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EMPHASIZING PERFORMANCE EXPECTATIONS TO INCREASE STUDENT ACHIEVEMENT

Abstract

This action research plan examines if emphasis on Algebra 1 Performance Expectations through unit plans, quizzes, and tests can increase student achievement on the Washington State End of Course Exam for Algebra. The study involved 42 high school students enrolled in two Algebra 1 classes in the researcher's school district. Students were introduced to performance expectations daily through unit lessons. Students were then assessed on those performance expectations through unit quizzes and tests, as well as through quizzes that were designed specifically to meet individual performance expectations. The study results indicated students' scores were significantly higher on the Algebra End of Course exam in comparison to their 8th grade assessment. Furthermore, particular performance expectations were found to be helpful in predicting students' success on the Algebra End of Course Exam.

PURPOSE

The purpose of this action research is to increase student achievement on the Algebra 1 End of Course Exam by emphasizing Performance Expectations throughout unit plans and subsequent assessments which focus on those expectations.

BRIEF INTRODUCTION AND PROBLEM STATEMENT

In past years, governmental and educational organizations have criticized the state of Washington for its approach to mathematics. In comparison to other state standardized tests "The WASL Mathematics Test is the least challenging…most notably because the content is less rigorous" (Achieve, Inc., 2005, p. 36). The Office of the Superintendent of Public Instruction has put much effort in the last few years towards updating the state standards and changing its standardized tests. Despite their efforts towards improvement, students still do not perform well on the End of Course Math Assessments in the researcher's school district. The researcher would like to determine if emphasizing Algebra 1 Performance Expectations in unit plans and assessments can raise awareness of standards and contribute to the achievement of students taking the Washington State End Of Course Assessment (EOC) for Algebra.

BACKGROUND

The researcher is employed by a smaller school district, suffering from low passing rates on Washington State mathematics assessments currently called the EOC. In the researcher's school district, 55.1% of students passed the Algebra EOC during the 2010-2011 school year compared to 64.3% statewide (Office of Superintendent of Public Instruction, 2012). Students in the researcher's district are not performing well on state math assessments. Several factors may contribute to the lower achievement level of students in this district including; poor alignment of the K-12 curriculum, misguided student placement into math classes, a student lack of effort or motivation, as well as the number of low income families in the district. In the 2010-2011 school year, 44% of students were on free or reduced lunch; a number that has increased every year since 2006. (Office of Superintendent of Public Instruction, 2012)

Until recently, the district had not aligned its K-12 math curriculum with the Washington State Standards. There were several pieces of alignment that were missing. The curriculum was never checked to make sure it was coherent with the Washington State Standards. The district lacked horizontal alignment; teacher's teaching the same content areas were free to move at their own pace. There was also no vertical alignment; as students moved from grade level to grade level there was no set skills that they were supposed to have learned. The lack of alignment likely led to gaps or omissions in the math content being taught. The recent adoption of new curriculum may be a solution to this problem, with evidence of improvement soon to emerge.

Another issue of concern is placing students at a level in which they can be most successful. School Districts strive to have students take more rigorous classes. "In less than two decades, policies designed to push eighth graders into algebra classes have succeeded in doubling the percentage of students enrolled in advanced mathematics" (Bracey, 2009, p. 57). However, one consequence of these policies is "large numbers of students taking courses for which they are unprepared" (Bracey, 2009, p. 57). The researcher's district has pushed many students into advanced classes, without assessing their preparedness. Consequently, students taking advanced courses struggle, because they are unprepared for the level of rigor in those courses.

Contributing to the problem may be low standards in Elementary and Middle Schools. It is the researcher's experience that students entering into high school Algebra 1 classes are often unprepared. "Students gain little by being forced into classes that are over their heads" (Bracey, 2009, p. 58). If a student does not learn the required content at each grade level, learning the content at successive levels is going to be more difficult. In the end, a large number of high school students lack lower level math skills.

From the researcher's experience, student attitudes towards schoolwork, homework, and education in general, have also proven to be an issue. Many students do not see the benefits of class work and homework, and so, choose not to complete much of it. A number of teachers within the district have spoken of the same problem within their classrooms. Without the requisite mathematical concepts and skills required by the state, students may leave high school with considerable gaps in their knowledge.

Finally, the researcher suspects that student motivation is negatively affected by the misunderstanding of the importance of performance expectations. The researcher has noticed student complaints about learning new material every day. Students do not make the connection between concepts or link how they build upon each other. Students fail to recognize the class goals, which are the state performance expectations. Because they see no goals, there is no value in the concepts being taught. Helping students recognize Algebra 1 goals and building on mastery of the standards should add motivation and consequently value.

SIGNIFICANCE OF STUDY

The purpose of this study is to determine if emphasizing Algebra 1 Performance Expectations through unit plans and subsequent assessments contributes to higher student achievement on the Washington State End Of Course Assessments. In completing this study, the researcher hopes to raise awareness of standards and build confidence within students so

they feel prepared for the End of Course Exam. Furthermore, the researcher hopes the added knowledge may prove to increase students' ownership of learning in the mathematics classroom in general.

RESEARCH QUESTION

Does emphasizing Algebra 1 Performance Expectations, in unit planning and assessments contribute to higher student achievement on the Washington State End Of Course Assessment?

REVIEW OF THE RELATED LITERATURE

The researcher found three areas of importance to this study. One goal is to increase student achievement on the End of Course Exam, so research on Standardized Testing is appropriate. Second, learning targets are explored as the Performance Expectations will be used as daily learning targets. And last, it is important to examine the importance of redundant assessment as this will be another treatment method used in this action research study. Further insight into these three categories, will provide evidence to support the researcher's study.

