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USING LEARNING TARGETS TO ENCOURAGE STUDENT SELF ASSESSMENT AND INCREASE STUDENT ACHIEVEMENT IN GEOMETRY

by Katelyn Pierce

ABSTRACT

This action research project involved a study of the relationship between using daily learning targets, student self-assessment, and student achievement in Geometry. The study involved 51 high school students enrolled in one of three Geometry classes at the researcher's school. The researcher was able to collect much of the data because of the system provided by the daily learning targets. Using data from student surveys, scores on classroom quizzes, Measures of Academic Progress scores, and End of Course scores, the researcher was able to analyze several aspects of a high school Geometry class. The findings include (1) how well students self-assess, (2) how student perceptions change from pre-quiz to post-quiz, (3) how well classroom quizzes can predict student achievement on state assessments, and (4) how much student achievement improves over the course of a year.

INTRODUCTION

The purpose of this study was to increase student achievement on the Geometry End of Course Exam (EOC) by communicating daily learning targets and encouraging student self-assessment. Learning targets, also referred to as educational objectives, lesson objectives, or learning goals, are statements in student-friendly language of what students should know and be able to do by the end of the lesson. Students can be disengaged and unfocused on the main ideas and concepts in a high school mathematics classroom. Their lack of focus may lead to poor performance on weekly quizzes, summative chapter tests, and the Mathematics EOC state assessment.

This action research study focuses on student achievement in Geometry. Typically, Geometry is a course taken as a high school freshman or sophomore, though the classes may include juniors as well. Since students must pass at least one Mathematics EOC to graduate high school, their underperformance is relevant. Though many factors contribute to low performance on the state exam, one factor worth investigating is the use of daily learning targets and student self-assessment.

Problem

Data over the last seven years show that the percent of Washington state students meeting the standards on the state exam has been decreasing. The scores of the students at the researcher's school, KHS, mirror that of the state. As recorded by the Office of Superintendent of Public Instruction (OSPI), 73.5% of Washington State students passed the Geometry EOC in 2011. At the researcher's high school (KHS), only 59.2% of the students passed the Geometry EOC in 2011. Over the last seven years, the percentage of KHS students meeting the standards has ranged from 36.7% to 59.2%.

As described by the OSPI, students in the classes of 2013 and 2014 will have to pass one Mathematics EOC assessment to be eligible for a diploma, while students beginning with the class of 2015 must pass two Mathematics EOC assessments. In summary, student performance on the Mathematics EOC exams can determine whether a student receives a diploma at the end of their high school experience, making student performance on this exam significant. In order to create change, educators must be willing to make adaptations to their teaching practices and determine the effectiveness of these changes. The researcher will investigate the benefits and effectiveness of communicating learning targets with students in hopes of increasing student achievement in Geometry.

REVIEW OF LITERATURE

There are many articles that demonstrate the benefits of communicating learning targets in daily lessons. One of these benefits is that communicating learning targets can focus instruction and set clear expectations for students. By communicating learning targets with students, it creates a system for teachers to provide feedback about their performance. Also, learning targets help teachers create valid assessments and help students prepare for classroom assessments. The following Review of Literature will explain each of these benefits in detail, starting with overall best practices of learning targets.

Learning Targets

There are several aspects of best practice when communicating learning targets, specifically in the ways they are presented. When presented properly, research indicates that communicating learning targets can increase student achievement. For students to significantly benefit from learning targets, however, teachers must first derive the targets from state or national standards and make them specific to daily lessons. The *EOC Crosswalks*, a document provided by OSPI, identifies the standards that are assessed on the Geometry EOC assessment. Teachers should adapt these standards into learning targets to communicate expectations or goals in student friendly language. Learning targets are most effective when they clearly and specifically set the goal or objective of the lesson. Though these targets should be linked to state standards, they should be specific to the daily lesson and should clearly state what the students should know and be able to do by the end of the lesson. One example of a learning target that could be used is, “I know the properties of a parallelogram. I can use these properties to solve for angles and side lengths”.

