final answer, change the original angle to degrees.

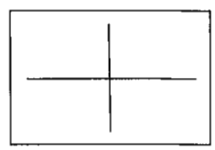
7. $-\frac{11\pi}{6}$ PC: ______   NC: ______

Ref: ______   Deg: ______



8. $\frac{5\pi}{9}$ PC: ______   NC: ______

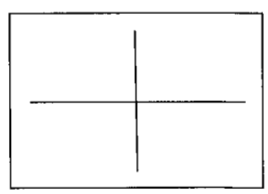
Ref: ______   Deg: ______



III. Sketch the angle in the box. Give a negative and positive conterminal angle and the reference angle. Give the coterminal angles that are as close to zero as possible. ***Give all answers in degrees.*** For the final answer, change the original angle to radians.

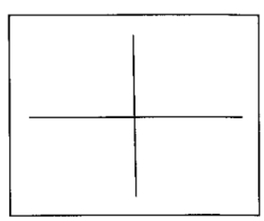
9. $840°$ PC: ______   NC: ______

Ref: ______   Rad: ______



10. $-214°$ PC: ______   NC: ______

Ref: ______   Rad: ______



Assuming the point is on the terminal side of an angle in standard position, determine the exact values of the six trigonometric functions of the angle.

11. (-6, -1) sin ϑ=_____ cos ϑ=_____ tan ϑ=_____

csc ϑ=_____ sec ϑ=_____ cot ϑ=_____

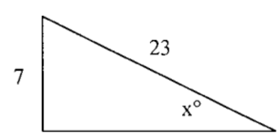
12. (3, -2) sin ϑ=_____ cos ϑ=_____ tan ϑ=_____

csc ϑ=_____ sec ϑ=_____ cot ϑ=_____

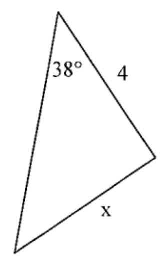
13. What is the arc length of a circle of radius 6 meters that is subtended by a 240° angle?

Solve for x in each of the following ***right*** triangles.

14.



15.



16. The terminal side of ϑ lies on the line $5x - 2y = 0$ in quadrant III. Find the values of sin ϑ, cos ϑ, and tan ϑ.

APPENDIX B:

Basic Trigonometry—Retake Assessment

1st Trig Test Algebra II Accel RETAKE Name;______________________

Choose the correct answer(s).

1. What is $\sin\left(\frac{7\pi}{4}\right)$?

A. $-\frac{1}{2}$ B. $\frac{\sqrt{3}}{2}$ C. $-\frac{\sqrt{2}}{2}$ D. $\frac{\sqrt{2}}{2}$

2. $\cos\frac{31\pi}{6} =$

A. $\frac{1}{2}$ B. $-\frac{1}{2}$ C. $\frac{\sqrt{3}}{2}$ D. $-\frac{\sqrt{3}}{2}$

3. Which quadrant(s) have a negative value for $\sin\vartheta$?

A. I B. II C. III D. IV

4. $\tan(-810°) =$

A. Undefined B. 0 C. 1 D. -1

5. Which of the following is a conterminal to $\frac{16\pi}{7}$. Circle all that apply

A. $-\frac{2\pi}{7}$ B. $\frac{23\pi}{7}$ C. $\frac{2\pi}{7}$ D. $-\frac{12\pi}{7}$

6. Which quadrant has the following characteristics: $\sin\vartheta < 0$ and $\tan\vartheta > 0$?

A. I B. II C. III D. IV

7. What is the reference angle for $280°$?

A. $10°$ B. $80°$ C. $-10°$ D. $-80°$

8. Given $\cos\vartheta = \frac{3}{5}$ and ϑ is in quadrant I, $\tan\vartheta =$ ______

A. $\frac{4}{5}$ B. $\frac{3}{5}$ C. $\frac{4}{3}$ D. $\frac{3}{4}$

Trig Chapter Algebra II Name: ______________

Be sure to show ALL WORK to receive any credit!!!!

I. Solve for each of the following. Only give EXACT answers.

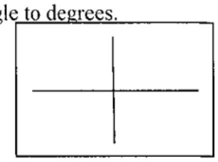
1. $\sin\left(-\frac{5\pi}{3}\right) =$ ______ 2. $\tan\left(\frac{2\pi}{3}\right) =$ ______ 3. $\cos\frac{11\pi}{6} =$ ______

4. $\cos 6\pi =$ ______ 5. $\sin\left(\frac{5\pi}{4}\right) =$ ______ 6. $\tan\left(-\frac{5\pi}{2}\right) =$ ______

II. Sketch the angle in the box. Give a negative and positive coterminal angle, and the reference angle. Give the conterminal angles that are as close to zero as possible. ***Give all answers in radians***. For the final answer, change the original angle to degrees.

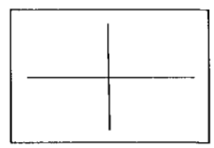
9. $-\frac{13\pi}{6}$ PC: ______ NC: ______

Ref: ______ Deg: ______



10. $\frac{7\pi}{9}$ PC: ______ NC: ______

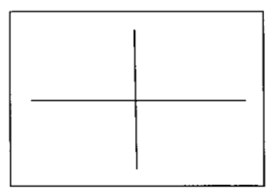
Ref: ______ Deg: ______



III. Sketch the angle in the box. Give a negative and positive conterminal angle and the reference angle. Give the coterminal angles that are as close to zero as possible. ***Give all answers in degrees.*** For the final answer, change the original angle to radians.

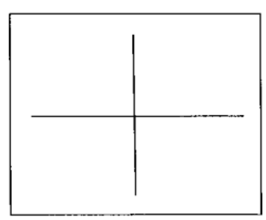
7. $-253°$ PC: ______ NC: ______

Ref: ______ Rad: ______



8. $860°$ PC: ______ NC: ______

Ref: ______ Rad: ______



Assuming the point is on the terminal side of an angle in standard position, determine the exact values of the six trigonometric functions of the angle.

11. (-9, -1)

sin ϑ =_____ cos ϑ =_____ tan ϑ =_____

csc ϑ =_____ sec ϑ =_____ cot ϑ =_____

12. (7, -2)

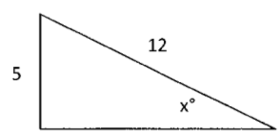
sin ϑ =_____ cos ϑ =_____ tan ϑ =_____

csc ϑ =_____ sec ϑ =_____ cot ϑ =_____

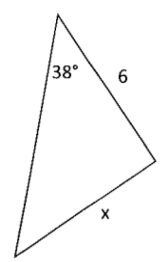
13. What is the arc length of a circle of radius 7 meters that is subtended by a $190°$ angle?

Solve for x in each of the following ***right*** triangles.

14.



15.



16. The terminal side of ϑ lies on the line $5x - 2y = 0$ in quadrant III. Find the values of sin ϑ, cos ϑ, and tan ϑ.

APPENDIX C:

Basic Trigonometry—Post-Assessment

1st Trig POST Test Algebra II Accel Name;______________________

Choose the correct answer(s).