Standardized Tests

The Algebra End of Course Exam is a Standardized Test for students in Washington. The researcher hopes to increase achievement on the EOC so examination of Standardized Testing is appropriate. Obviously standardized tests (ST's) are one way of holding school districts and teachers accountable for what they are teaching. More importantly, they are useful tools for assessing student achievement and can be used to focus instruction on desired standards or outcomes. One of the main advantages to STs is the amount of data collected over time. Through repetition, the tests are determined to have a high degree of reliability and validity, meaning the test results can often be replicated and generalized. Another advantage to STs is that they can assess mastery of certain topics, skills, and concepts. They can be used to assess a student's preparedness for the next level of instruction. STs can also be used to keep teachers and school districts accountable. The tests can be helpful in showing whether or not students are receiving the level of instruction that is necessary for their success. However, many critics feel these high-stakes tests harm teaching and learning by narrowing the breadth and depth of curriculum. School districts and teacher's get so wrapped up in the task of making sure that students perform well on STs that they essentially end up teaching to the test. This leads to covering a large amount of content, without emphasizing mastery of the content. Also, when teachers spend an excessive amount of time preparing for tests, they focus so much on content standards that process standards, such as problem solving, are often lacking. Wiggins has "found that far too many of our students at all grade levels do poorly on questions requiring inference," and argues that "teaching for greater understanding would improve results" (Wiggins, Bashing State Tests, 2010, p. 49).

"Given the tradition of social promotion and variable expectations in many schools, serious standards are only credible in the U.S. when validated by high-stakes tests" (Tucker, 2011, p. 434). STs are important in the assessment of student achievement and school district accountability. And because they are one of the few ways to measure both of these factors,

they are a necessary diagnostic tool in education. In order to raise the scores on high-stakes tests in her school district, the researcher has chosen to raise awareness of standards in her classroom so that students can be successful on the Algebra EOC exams.

Performance Expectations

One part of the treatment employed in this action research plan is daily emphasis on the Washington State Standards known as performance expectations (PE's). The PE's will be used as learning targets or daily student objectives outlining what math skills students should be able to complete by the time they finish the lesson. Learning targets help students understand what skills and knowledge are important in the lessons. They give direction by showing students where they are going, and what they will be able to do when they get there. "They (learning targets) enhance student learning and achievement only when educators commit to consistently and intentionally sharing them with students" (Moss, Brookhart, & Long, 2011, p. 68).

> Definite directions, rules, standards, and parameters should be set to give students guidance in performing a skill or creating a product, because these will be used to measure student progress toward mastery and excellence. Students should understand that their product and performance are pitted against a clear standard – not against the subjective judgment of a teacher. Therefore, nothing is arbitrary, but instead, there are clear expectations and categories of performance. Students must be aware of that which they must master – and then be given opportunity to prove it. (Jones, 2003, p. 15)

The use of learning targets parallels an instructional technique that Marzano refers to as Goal Specification. In a meta-analysis, Marzano found that when goal specification was used prior to a lesson, students averaged a percentile gain of 34 points. Marzano also noted that goals do not have to be extremely specific, and leaving them a little open to student interpretation actually increased the effect size compared to specific goals (Marzano, 1998, p. 94). Similar to Marzano's technique, the researcher will emphasize PE's daily when introducing the lesson. Furthermore, the PE's are not specific, and a discussion with students could be useful in understanding the goals of each PE as well as how PE's connect to one another.

The researcher hopes to increase student motivation through emphasis of the PE's as learning targets. Student motivation can often be attributed to a lack of understanding and a lack in relevancy of content. Wiggins and McTighe state that "these problems are interrelated…They can be traced to one underlying factor – the lack of clarity about the goals of high school education" (Wiggins & McTighe, Put Understanding First, 2008, p. 36). Moss found that, "when teachers consistently shared learning targets in meaningful ways, students quickly became more capable decision makers who knew where they were headed and who shared responsibility for getting there" (Moss, Brookhart, & Long, 2011, p. 68).

Redundant Assessment

Assessing students in multiple ways is another strategy that the researcher plans to implement. Some of the assessments will be brief formative assessments such as an entry task or homework. Other assessments will be PE quizzes, unit quizzes, and unit tests. The PE quizzes

will be used as a diagnostic tool to assess how students are performing on individual standards. The unit quizzes and tests will assess multiple PE's at once. The reasoning behind multiple assessments is that repetition, or practice is a key to success. Jensen writes, "The simple fact is that repetition strengthens connections in the brain…the more we use an idea correctly, the more we activate a skill or complete the same process, the smoother, faster, and more accurate we get at it" (Jensen, 2005, p. 38).

Assessments are only as useful as the feedback that is provided after the assessment. Jones stressed the need for ongoing and multiple forms of assessment. As noted above, the researcher plans to use several forms of assessment. With each of these there will be varying levels of feedback used. Students will be able to chart their own progression through the PE's using a checklist provided by the researcher. Answers to daily warm-ups and homework will be another way for students to self assess their progress. However, the PE quizzes, unit quizzes, and tests will be a primary source for the researcher to provide feedback to the students on achievement relative to PE's. In many cases there will be a chance for students to fix mistakes in order to strengthen their understanding of the skill. "If children know at any given time where they are on the road to the performance goal, there will be more likelihood of intrinsic motivation" (Jones, 2003, p. 123). The researcher aims to create opportunities for students to assess their progress in class, and opportunities to make improvements where needed.

METHODOLOGY

The population of interest for this action research study is all students enrolled in Algebra 1 in the researcher's school district. This is a convenience sample as the participants are the 42 students enrolled in the researcher's Algebra 1 classes. Students are placed into Algebra 1 classes based on other factors of scheduling. Counselors choose which class to add a student to after they have placed them into elective courses. Although assignment to classes is not random, it could still be considered relatively representative of the population of students required to take algebra.

TREATMENT AND DATA COLLECTION

All students enrolled in the researcher's Algebra 1 courses will receive a check list of performance expectations to visualize what will be covered throughout the year. The goal is to use the checklist on a daily basis to refer to PE's being addressed. Also, the checklist will serve as a point of reference to reflect on periodically throughout the year to show progress. The researcher will emphasize performance expectations used in daily lessons including process expectations which will be practiced continuously through daily work. Emphasis on PE's will include stating the PE in the introduction to the lesson, and having students explain the connection between the lesson and the PE at the end of the class. Daily warm ups, based off of the previous days PE, will also be used to provide review.

Quantitative Data for this action research study will be collected through multiple forms of assessment. PE quizzes will assess each student's ability at a point in time where mastery of the PE should have occurred. Only PE's included on the Algebra EOC will be quizzed. The PE quizzes will have 5 questions. Question 1 will be a very basic content question in the form of multiple choice. Question 2 will be a basic content question in the form of free response.