When teachers communicate learning targets, students receive a set of clear expectations. Garrison and Ehrinhaus (2007) state that sharing learning targets with students "engages them in instruction and the learning process by creating clear expectations. In order to be successful, students need to understand and know the learning target." In fact, Moss, Brookhart, and Long argue that teachers can empower students through learning targets stating, "now that students know where they are going, they are more motivated to do the work to get there" (2011). Communicating learning targets in just one way is insufficient; teachers should post learning targets visually, state targets verbally, and model the targets in classroom activities to accommodate all types of learners. Also, presenting the targets all three ways will reinforce the language in the lesson and the expectations of the students. When the target is communicated

and posted throughout a lesson, it is available for students to reflect upon their progress toward the target.

Marzano researched the results of several studies that explored the effectiveness of communicating learning objectives on student achievement. He then synthesized these finding in his 1998 meta-analysis, "A Theory-Based Meta Analysis of Research on Instruction", where he states

> The effect size for techniques that engage the goal specification function was 0.97 indicating a percentile gain of 34 points. The working dynamic behind all techniques within this category is the teacher providing students with specific learning objectives prior to a lesson (p. 94).

Similarily, Chappuis (2005) tells teachers: "share the learning targets before you begin instruction, in language your students can understand" (p 40). This could, in fact, be the most important factor of learning targets. If students cannot understand the language of the target, the learning target will not serve its purpose and any benefits will be lost.

Marzano summarizes the findings of Lipsey and Wilson in their 2003 book, *What Works in Schools: Translating Research into Action* (2003), explaining that they examined over 200 studies and found that setting academic goals had an average effect size of 0.55. Marzano (2003) describes this statistic stating that "the achievement scores in classes where clear learning goals were exhibited were 0.55 standard deviations higher than the achievement scores for classes where clear learning targets were not established (p 35). This effect size indicates a 21 percentage point difference in student achievement.

Learning Targets and Feedback

Educators agree that feedback is a critical part of the learning process. When providing feedback, teachers should be mindful of the learning targets. Chappuis (2005) explains that teachers should provide feedback to students, outlining areas needing improvement rather than just assigning grades. Furthermore, Chappuis and Stiggins (2002) state that "teacher feedback for learning draws an even bigger picture by telling students where they are now relative to the defined learning targets - and where teachers ultimately want them to be" (p. 42). Providing specific feedback about where students are currently performing compared to the proficient level will help students focus their energy in areas where they need the most improvement. Feedback on current performance and additional feedback toward targets provides students with clear guidance toward higher achievement.

Marzano (2003) reports that the effect of feedback on student achievement ranges "from a low of 21 percentile points to a high of 41" (p. 37). He also states that this percentile gain indicates that "academic achievement in classes where feedback is provided to students is considerably higher than the achievement in classes where it is not" (2003, p. 37). Marzano also studied the effects of setting objectives and providing feedback. Marzano (2003) divides "setting objectives and providing feedback" into several specific behaviors, including,

> setting specific learning goals at the beginning of a unit, providing feedback on learning goals throughout the unit, asking students to keep track of their progress on the learning goals, providing feedback at the end of the unit, asking students to assess themselves at the end of a unit (p.82).

In this study, Marzano (2003) concluded that the effect size of setting objectives and providing feedback for students was on average 0.61 with a percentile gain of 23 points (p. 80).

Learning Targets and Assessments

Learning targets can guide assessments, both summative and formative. When teachers link learning targets to quizzes or tests, students will have a clear idea of what they need to focus on to be successful. Chappuis, Chappuis, and Stiggins (2009) support this idea, stating, "If we don't begin with clear statements of the intended learning - clear and understandable to everyone, including students - we won't end up with sound assessments" (p. 16). Building formative assessments from learning targets can be especially beneficial, enabling students to partially demonstrate mastery of the learning targets while still learning about it. Chappuis supports this idea stating, "You can arrange the items according to the learning targets they assess and give students the list of learning targets correlated to the test item numbers. When they receive their corrected test, students can identify which learning targets they have mastered and which learning targets they need to work on further" (2005). The researcher also supports other types of repeated assessments, bi-weekly quizzes, for example, where students may make corrections to the incorrect problems to show improvement and growth. Giving students this extra opportunity allows students to look back on their performance and to improve on targets they have not yet mastered.