1. What is $\cos\left(\frac{9\pi}{4}\right)$?

A. $-\frac{1}{2}$ B. $\frac{\sqrt{3}}{2}$ C. $-\frac{\sqrt{2}}{2}$ D. $\frac{\sqrt{2}}{2}$

2. $\sin\frac{17\pi}{6} =$

A. $\frac{1}{2}$ B. $-\frac{1}{2}$ C. $\frac{\sqrt{3}}{2}$ D. $-\frac{\sqrt{3}}{2}$

3. Which quadrant(s) have a positive value for $\tan\vartheta$?

A. I B. II C. III D. IV

4. $\tan(-630^\circ) =$

A. Undefined B. 0 C. 1 D. -1

5. Which of the following is a conterminal to $\frac{3\pi}{7}$. Circle all that apply

A. $\frac{22\pi}{7}$ B. $\frac{10\pi}{7}$ C. $\frac{6\pi}{7}$ D. $-\frac{6\pi}{7}$

6. Which quadrant has the following characteristics: $\cos\vartheta < 0$ and $\tan\vartheta > 0$?

A. I B. II C. III D. IV

7. What is the reference angle for $370°$?

A. $10°$ B. $70°$ C. $-10°$ D. $-70°$

8. Given $\cos\vartheta = \frac{3}{5}$ and ϑ is in quadrant IV, $\tan\vartheta =$ _______

A. $\frac{4}{5}$ B. $-\frac{4}{3}$ C. $\frac{4}{3}$ D. $-\frac{3}{5}$

Trig Chapter Algebra II Name: ____________

<u>Be sure to show ALL WORK to receive any credit!!!!</u>

I. Solve for each of the following. Only give EXACT answers.

1. $\sin\left(-\dfrac{4\pi}{3}\right) =$ ______ 2. $\tan\left(\dfrac{5\pi}{3}\right) =$ ______ 3. $\cos\dfrac{7\pi}{6} =$ ______

4. $\cos 4\pi =$ ______ 5. $\sin\left(-\dfrac{5\pi}{4}\right) =$ ______ 6. $\tan\left(\dfrac{9\pi}{2}\right) =$ ______

II. Sketch the angle in the box. Give a negative and positive coterminal angle, and the reference angle. Give the conterminal angles that are as close to zero as possible. ***Give all answers in radians.*** For the final answer, change the original angle to degrees.

9. $\dfrac{15\pi}{6}$ PC: ______ NC: ______

Ref: ______ Deg: ______

10. $-\dfrac{5\pi}{7}$ PC: ______ NC: ______

Ref: ______ Deg: ______

III. Sketch the angle in the box. Give a negative and positive conterminal angle and the reference angle. Give the coterminal angles that are as close to zero as possible. ***Give all answers in degrees.*** For the final answer, change the original angle to radians.

7. $-305°$ PC: ______ NC: ______

Ref: ______ Rad: ______

8. $730°$ PC: ______ NC: ______

Ref: ______ Rad: ______

Assuming the point is on the terminal side of an angle in standard position, determine the exact values of the six trigonometric functions of the angle.

11. (-8, 1)

sin ϑ =_____ cos ϑ =_____ tan ϑ =_____

csc ϑ =_____ sec ϑ =_____ cot ϑ =_____

12. (-1, -5)

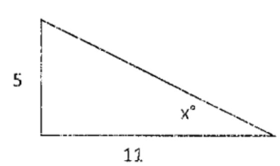
sin ϑ =_____ cos ϑ =_____ tan ϑ =_____

csc ϑ =_____ sec ϑ =_____ cot ϑ =_____

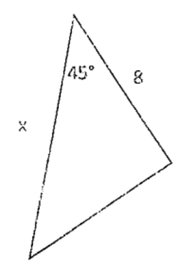
13. What is the arc length of a circle of radius 5 meters that is subtended by a $75°$ angle?

Solve for x in each of the following ***right*** triangles.

14.



15.



16. The terminal side of ϑ lies on the line $4x - 3y = 0$ in quadrant III. Find the values of sin ϑ, cos ϑ, and tan ϑ.

APPENDIX D:

Factoring—Original Summative Assessment

Name________________________________

Date______________ Period______

Unit 3: Factoring Test Original

1) $-9n^4 - 31n^3 - 12n$

2) $9x^2n + 50xn - 24n$

3) $2a^2 + 2ab$

4) $2x^3 + 22x^2y + 56y^2x$

5) $6u^4 + 60u^3\,v + 126v^2u^2$

6) $4x^2 + 4x + 1$

7) $n^6 - 4$

8) $a^4 + 4a^2 + 4$

9) $k^4 - 9$

10) $-u^3 + 1$

11) $432x^5 - 686x^2$

12) $125x^6 + 64y^6$

13) $64xa^6 - 27xb^6$

14) $f(x) = x^6 - 7x^3 - 8$

15) $f(x) = x^8 - 32x^4 + 256$

16) $891v^3r^2 - 44vr^2$

17) $(x-4)^2 - 3$

18) $16 - (x+3)^2$

APPENDIX E:

Factoring—Retake Assessment

Name:__________________________ UNIT 3: Factoring Test RETAKE

Date:________________________ Period:______

1) $-2x^4 + 5x^3 + 12x$

2) $18x^3 + 3x^2 - x$

3) $15ab + 20b^2$

4) $6x^2y + 3xy^2 - 9y^3$

5) $2x^4 + 10x^3y + 12x^2y^2$

6) $4x^2 - 12x + 9$

7) $n^6 - 25$

8) $x^4 + 6x^2 + 9$

9) $x^4 - 4$

10) $-x^3 + 8$

11) $81x^5 + 192x^2$

12) $8n^6 - 125y^6$

13) $216xn^6 + 8xy^6$

14) $f(x) = x^6 - 13x^3 + 12$

**15) $f(x) = x^8 - 162x^4 + 6561$

16) $72x^3y^2 - 128xy^2$

17) $(x - 9)^2 - 5$

18) $25 - (x + 4)^2$

APPENDIX F:

Factoring—Post-Assessment

Name:___________________________ UNIT 3: Factoring POST Test

1) $-5x^4 + 2x^3 + 1x$

2) $12x^3 + 12x^2 + 3x$

3) $10ab + 30b^2$

4) $15x^2y + 5xy^2 - 10y^3$

5) $3x^4 + 18x^3y + 24x^2y^2$

6) $9x^2 + 12x + 4$

7) $n^6 - 100$

8) $x^4 - 10x^2 + 25$

9) $x^4 - 25$

10) $-x^3 + 27$

11) $16x^5 - 128x^2$

12) $125n^6 + 64y^6$

13) $3xn^6 + 24xy^6$

14) $f(x) = x^6 - 13x^3 + 40$

**15) $f(x) = x^8 - 32x^4 + 256$

16) $125x^3y^2 - 20xy^2$

17) $(x-25)^2 - 8$

18) $25 - (x+8)^2$

APPENDIX G:

Figure 2: Basic Trigonometry—No Retake

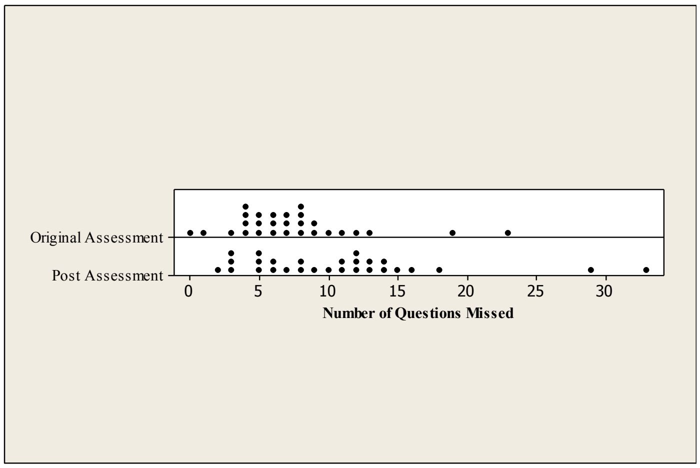


Figure 2: Basic Trigonometry—No Retake

APPENDIX H:

Figure 3: Basic Trigonometry—Retake

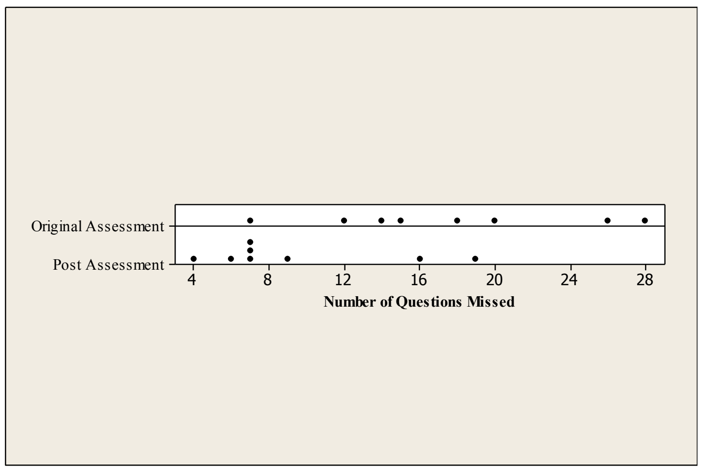


Figure 3: Basic Trigonometry—Retake

APPENDIX I:

Figure 4: Basic Trigonometry—Original Minus Post

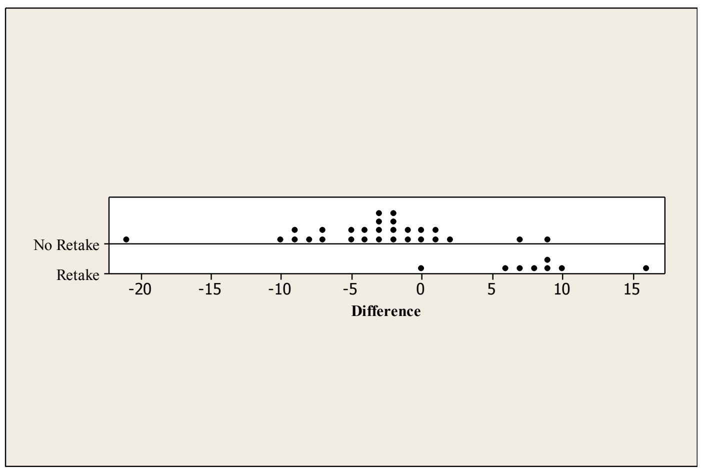


Figure 4: Basic Trigonometry—Original Minus Post

APPENDIX J:

Table 1: Basic Trigonometry Test—Descriptive Statistics

Table 1: Basic Trigonometry Test—Descriptive Statistics								
Variable	N	Mean	St Dev	Min	Q1	Median	Q3	Max
Number of Questions Missed on Original: No Retake	28	7.571	4.872	0.000	4.250	7.000	9.000	23.000
Number of Questions Missed on Post: No Retake	28	10.82	7.19	2.00	5.25	10.50	13.75	33.00
Original Minus Post: No Retake	28	−3.25	5.58	−21.00	−6.50	−3.00	−0.25	9.00
Number of Questions Missed on Original: Retake	8	17.50	7.05	7.00	12.50	16.50	24.50	28.00
Number of Questions Missed on Post: Retake	8	9.38	5.26	4.00	6.25	7.00	14.25	19.00
Original Minus Post: Retake	8	8.13	4.45	0.00	6.25	8.50	9.75	16.00

APPENDIX K:

Figure 5: Basic Trigonometry—Original Minus Post Boxplot

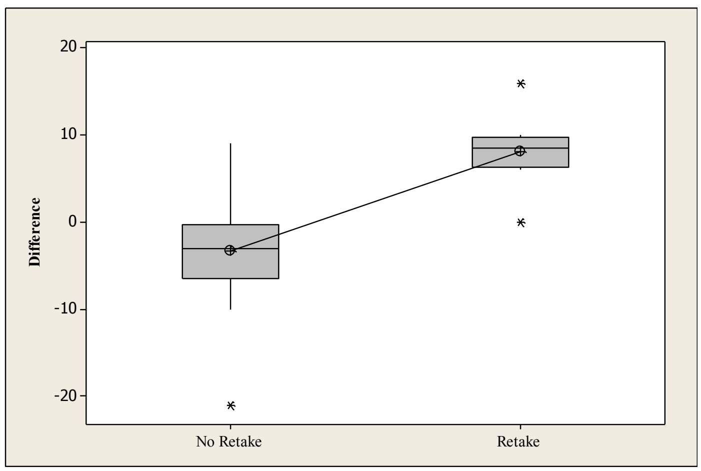


Figure 5: Basic Trigonometry—Original Minus Post Boxplot

APPENDIX L:

Figure 6: Factoring—No Retake

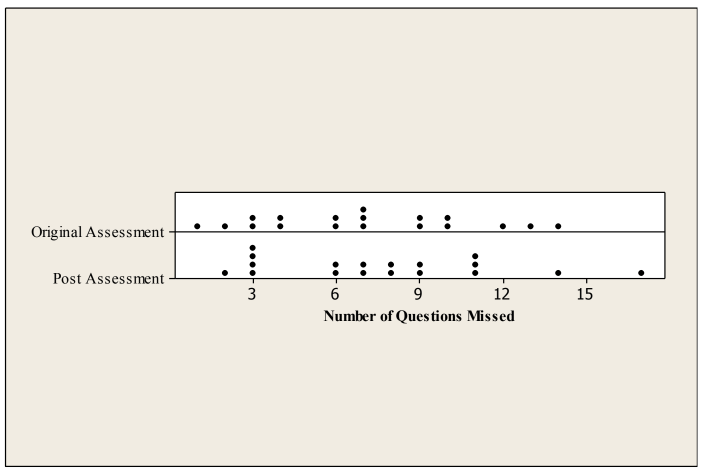


Figure 6: Factoring—No Retake

APPENDIX M:

Figure 7: Factoring—Retake

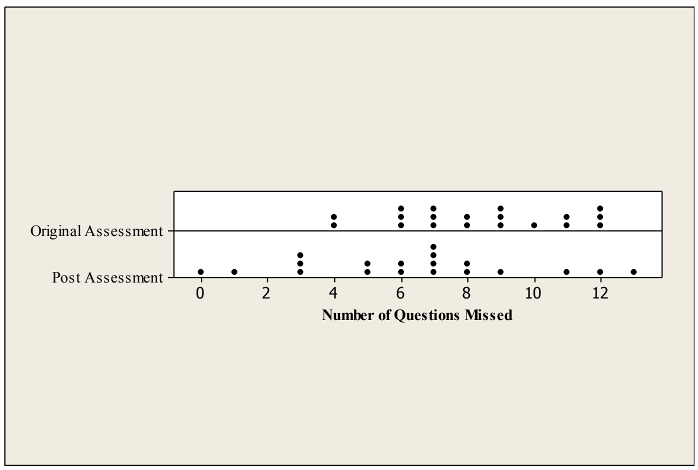


Figure 7: Factoring—Retake

APPENDIX N:

Figure 8: Factoring—Original Minus Post

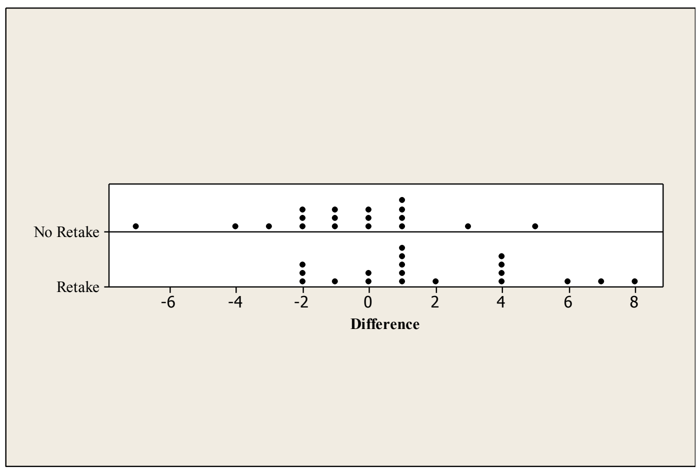


Figure 8: Factoring—Original Minus Post

APPENDIX O:

Table 2: Factoring Test—Descriptive Statistics

Table 2: Factoring Test—Descriptive Statistics								
Variable	N	Mean	St Dev	Min	Q1	Media n	Q3	Max
Number of Questions Missed on Original: No Retake	18	7.056	3.827	1.000	3.750	7.000	10.000	14.000
Number of Questions Missed on Post: No Retake	18	7.667	4.130	2.000	3.000	7.500	11.000	17.000
Original Minus Post: No Retake	18	−0.611	2.660	−7.000	−2.000	−0.500	1.000	5.000
Number of Questions Missed on Original: Retake	19	8.316	2.567	4.000	6.000	8.000	11.000	12.000
Number of Questions Missed on Post: Retake	19	6.368	3.483	0.000	3.000	7.000	8.000	13.000
Original Minus Post: Retake	19	1.947	3.009	−2.000	0.000	1.000	4.000	8.000

APPENDIX P:

Figure 9: Factoring—Original Minus Post Boxplot

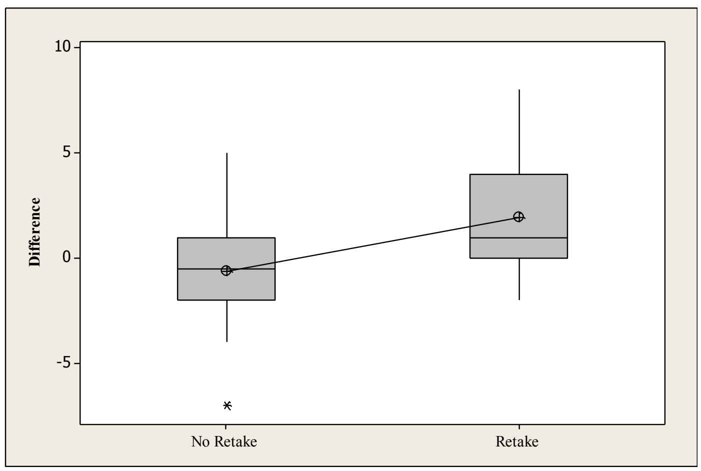


Figure 9: Factoring—Original Minus Post Boxplot

APPENDIX Q:

Table 3: Basic Trigonometry—No Retake Number of Questions Missed

Table 3: Basic Trigonometry—No Retake Number of Questions Missed			
Student	**Original**	**Post**	**Original Minus Post**
Student 1	6	5	1
Student 2	9	14	−5
Student 3	8	29	−21
Student 5	5	6	−1
Student 6	19	12	7
Student 8	8	10	−2
Student 10	4	2	2
Student 11	23	33	−10
Student 14	4	12	−8
Student 15	3	5	−2
Student 17	7	11	−4
Student 18	1	3	−2
Student 20	6	9	−3
Student 21	13	18	−5
Student 22	8	11	−3
Student 23	10	12	−2
Student 24	4	13	−9
Student 25	9	8	1
Student 26	5	5	0
Student 27	7	14	−7
Student 28	8	8	0
Student 29	5	6	−1
Student 30	4	7	−3
Student 31	7	16	−9
Student 32	12	3	9
Student 34	11	15	−4
Student 35	0	3	−3
Student 37	6	13	−7

APPENDIX R:

Table 4: Basic Trigonometry—Retake Number of Questions Missed

Table 4: Basic Trigonometry—Retake Number of Questions Missed			
Student	**Original**	**Post**	**Original Minus Post**
Student 4	18	9	9
Student 7	12	6	6
Student 9	15	7	8
Student 13	7	7	0
Student 16	20	4	16
Student 19	28	19	9
Student 33	26	16	10
Student 36	14	7	7

APPENDIX S:

Table 5: Factoring—Retake Number of Questions Missed

Table 5: Factoring—Retake Number of Questions Missed			
Student	Original	Post	Original Minus Post
Student 4	10	9	1
Student 6	7	7	0
Student 7	6	5	1
Student 8	12	13	−1
Student 9	9	3	6
Student 10	4	3	1
Student 13	6	5	1
Student 16	9	1	8
Student 18	7	0	7
Student 19	12	8	4
Student 20	6	8	−2
Student 21	12	12	0
Student 23	11	7	4
Student 27	8	7	1
Student 32	11	7	4
Student 33	9	11	−2
Student 35	7	3	4
Student 36	4	6	−2
Student 37	8	6	2

APPENDIX T:

Table 6: Factoring—No Retake Number of Questions Missed

Table 6: Factoring—No Retake Number of Questions Missed			
Student	Original	Post	Original Minus Post
Student 1	3	6	−3
Student 2	10	9	1
Student 3	14	11	3
Student 5	2	3	−1
Student 11	12	14	−2
Student 12	13	17	−4
Student 14	10	11	−1
Student 15	7	7	0
Student 17	4	3	1
Student 22	7	2	5
Student 24	7	9	−2
Student 25	6	7	−1
Student 26	3	3	0
Student 28	6	6	0
Student 29	1	8	−7
Student 30	4	3	1
Student 31	9	11	−2
Student 34	9	8	1

APPENDIX U:

Figure 10: Comparison of Performances on Basic Trigonometry Learning Target 1

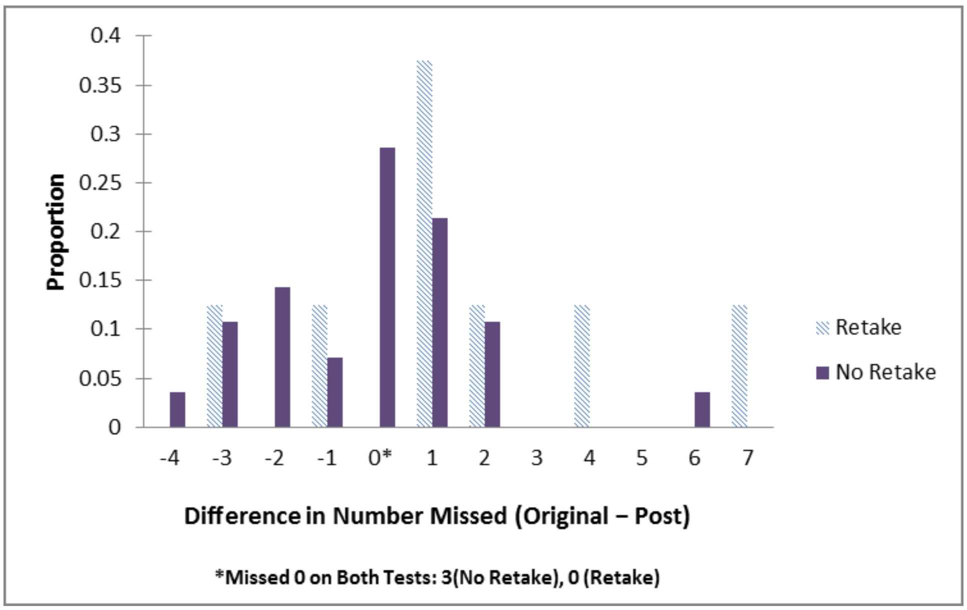


Figure 10: Comparison of Performances on Basic Trigonometry Learning Target 1

APPENDIX V:

Figure 11: Comparison of Performances on Basic Trigonometry Learning Target 2

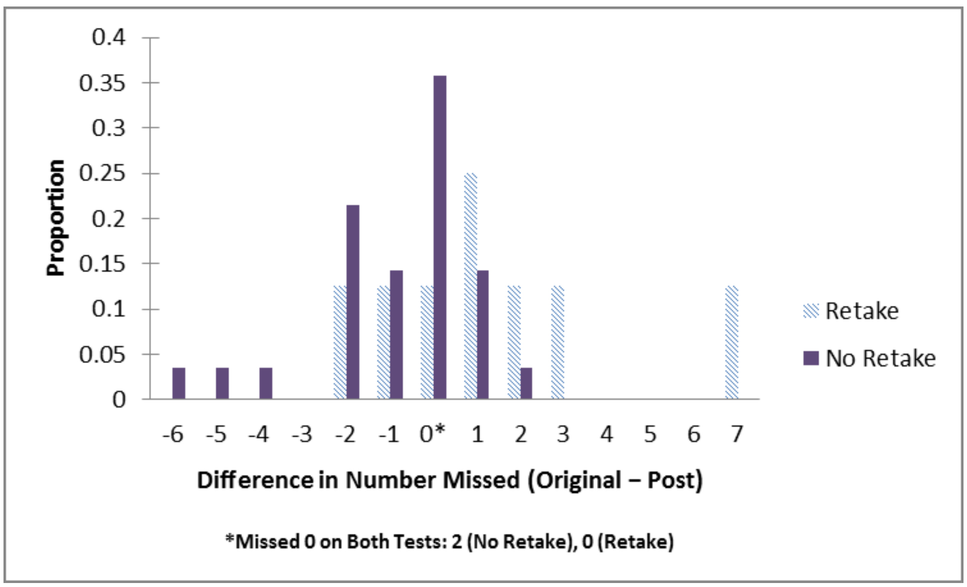


Figure 11: Comparison of Performances on Basic Trigonometry Learning Target 2

APPENDIX W:

Figure 12: Comparison of Performances on Basic Trigonometry Learning Target 3

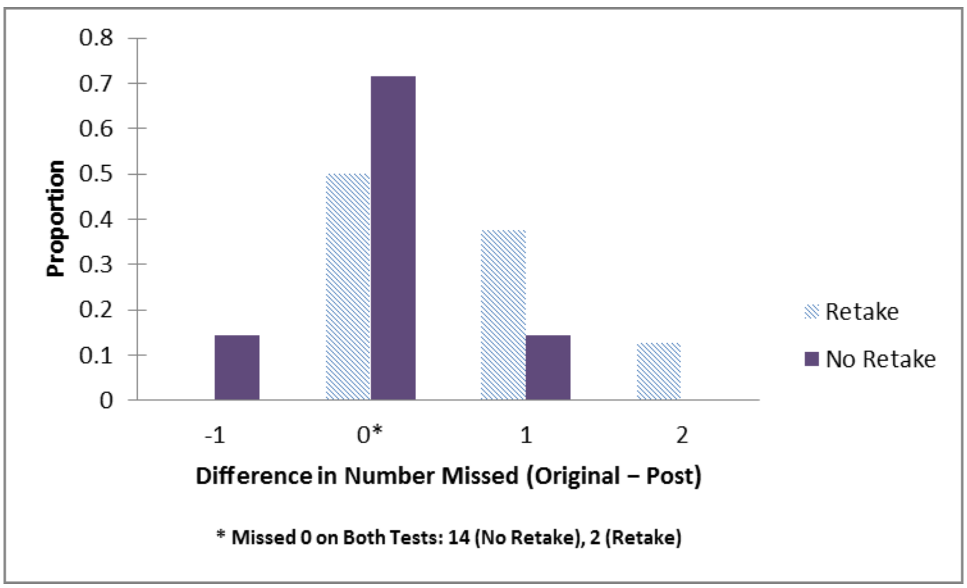


Figure 12: Comparison of Performances on Basic Trigonometry Learning Target 3

APPENDIX X:

Figure 13: Comparison of Performances on Basic Trigonometry Learning Target 4

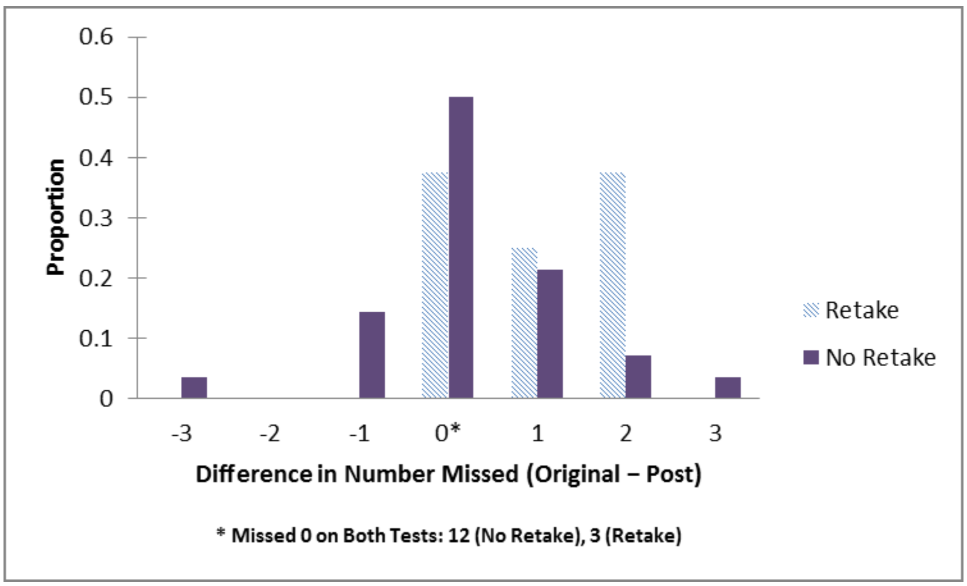


Figure 13: Comparison of Performances on Basic Trigonometry Learning Target 4

APPENDIX Y:

Figure 14: Comparison of Performances on Basic Trigonometry Learning Target 5

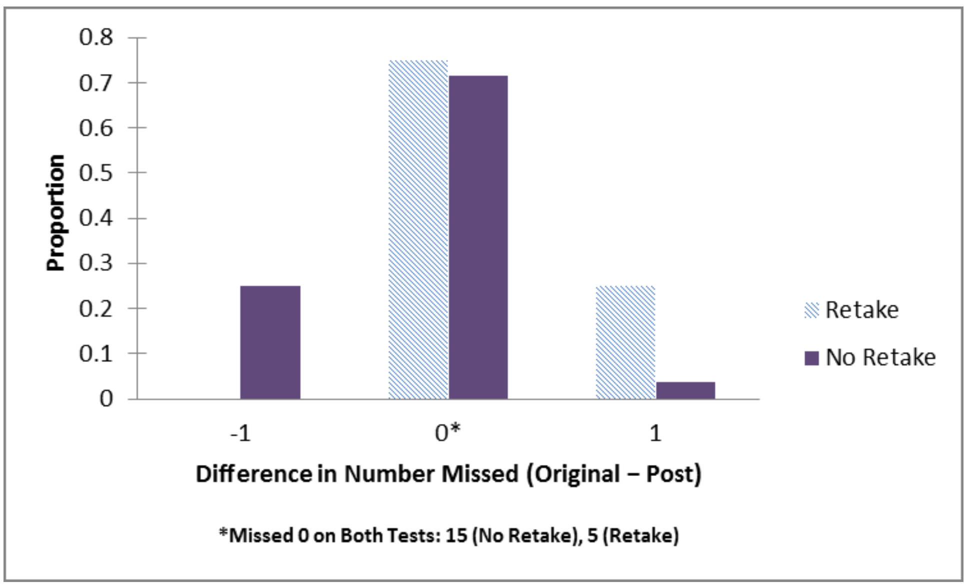


Figure 14: Comparison of Performances on Basic Trigonometry Learning Target 5

APPENDIX Z:

Figure 15: Comparison of Performances on Basic Trigonometry Learning Target 6

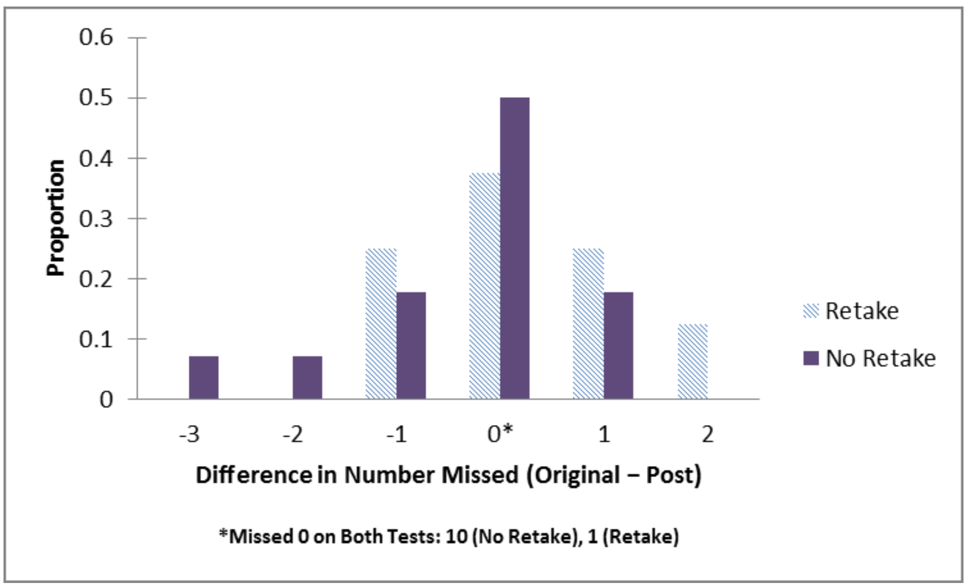


Figure 15: Comparison of Performances on Basic Trigonometry Learning Target 6

APPENDIX AA:

Figure 16: Comparison of Performances on Basic Trigonometry Learning Target 7

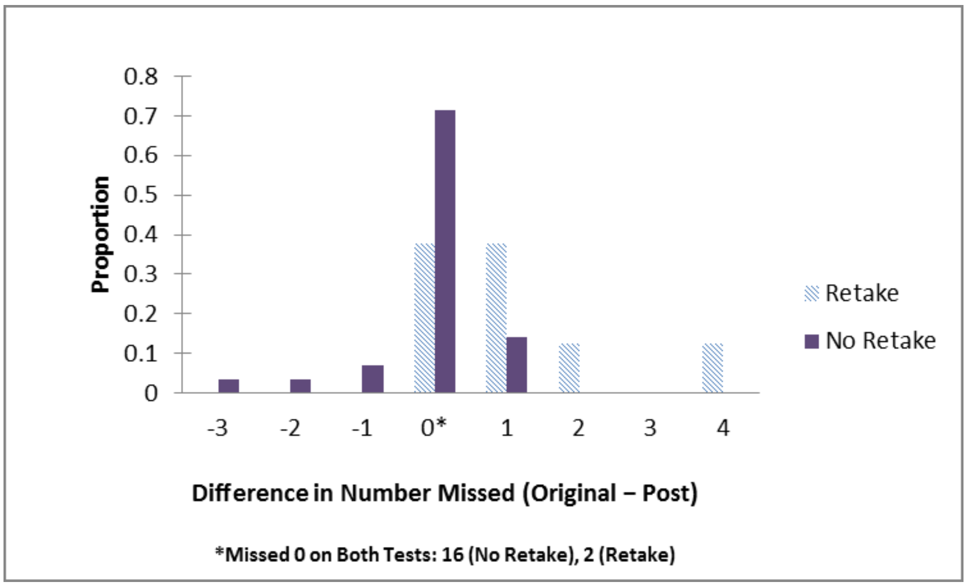


Figure 16: Comparison of Performances on Basic Trigonometry Learning Target 7

APPENDIX BB:

Figure 17: Comparison of Performances on Basic Trigonometry Learning Target 8

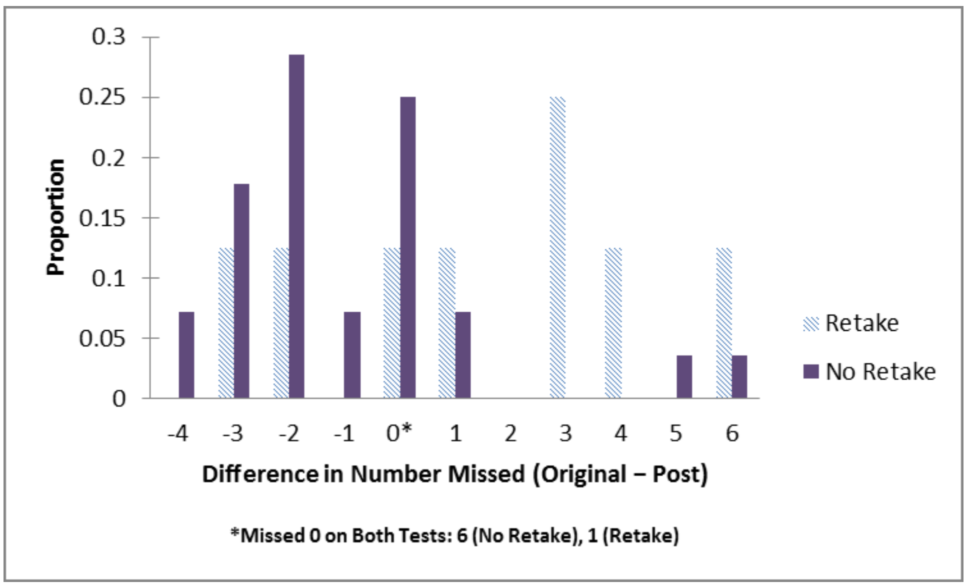


Figure 17: Comparison of Performances on Basic Trigonometry Learning Target 8

APPENDIX CC:

Figure 18: Comparison of Performances on Basic Trigonometry Learning Target 9

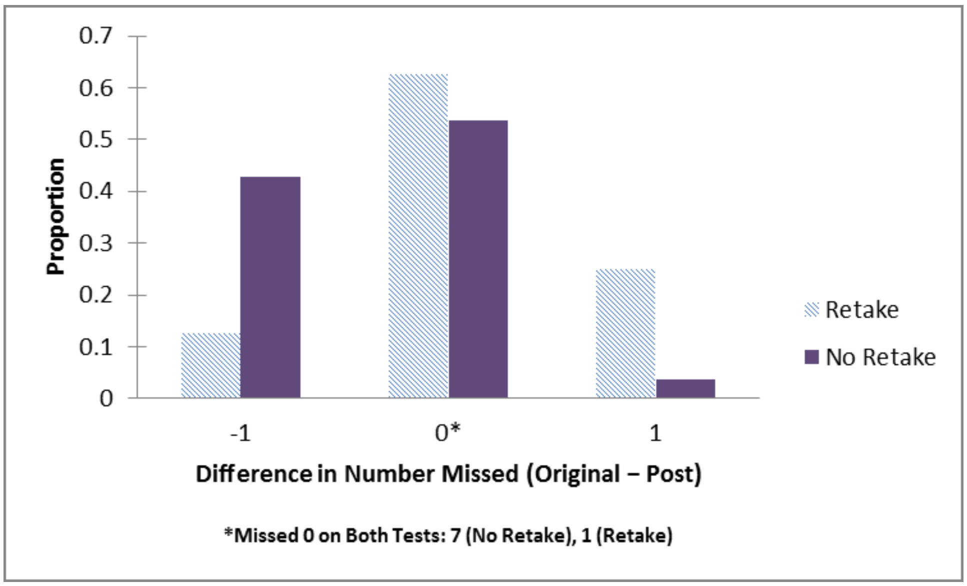


Figure 18: Comparison of Performances on Basic Trigonometry Learning Target 9

APPENDIX DD:

Figure 19: Comparison of Performances on Basic Trigonometry Learning Target 10

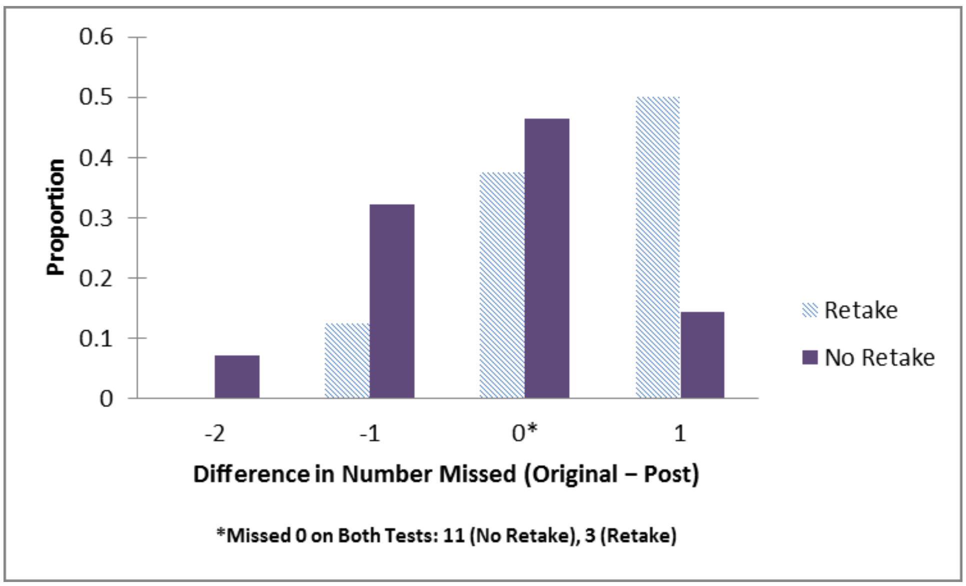


Figure 19: Comparison of Performances on Basic Trigonometry Learning Target 10

APPENDIX EE:

Figure 20: Comparison of Performances on Factoring Learning Target 1

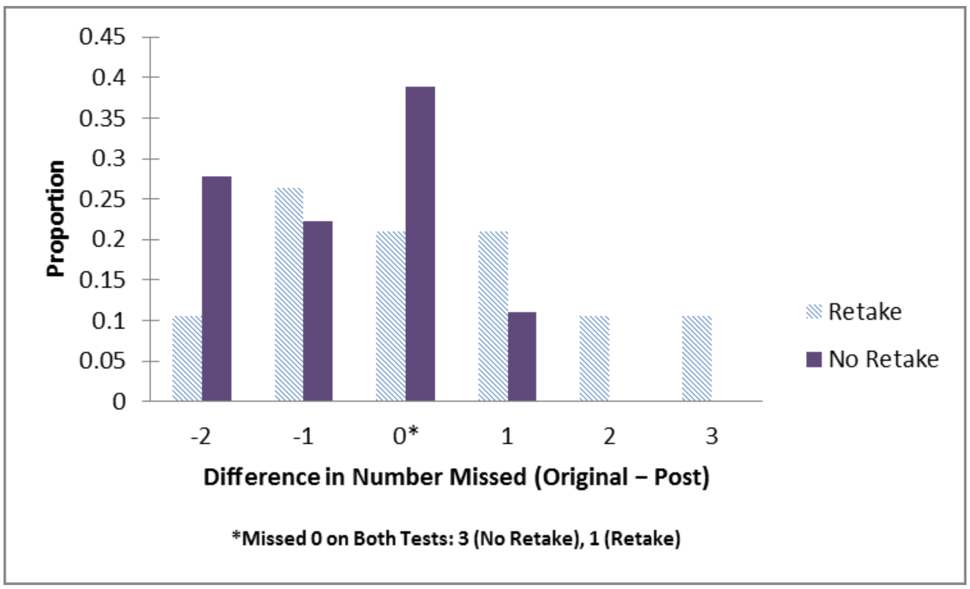


Figure 20: Comparison of Performances on Factoring Learning Target 1

APPENDIX FF:

Figure 21: Comparison of Performances on Factoring Learning Target 2

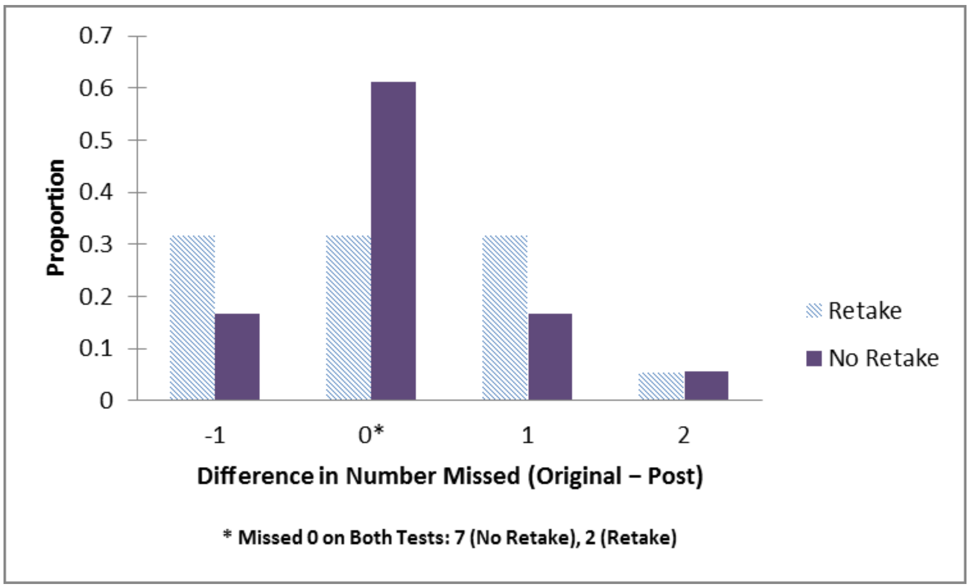


Figure 21: Comparison of Performances on Factoring Learning Target 2

APPENDIX GG:

Figure 22: Comparison of Performances on Factoring Learning Target 3

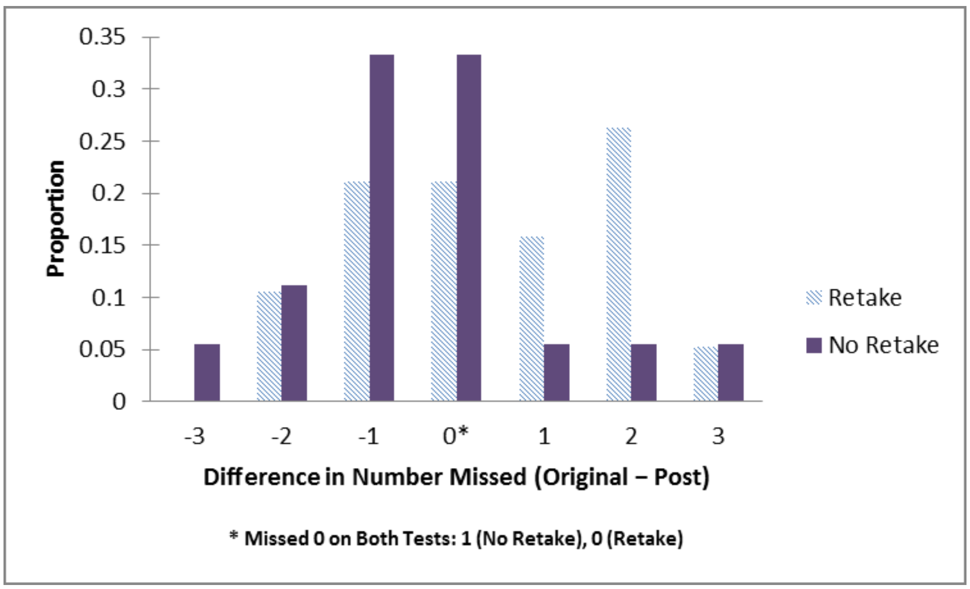


Figure 22: Comparison of Performances on Factoring Learning Target 3

APPENDIX HH:

Figure 23: Comparison of Performances on Factoring Learning Target 4

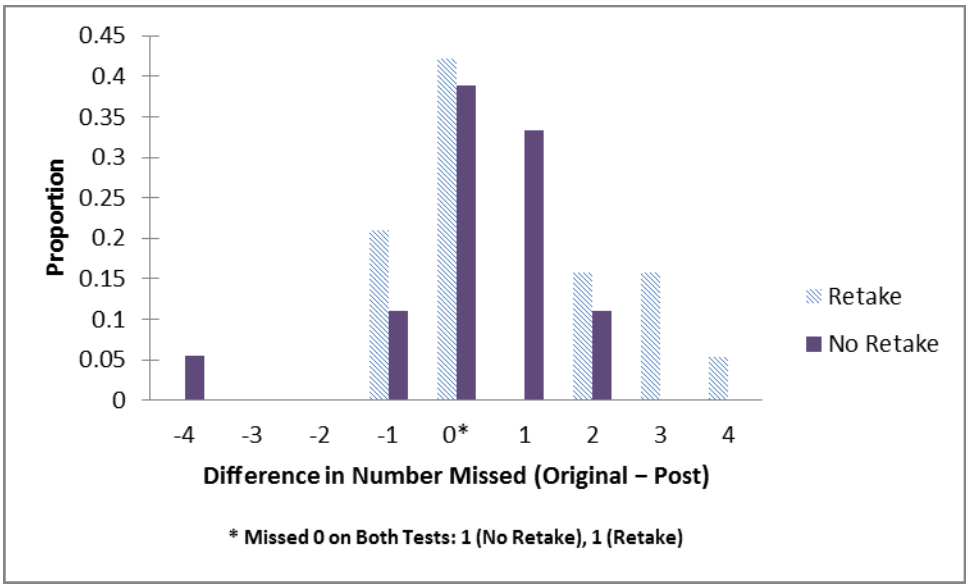


Figure 23: Comparison of Performances on Factoring Learning Target 4

APPENDIX II:

Figure 24: Comparison of Performances on Factoring Learning Target 5

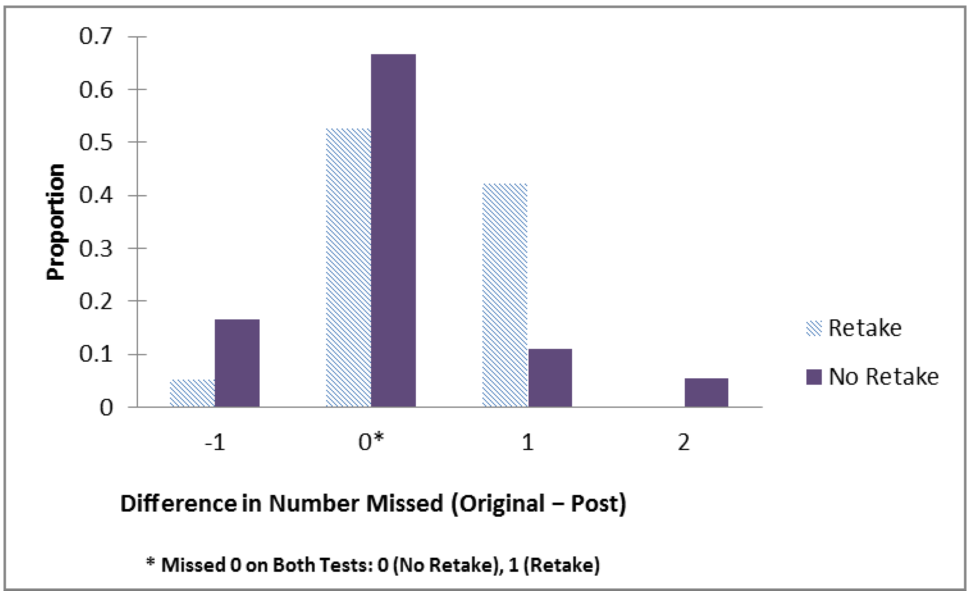


Figure 24: Comparison of Performances on Factoring Learning Target 5