Question 3 will be similar to that in which a student could expect to see on the Algebra EOC. These will be gathered from Algebra EOC practice problems. Question 4 will be a guided problem solving question. And last, question 5 will be an open-ended problem solving question. PE quizzes will be developed by the researcher. (See Appendix A for sample treatments)

Mid-Chapter Quizzes and Tests are another form of assessment that will determine student performance on PE's. These will provide more Quantitative Data and can be used to assess multiple PE's at once. Individual PEs will be labeled next to each question on quizzes and tests. These assessments are common throughout the math department at the researcher's school. They have been developed in previous years by colleagues in the math department. Therefore they have already been assessed for validity and reliability and any needed changes have been made to improve the assessments.

The final quantitative assessment of student achievement will be the results of the Algebra EOC. These results will be used to assess the student's overall knowledge of the PE's. Although it will not be possible to determine the performance of students on individual PE's, the Algebra EOC will provide a culminating value.

ANALYSIS

In this section, the researcher examines the data to determine whether student achievement on the Algebra EOC increased. The analysis also includes data that may be useful in predicting EOC scores. And last, the researcher will provide insight into specific PE's that were found to be the most indicative of how students will perform on the Algebra EOC.

Student Achievement on State Exams Increased

One goal of this action research is to determine if student achievement increased as a result of the treatments imposed. In Washington, all 3rd through 8th graders take a Measurement of Student Progress Exam (MSP) for math. In High School they take an End of Course Exam for Algebra and Geometry. Students receive a scaled score on these exams, which places them in a math achievement level. These tests are designed so that the scores can be compared across years.

Figure 1 shows the distribution of MSP scores by level for students in the researcher's classes. The distribution is slightly skewed right, as more students scored at level 1 or level 2. Level 3 and level 4 are considered passing, and only 38% of students in the researcher's classes passed the mathematics portion of the MSP as

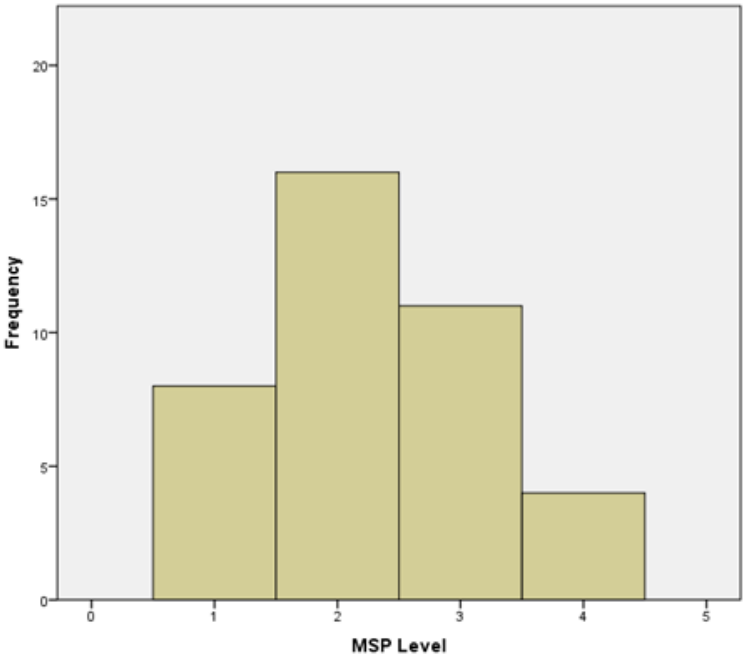

Figure 1. **Distribution of MSP levels.**

8th graders.

Figure 2 shows the distribution of Algebra EOC scores by level for students in the researcher's classes. The distribution is roughly symmetric for this test. Similar to the MSP, scoring a level 3 or level 4 on the EOC is considered passing, and 53% of students in the researcher's class passed. This shows that more students passed the Algebra EOC than the 8th grade MSP.

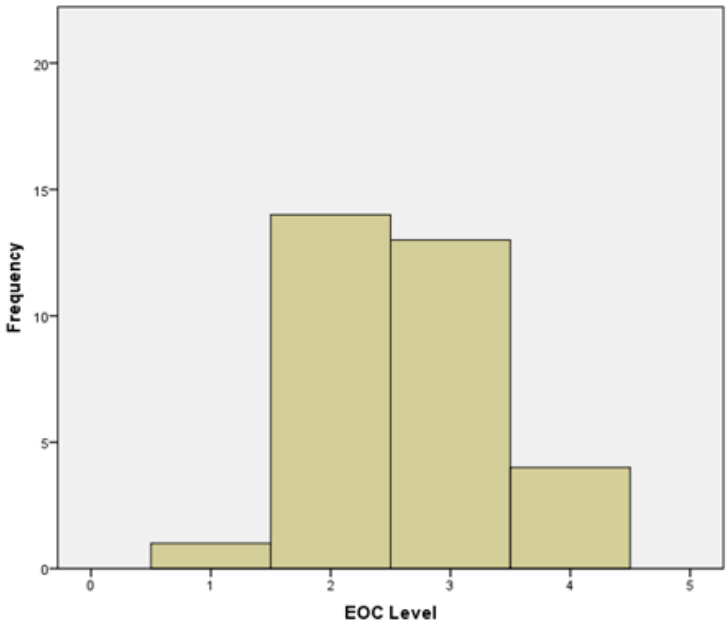

Figure 2. **Distribution of Algebra EOC levels.**

Figure 3 shows individuals' scores on the MSP compared to their Algebra EOC scores. The line models where MSP scores and Algebra EOC scores are equal. Points above the line are students who scored higher on the Algebra EOC than on the MSP. In comparing individual students' MSP scores to their Algebra EOC scores, 23 out of 32 students' scores improved. This means that approximately 72% of students in the researcher's class improved on the state mathematics test.

A paired samples t-test was conducted to evaluate whether the mean Algebra EOC scores were significantly different than the mean MSP scores. The results indicated that the mean Algebra EOC score ($M = 405$, $SD = 32$) was significantly greater than the mean MSP score ($M = 391$, $SD = 25$), $t(29) = -2.91$, $p < .01$. A 95% confidence interval suggests that the mean improvement (EOC - MSP) in students' scores is between 4.3 and 24.4 points. This means that on average, students Algebra EOC scores were between 4 and 24 points higher than that of their MSP scores. Furthermore, a linear regression analysis was conducted to evaluate how well the MSP scores predict Algebra EOC scores. The scatter plot, as shown in Figure 3, indicates that the two variables are linearly related such that as the student's MSP score increases their Algebra EOC score also increases. The regression equation for predicting the Algebra EOC score is

EOC Score = 0.74(*MSP Score*) + 114.