Learning targets are a beneficial tool for both teachers and students, in terms of assessment. Teachers can use learning targets to create valid assessments, both summative and formative. Likewise, students can use learning targets to be more successful on assessments by focusing their efforts and identifying misconceptions.

Learning Targets and Self-Assessment

Self-assessment is a valuable tool for teachers to use to encourage students to reflect and evaluate their own learning. As stated by Zhelov and Petrov, "Generally, one can say that reflection is one of the most valuable tools for the student intellectual stimulation in mathematics education". (2010, p. 2) Using learning targets, students can determine areas in which they are competent compared to areas that may need improvement. As reported by Petty (2006), having students assess themselves has an effect size of 0.54 on student achievement (p. 66). Petty also describes several advantages of self-assessment. First, he explains that when students self-assess, they become aware of the learning goals and helps them become more familiar with the characteristics of good work (Petty, 2006, p. 267). As stated in an article from the National Council of Supervisors of Mathematics (2009), "Students who understand learning targets can reflect on their individual progress toward that target. Students can establish learning goals and actions that they will take in order to reach the targets" (p. 2).

Teachers can encourage students to self-assess by using learning targets. In fact, Petty (2006) describes how teachers can accomplish this he explains,

> At the end of a task, topic or lessons students are reminded of the goals, objectives or assessment criteria. Students are then asked to take, say, five minutes to look over their work and self-assess: what they have learned, know and can do, and when they still need to learn or practice to achieve the goal or objectives (p. 264).

When teachers prompt students with these questions, the students can then take control on their learning and determine where they should focus their efforts. In fact, Chappuis, Chappuis, and Stiggins (2009) explain that students "learn best when they monitor and take responsibility for their own learning" (p. 17). Clearly, if a student can accurately determine whether they understand a concept, they will be better prepared to take the next steps toward mastery.

Overall, there are several different benefits of using learning targets in the classroom, especially in the areas of feedback, assessment, and self-assessment. Learning targets or objectives have proved to increase student achievement, as described by Marzano, Lipsey, and Wilson. Learning targets can be seamlessly combined with feedback to provide students with clear and concise explanations of how they are performing and areas for them to improve. Assessments can be more precise and intentional by using learning targets to create and guide these assessments, which in turn will provide students with a better road map to success.

METHOD

Research Design

The researcher investigated the effects of using learning targets and students self assessment on student performance in Geometry by using both quantitative and qualitative analyses. The quantitative analysis involved weekly quizzes and the End of Course assessment, taken June 12, 2012. These weekly quizzes assessed students' performance on the learning targets covered in class. The qualitative analysis includes students' responses on surveys, which were collected approximately twice per week, with two surveys corresponding to one quiz. Students completed pre-quiz and post-quiz surveys. The day before a quiz, students completed a pre-survey. Students rated themselves on how they thought they would perform on the quiz the following day, choosing from good (2), okay (1), or bad (0). Students would complete the post survey immediately after finishing a quiz and rate themselves on how well they think they performed on the quiz, choosing from the same three options as the pre-survey.

The original research question was: Can communicating learning targets in Geometry classes increase student achievement on the End of Course Assessment? However, after collecting so much meaningful data, the researcher developed several other questions:

- Finding 1: How well can students self-assess after completing a classroom quiz? Is there a relationship between post-survey ratings and student performance on classroom quizzes? Can the researcher create a system that can predict how students are assessing themselves? How well does the researcher's perception of "good" student performance compare to students' perceptions?
- Finding 2: How do student's perceptions of their performance (or expected performance) change from pre-survey to post-survey? Are males' and females' perceptions significantly different? Why might these differences occur (if there are any)?
- Finding 3: Is there a relationship between student performance on classroom quizzes and EOC Levels? Can student performance on classroom quizzes predict performance/scores on the EOC?
- Finding 4: Did students improve throughout the year by way of EOC Scores and MAP scores? Is this improvement significant? Did one perform significantly better than the other on the EOC, MAP, or classroom quizzes?