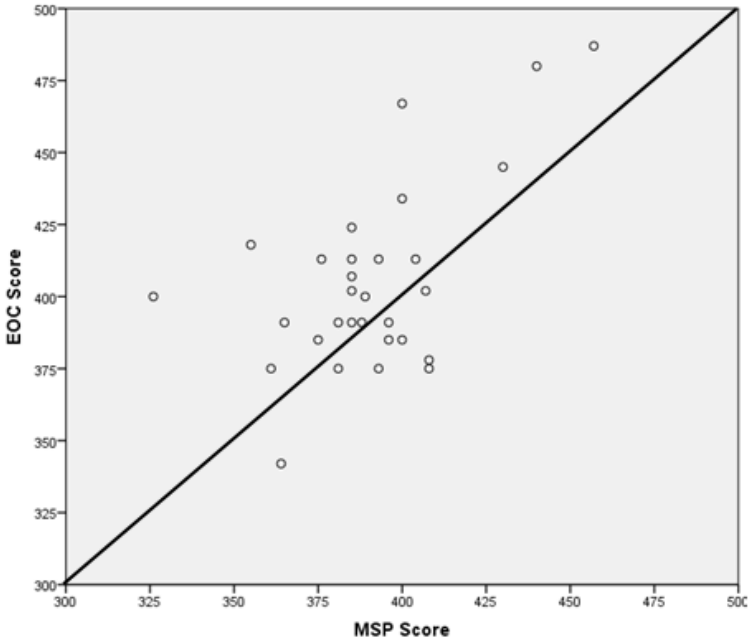

Figure 3. **Individual students' MSP scores compared to Algebra EOC scores.**

This regression equation implies that if a student scores at least 387 on their MSP they should pass the Algebra EOC with the minimum score of 400. The linear combination of MSP scores was significantly related to students' Algebra EOC scores, $F(1, 28) = 14.28$, $p < .01$. The correlation coefficient was moderate at .58, indicating that approximately 34% of the variation in Algebra EOC scores can be explained by the linear relationship between 8th grade MSP scores and Algebra EOC scores.

One thing to note is that the researcher's Algebra 1 classes are a mix of students from all different grade levels. Table 1 shows the distribution of students from each grade level in the researcher's classes.

Table 1

Distribution of Students in Researcher's Classes by Grade Level

Freshman	Sophomores	Juniors	Seniors
25	5	10	2

The paired samples t-test mentioned before compares MSP scores to Algebra EOC scores for all students in the researcher's classes. However, for some students, these tests were several years apart. Additionally, these students may have taken Algebra 1 more than once in their high school careers. The researcher wanted to see if results of the paired sample t-test would change if only freshman, who are in their first year of Algebra 1, are included in the test.

The results for the t-test indicated that for freshman alone, the mean Algebra EOC score ($M = 408, SD = 35$) was also significantly greater than the mean MSP score ($M = 394, SD = 27$), $t(22) = -2.31$, $p = .03$. Furthermore, a 95% confidence interval suggests that the mean improvement (EOC - MSP) in students' scores is between 1.4 and 27.0 points. This means that on average, freshman Algebra EOC scores were between 1 and 27 points higher than that of their MSP scores.

In summary, students' achievement on the Algebra EOC increased in comparison to 8th grade MSP scores. This was shown to be true for both 9th graders who are taking the EOC for the first time and, more importantly, for a majority of students in the researcher's classes. Furthermore, students' 8th grade MSP scores can be helpful in predicting achievement on their Algebra EOC scores.

Predicting Student Performance on the Algebra EOC

With evidence to support increased student achievement, it would be beneficial to analyze which treatments the researcher imposed that may predict student achievement on the Algebra EOC. The researcher used several treatments that assessed individual PE's including quiz scores, test scores, and PE Quiz scores. There were 173 PE specific questions that were assessed in this action research.

A linear regression analysis was conducted to evaluate how well the number of assessed PE's that students answered correctly predicts Algebra EOC scores. The scatter plot, as shown in Figure 4, indicates that the two variables are linearly related such that as the number of correct PE's increases the Algebra EOC score also increases. The regression equation for predicting the Algebra EOC score is

EOC Score = 1.25(*Correct PE's*) + 300.

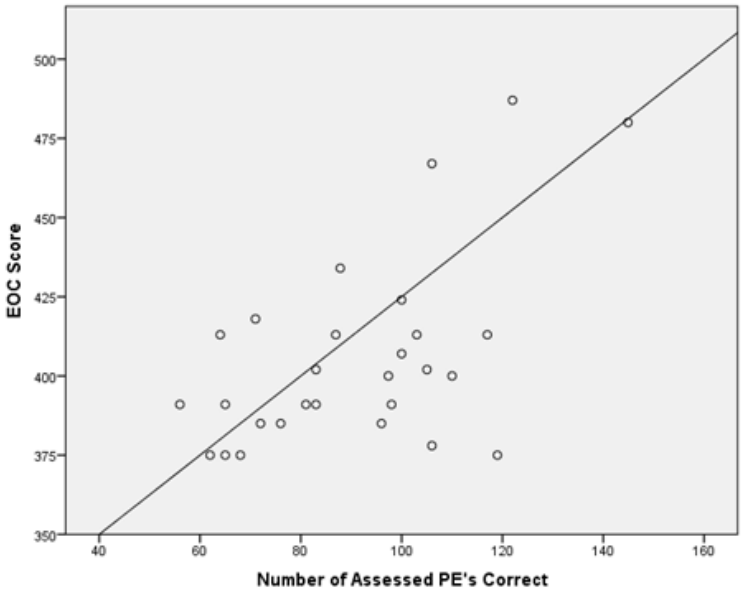

Figure 4. **Total number of correct PE's compared to Algebra EOC score.**

This regression equation implies that if a student can correctly answer at least 80 of the PE's assessed in class they should pass the Algebra EOC with the minimum score of 400. The linear combination of PE's assessed was significantly related to students' Algebra EOC scores, $F(1, 26) = 12.25$, $p < .01$. The correlation coefficient was moderate at .56, indicating that approximately 32% of the variation in Algebra EOC scores can be explained by the linear relationship between the number of assessed PE's that were correct and the Algebra EOC score.

Looking further into the data, the boxplots in Figure 5 explore the relationship between the levels that students scored on the Algebra EOC in comparison to the percent of correctly answered PE's. Students scoring at a level 2 or 3 had very similar ranges when it came to the percent of PE's they answered correctly falling between 35% and 70%. The range for level 4 is between 60% and 85%, however, it looks as though students, who can answer at least 70% of assessed PE's correctly, are almost guaranteed to pass the test with a level 4 rating.

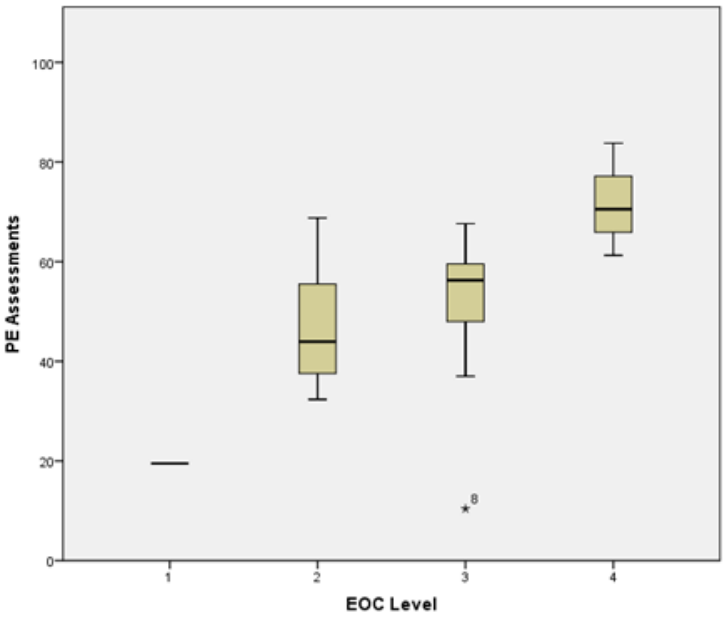

Figure 5. **Percentage of correct PE assessments by Algebra EOC level.**

Overall, it seems that how well students perform on the PE's that are assessed in the researcher's class is a relatively good indicator of how well they will fare on the

Algebra EOC. However, more analysis will show if there are individual PE's that may actually be more predictive of students' success on the Algebra EOC.

PE's Predicting Algebra EOC Scores

This action research used several quizzes and tests to assess students' performance on individual PE's. Consequently, there were varying numbers of items that assessed each PE. Table 2 shows the number of questions from the 10 PE specific quizzes, 5 chapter quizzes, and 5 chapter tests the researcher used to assess each PE.

A multiple regression analysis was conducted to evaluate how well the PE's predict Algebra EOC scores. The predictors were all PE's assessed during this action research (listed in Table 2), while the criterion variable was the student's Algebra EOC scores. The linear combination of PE's assessed was significantly related to students' Algebra EOC scores, $F(16, 13) = 2.94$, $p = .03$. The sample multiple correlation coefficient was .89, indicating that approximately 78% of the variation in Algebra EOC Scores can be explained by the linear combination of PE's assessed.

In Table 3 the significance level for each predictor is shown. There are two predictors that stand out above the rest. The first is A1.1.C, which was statistically significant ($p = .003$). The second, A1.2.F, is not statistically significant ($p > .05$), but still has a low p-value ($p = .102$) showing it has an impact on this multiple regression model.

Table 2

Number of questions assessed per PE

PE	Number of Questions
A1.1.C	6
A1.1.D	1
A1.1.E	3
A1.2.C	20
A1.2.E	17
A1.2.F	20
A1.4.A	18
A1.4.B	13
A1.4.D	23
A1.5.C	5
A1.6.A	17
A1.6.B	9
A1.6.C	7
A1.6.D/E	9
A1.7.A	2
A1.7.C	3
Total	173

Table 3

Significance of Predictors on Algebra EOC Scores

Predictors	t	Sig.
A1.1.C	3.724	0.003**
A1.1.D	-0.003	0.998
A1.1.E	0.206	0.840
A1.2.C	0.861	0.405
A1.2.E	0.477	0.641
A1.2.F	1.759	0.102*
A1.4.A	-0.381	0.709
A1.4.B	0.547	0.594
A1.4.D	-0.794	0.441
A1.5.C	-1.311	0.213
A1.6.A	0.788	0.445
A1.6.B	-1.288	0.220
A1.6.C	0.188	0.854
A1.6.D/E	-0.563	0.583
A1.7.A	-1.516	0.154
A1.7.C	0.055	0.957

* $p < .11$, ** $p < .01$

To determine how well these two PE's of interest predict Algebra EOC scores, a multiple linear regression was performed. The predictors were A1.1.C and A1.2.F, while the criterion variable was the student's Algebra EOC scores. The linear combination of A1.1.C and A1.2.F was significantly related to students' Algebra EOC scores, $F(2, 27) = 25.09$, $p < .01$. The sample multiple correlation coefficient was .81, indicating that approximately 66% of the variation in Algebra EOC scores can be explained by the linear combination of these two PE's.

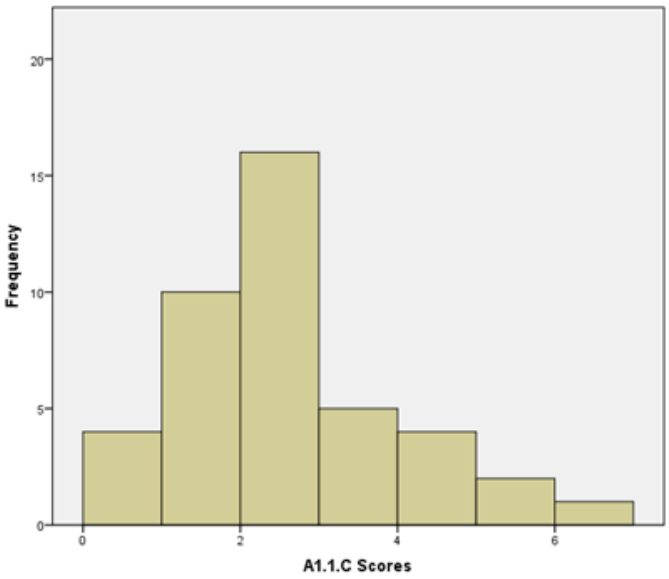

Figure 6. **Scores for questions assessing PE A1.1.C.**

The histogram in Figure 6 shows the distribution of scores for the A1.1.C PE. There were 6 questions assessed for this PE. The distribution is slightly skewed right with a median of 3. This shows that although a majority of students scored less than half of the questions assessing this PE correctly, it was still a predictor for scores on the Algebra EOC. There are many reasons why this PE may be a good predictor of Algebra EOC scores. A1.1.C involves solving systems of equations and inequalities. However, if a student is able to solve a system of equations, they should be able to solve equations and inequalities in one variable. They may also be able to model situations using equations. Furthermore, they should be proficient in applying order of operations on both numbers and variables.