Participants

As of October 2009, there were approximately 375 students enrolled at KHS. All 52 students were enrolled in Geometry for both semesters, though the researcher only collected data during the second semester which started February 1, 2012. The students participating in this study were in grades 9-11, ages fourteen through seventeen, divided among three periods.

DATA ANALYSIS/RESULTS

At the beginning of this action research project, the researcher intended to determine the effectiveness of learning targets. Since there was not a control group, only treatment groups, the data will not distinguish between student learning derived from learning targets and overall student learning. The researcher had no control group because it is unethical to provide quality instruction to one group and not to another. However, through student surveys, quiz scores, MAP scores, and the EOC assessment, the researcher learned a lot about student performance in Geometry.

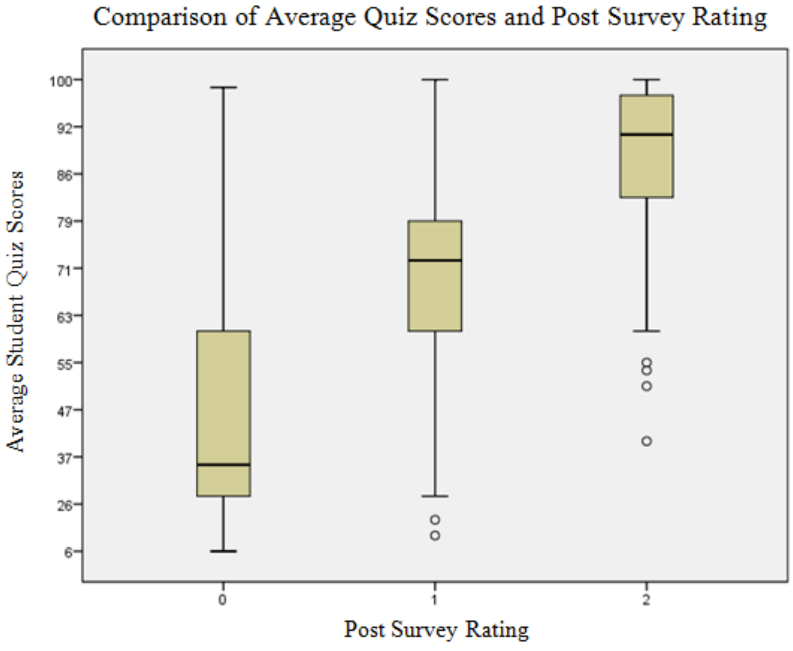
The researcher was able to collect a lot of the assessment and survey data in this study, because of the system provided by the daily learning targets. In the surveys described earlier, students were asked to reflect on their understanding of the learning targets. Also, the classroom quizzes were created to assess student understanding of the learning targets. Finally, the learning targets were derived from state standards in Geometry, which is what is assessed on the Mathematics EOC. In summary, daily classroom learning targets are what brought various themes in the data together.

Finding #1 – Student Self-Assessment

The first finding stems from investigating how well students can self-assess. The research questions are: How well can students self-assess after completing a classroom quiz? Is there a relationship between post-survey ratings and student performance on classroom quizzes? Can the researcher create a system that can predict how students are assessing themselves? How well does the researcher's perception of "good" student performance compare to students' perceptions?

In both the pre- and post-surveys, students had three options to choose from: good (2), okay (1), or bad (0). Before determining how well students can self-assess, it is important to observe the relationship between average quiz scores and each of the three survey ratings. The box plot below shows the distribution of average student quiz percentages for each of the post-survey rating options.

Student's Post Survey Rating	Student's Average Quiz Percent
0	43.9% $n = 37$
1	69.6% $n = 109$
2	87.7% $n = 162$



Notice that as students' post survey rating increases, so does the average quiz percentage. In the box plot, it is clear to see that students with post survey ratings of 2 earned the highest average quiz scores and students with post survey ratings of 0 have the lowest average quiz scores. Also, notice between a post-survey rating of 0 and 1 students' average quiz percentages jump 25.7% and between ratings of 1 and 2 students' average quiz percentages jump 18.1%.