The histogram in Figure 7 shows the distribution of scores for the A1.2.F PE. There were 20 questions assessed for this PE. The distribution is roughly symmetric with a center at 8. Again, this histogram shows that a majority of students scored less than half of the assessed questions correctly. A1.2.F, involves operations such as addition, subtraction, multiplication, and division of polynomials. Again, this is a tool that is essential to Algebra and showing proficiency in this skill, may lead to success in other skills. Perhaps this is why it was shown to be a good predictor of Algebra EOC scores.

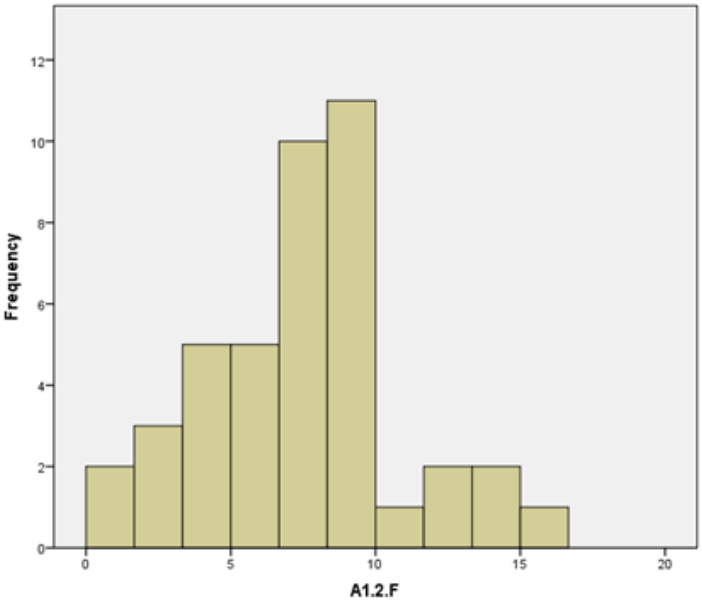

Figure 7. **Scores for questions assessing PE A1.2.F.**

There are many skills in Algebra 1 that solving systems of equations and operating on polynomials can extend to. Therefore, if students are proficient in these two skills, it makes sense that they may also be proficient in many

others. Although it seems surprising that Algebra EOC scores are fairly highly related to only two of the PE's, it is somewhat understandable given what skills these PE's are assessing. Table 4 below shows the PE's that were assessed during this action research.

From the researcher's experience, the PE's that were not significant in the multiple regression analysis tend to be more difficult for students to master than the two PE's that were significant. They involve working with quadratics, exponentials, and even statistics. Furthermore, in analyzing the p-values from Table 3, many of the highest p-values are for PE's that the researcher did not focus on in class. For example, A1.1.D, A1.1.E, and A1.7.C are PE's that were not used as learning targets and did not have a PE quiz associated with them. Therefore, they were not assessed as frequently as many of the other PE's. Understandably, they were not shown to be significant in the multiple regression.

Table 4

Assessed Algebra PE's

PE	Skill
A1.1.C*	Solve problems that can be represented by a system of two linear equations or inequalities
A1.1.D	Solve problems that can be represented by quadratic functions and equations.
A1.1.E	Solve problems that can be represented by exponential functions and equations.
A1.2.C	Interpret and use integer exponents and square and cube roots, and apply the laws and properties of exponents to simplify and evaluate exponential expressions.
A1.2.E*	Use algebraic properties to factor and combine like terms in polynomials.
A1.2.F*	Add, subtract, multiply, and divide polynomials
A1.4.A*	Write and solve linear equations and inequalities in one variable.
A1.4.B*	Write and graph an equation for a line given the slope and the y-intercept, the slope and a point on the line, or two points on the line, and translate between forms of linear equations
A1.4.D*	Write and solve systems of two linear equations and inequalities in two variables.
A1.5.C	Solve quadratic equations that can be factored as (ax + b)(cx + d) where a, b, c, and d are integers.
A1.6.A*	Use and evaluate the accuracy of summary statistics to describe and compare data sets.
A1.6.B*	Make valid inferences and draw conclusions based on data.
A1.6.C*	Describe how linear transformations affect the center and spread of univariate data.
A1.6.D*/E	Find the equation of a linear function that best fits bivariate data that are linearly related, interpret the slope and y-intercept of the line, and use the equation to make predictions.
A1.6.D/E*	Describe the correlation of data in scatterplots in terms of strong or weak and positive or negative
A1.7.A*	Sketch the graph for an exponential function of the form y = abn where n is an integer, describe the effects that changes in the parameters a and b have on the graph, and answer questions that arise in situations modeled by exponential functions.
A1.7.C	Express arithmetic and geometric sequences in both explicit and recursive forms, translate between the two forms, explain how rate of change is represented in each form, and use the forms to find specific terms in the sequence.

*PE's that were assessed with a PE specific quiz

Equity in Semester Grades for Gender, Period, and Graduation Year

While analyzing data, the researcher discovered some interesting facts about equity in assessment of students. These discoveries can generalize to the researcher's teaching as well.

Figure 8 shows box plots for students' second semester grades by gender. The female plot is approximately normal ranging from 53%-97% with a center at 79%. The male plot is slightly skewed left ranging from 20%-94%, with a center at 68%. Although these boxplots look very different, mostly due to the difference in ranges, the means for 2nd semester grades for boys and girls are not significantly different.

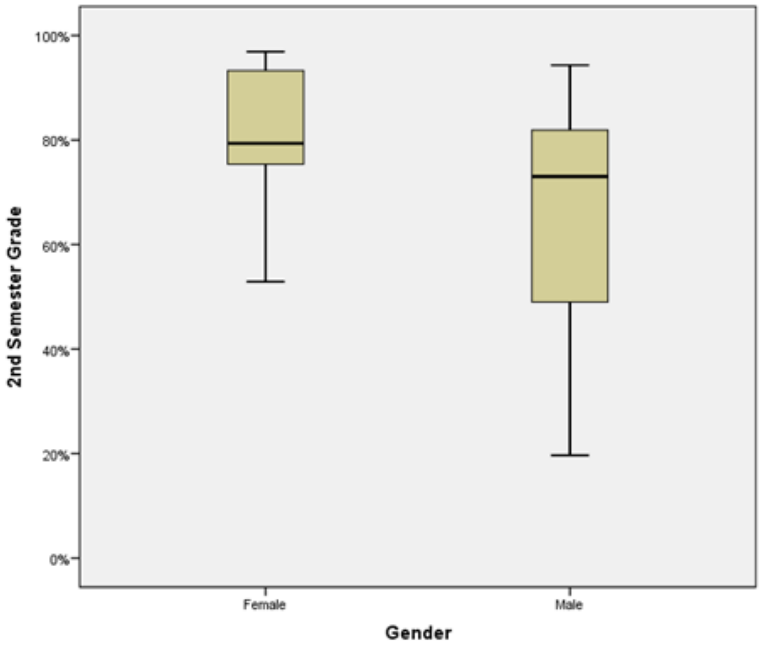

Figure 8. **Second semester grades for males and females.**

An independent samples t-test was conducted to evaluate whether the second semester grades were significantly different for males and females. The results indicated that the mean grade for females (*M = 79%, SD = 14%*) was not significantly different than the mean grade for males (*M = 67%, SD = 19%*), $t(40) = 2.30$, $p = .33$. This implies males and females are receiving similar grades in the researcher's classes.

The same can be shown regarding class period. Figure 9 shows boxplots for students' second semester grades by class period. The 1st period class is skewed left ranging from 20%-97% with a center at 79%. The 4th period class is slightly skewed left ranging from 35%-96%, with a center at 74%. The boxplots for these two class periods are very similar.

An independent samples t-test was conducted to evaluate whether the second semester grades were significantly different for 1st period and 4th period. The results indicated that the mean grade for 1st period (*M = 73%, SD =*

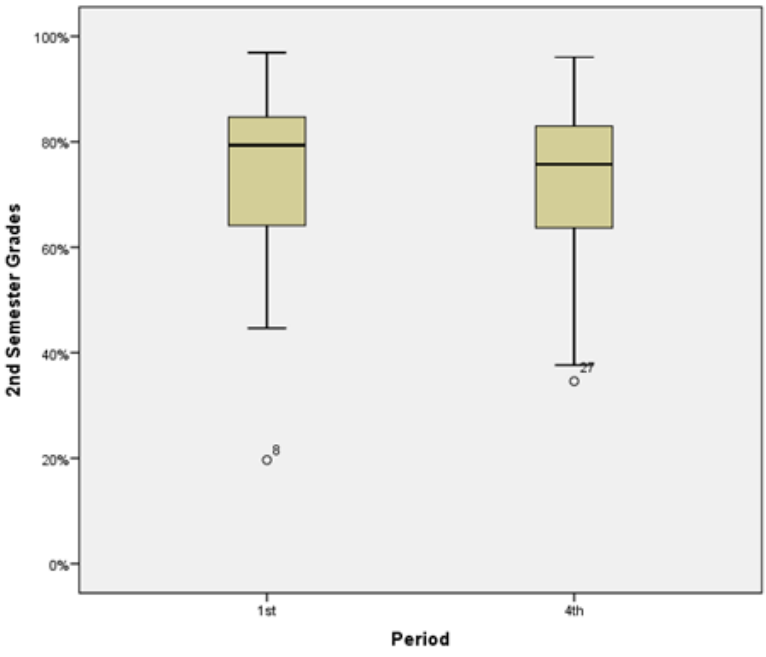

Figure 9. **Second semester grades by class period.**

20%) was not significantly different than the mean grade for 4th period (*M = 72%, SD = 17%*), *t*(40) = .23, *p* =.58. This implies students in the researcher's 1st period and 4th period classes are receiving similar grades.

Similarly, equity can be shown in students' grades in comparison with their graduation year. The boxplot in Figure 10 shows freshman are slightly skewed left with mean of 76%. Sophomores are skewed left with a mean of 65%. Juniors are approximately normal with a mean of 65%. And seniors have a mean of 81%. (Note: There were only two seniors in the class so this is not a very representative group.)

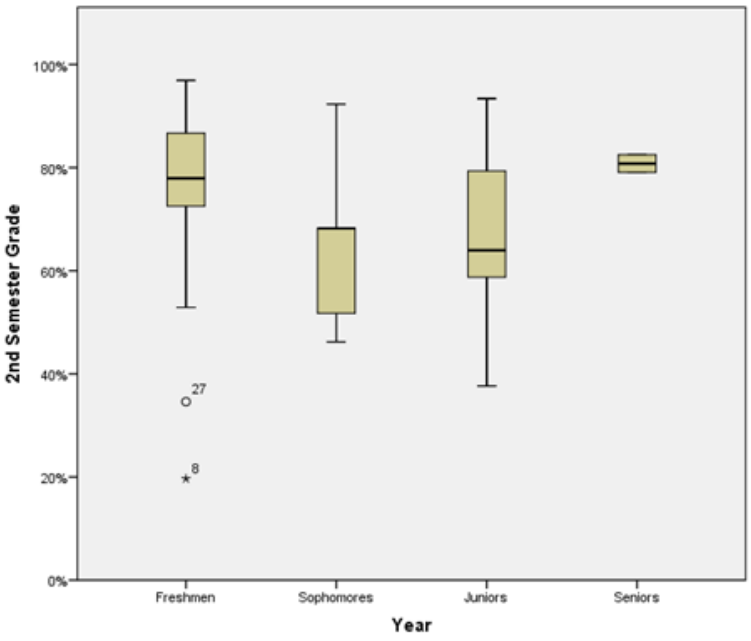

Figure 10. **Second semester grades by graduation year.**

Notice that sophomores had the lowest mean (*M = 65%, SD = 18%*), and seniors had the highest mean (*M = 81%, SD = 2.4%*). Because these two groups showed the largest difference between means, an independent samples t-test was performed to see if this difference was significant. The results indicated that the mean grade for sophomores and seniors was not significantly different *t*(5) = -1.15, *p* =.21. This implies there is no difference in the grades of students in comparison to their graduation year.

These findings are important because they show there is equity in the researcher's grading. In each grouping variable that could indicate bias, such as gender, class period, and grade level, there were no significant differences. Most importantly, this shows the researcher is consistent and equitable when grading both male and female students as well as each Algebra class.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Historically, the researcher's school district has suffered from low achievement on Washington State Assessments for math. The goal of this action research was to increase student achievement by emphasizing PE's in the researcher's classroom. Analysis has shown that students significantly raised their scores on the Algebra EOC compared to that of their 8th grade MSP. Furthermore, the school district as a whole is showing improvement on the Algebra EOC. In the 2011-2012 school year, the passing rate grew to 62%. This improvement has occurred at a time where the percent of students on free and reduced lunch is at an all-time high, reaching 44% during the 2011-2012 school year. (Office of Superintendent of Public Instruction, 2012)

The researcher's school district is showing improvement on the Algebra EOC. More specifically, the researcher's students are also showing improvement. However, the researcher

cannot be confident that this improvement is entirely due to the effects of the treatments imposed in this study. This action research occurred simultaneously with the introduction of new curriculum in the researcher's school. This new curriculum may also be a contributing factor to the increase in student achievement. Further research would be needed to show if the emphasis on PE's alone could help raise student achievement.

Analysis showed that treatments the researcher imposed may be useful in predicting students' scores on the Algebra EOC. For example, students' performance on the PE's that were assessed in class were indicators of how well students' performed on the Algebra EOC. It was also shown that two PE's in particular, A1.1.C and A1.2.F, correlated well with students' scores on the Algebra EOC. However, the researcher noticed that students did not perform as well on any of the assessed PE's as their overall performance in class. For example, the mean percent of assessed PE's that students correctly answered was 50%. Looking at students' second semester grades in the researcher's classes reveals that the average grade was 71%. This shows that students' grades in class are inflated compared to how they are performing on the PE's.

There are several factors that may contribute to the difference in PE assessment compared to overall grades in the class. One factor is that students' grades in class include homework, which is graded on participation. Another factor is questions on quizzes and tests are given partial credit in the researcher's grade book, but for the purpose of assessing PE's, those scores were not given partial credit. The last, and probably most important factor, is that the researcher and the district as a whole need to increase the rigor of the Algebra achievement standards. Although the district has seen huge improvements over the last few years, it is still below the state average. Increasing the rigor in the school district would be beneficial in increasing student achievement on the EOC's.

This action research study has evidence to support that focusing instructional assessment on PE's increased student achievement. However, the researcher would make a few changes before imposing these treatments in future teaching practices. From the researcher's perspective, the emphasis on the PE's as learning targets was beneficial to student learning. It created discussion in class on what the words in the PE's meant, what the intended skills were, and how each PE related to subsequent PE's. A qualitative analysis would be helpful; to assess student opinion of using the PE's as learning targets, and whether they believed this treatment to be helpful.

Another treatment, PE's labeled on quizzes and tests, was beneficial because it made it easy to align assessments with individual PE's. It also made data collection quick and easy to review. The treatment imposed that the researcher would change is how the PE Quizzes are used. The PE quizzes were in addition to the quizzes and tests that were already being used in the class and it became too much formal testing. However, the researcher believes the questions that were on the PE quizzes were good questions, so they could be implemented into the classroom as a formative assessment such as an entry or exit task, a quick check for understanding, or even as class work or homework. This change would be beneficial for both the students, and for the teacher who can take advantage of more time for instruction, practice, and application.

This action research was beneficial in focusing the researcher's teaching methods on student achievement. Additionally, it was beneficial for students, as they were able to focus on the goals of the class and, more importantly, increase achievement on the Algebra EOC. The

researcher hopes dissemination of the treatments imposed in this action research study to her colleagues may also prove to be valuable for their school district as a whole.

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Appendix A

SAMPLE PE QUIZ

Name: **Date:** **Period:**

A1.4.D: Write and solve systems of two linear equations and inequalities in two variables.

1. Which of the following is a solution to the given system of equations?

$$y = 4x + 2$$
$$2x + y = -10$$

a. (2, 10) b. (-2, -6) c. (-2, -6) d. (-6, -22)

2. If 4 apples and 2 oranges cost $1, and 2 apples and 3 oranges cost $0.70, write a system of equations that could be used to determine the cost of each apple and each orange. (No need to solve!)

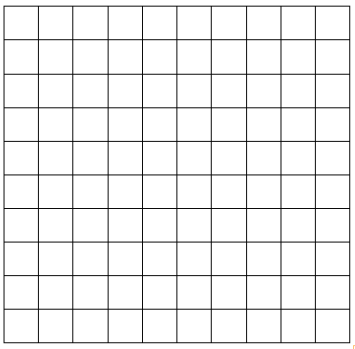
3. Solve the system of equations using the method of your choice.

$-2x + y = 2$
$x + y = -1$

4. Graph the following inequalities.

$x - 2y \leq 10$

$y > -2x$



5. Only chocolate and vanilla ice cream cones are sold at an ice cream store. In one day, the number of chocolate cones sold was more than 4 times the number of vanilla cones sold. A total of 121 cones were sold that day. Determine the total number of chocolate and vanilla cones sold that day.

SAMPLE PE CHECKLIST

Algebra 1 Performance Expectations (PE's)

PE	Content	√	Quiz Score
A1.1.A	Select and justify functions and equations to model and solve problems.		
A1.1.B	Solve problems that can be represented by linear functions, equations, and inequalities.		
A1.1.C	Solve problems that can be represented by a system of two linear equations or inequalities.		
A1.1.D	Solve problems that can be represented by quadratic functions and equations.		
A1.1.E	Solve problems that can be represented by exponential functions and equations.		

SAMPLE WARM-UP QUESTION

Draw and label pictures that would help explain the PE from yesterday. Remember to also include the additional descriptive words we discussed. Then, compare with your partners.
A1.6.E: Describe the correlation of data in scatterplots in terms of strong or weak and positive or negative.

SAMPLE CLASSROOM QUIZ OR TEST QUESTION WITH PE NOTED

For #9 and #10, solve and graph each absolute value inequality. *(A1.4.A)*

9. $|2 - 2x| < -6$

10. $|8x + 2| \geq 14$