To determine how well students self-assess, the researcher created a "goodness rating". The purpose of creating this new variable was to see how well the researcher's perception matches with the students' perception of good or bad performance on quizzes.

- If students earned above a 90% on a quiz, they were assigned a goodness rating of 2.
- If students earned less than 50% on a quiz, they were assigned a goodness rating of 0.
- If students earned between a 50% and a 90% on a quiz, the researcher determined their goodness rating by comparing that week's quiz score with their average quiz score.
    - If their quiz score was more than one standard deviation below their average quiz score, they were assigned a goodness rating of 0.
    - If their quiz score was more than one standard deviation above their average quiz score, they were assigned a goodness rating of 2.
    - If their quiz score was within one standard deviation of their average quiz score, they were assigned a goodness rating of 1.

Essentially, a "Goodness Rating" of 2 indicates that either the student earned an A or did significantly better than usual. For example, one student in the study earned an 87.5% on the week 5 quiz. She had an average quiz score of 57.7% with a standard deviation of 22%. Since she earned more than one standard deviation more than her average quiz score, the "Goodness Rating" assigned her a 2. In the same way, if a student is one standard deviation below their average quiz score that would suggest poor performance and the "Goodness Rating" would assign this student a 0. By creating the "Goodness Rating" this way, we allow for individualization of this rating, since what is "good" performance for one student may not be for another.

This "Goodness Rating" created a system by which we can describe how effective students are at assessing themselves. The table below shows how many students post-survey matched up with the value they were assigned with the "Goodness Rating".

Goodness Rating & Post Survey Rating Cross-tabulation

		Post Survey Rating			Total
		0	**1**	**2**	
Goodness Rating	**0**	24	31	12	67
	1	11	64	51	126
	2	2	14	99	115
Total		37	109	162	308

Observe the totals for the "Goodness Rating" and Post Survey Rating. Notice that the "Goodness Rating" assigned more ones than any other rating (126), but when students assessed themselves there were more twos than any other rating (162). This could suggest that either student's perception of good performance includes slightly lower scores than the "Goodness Rating" or that students were optimistic about their performance.

The table also shows how student responses to the post survey correspond with the goodness rating. Of the 162 student ratings of 2, the goodness rating would have assigned 99 students a 2, 51 a 1, and 12 a 0. According to the "Goodness Rating", students who rated themselves a 2 were correct 61% of the time, students who rated themselves a 1 were correct 59% of the time, and students who rated themselves a 0 were correct 65% of the time. After running a χ^2 test, the researcher concluded that the values in our tables are significantly different in the columns and rows ($p<.001$). Combining this with the percentage of students that "correctly" rated themselves after a survey; we conclude that the "Goodness Rating" has captured how students are rating themselves moderately well.

The table below breaks up the data based on the "Goodness Rating" assignment. For each of the "Goodness Ratings", there are comparisons of how students rated themselves on the post-survey and the corresponding average quiz score.

Comparing Goodness, Post-Survey, and Quiz Scores

Goodness Rating	Post Survey Rating	Average Quiz Score	Standard Deviation	N
0	0	29.4%	11.5%	24
	1	54.6%	18.7%	31
	2	73.3%	15.2%	12
	Total	48.9%	22.5%	67
1	0	65.8%	11.4%	11
	1	72.0%	10.2%	64
	2	78.3%	9.6%	51
	Total	74.0%	10.7%	126
2	0	97.6%	0.58%	2
	1	91.3%	6.8%	14
	2	94.3%	5.5%	99
	Total	94.0%	5.7%	115
Total	0	43.9%	23.8%	37
	1	69.6%	17.2%	109
	2	87.7%	11.5%	162
	Total	76.0%	21.2%	308

When looking at the following table, there are several results worth mentioning. The following notes are divided into three categories determined by the "Goodness Rating".

- Of the students who were assigned a "Goodness Rating" of 0, those who rated themselves a zero scored lower than those rating themselves a 1 or 2. Average quiz scores jump 25 percentile points from a post-survey rating of 0 to 1, and from 1 to 2 it jumps 18 percentile points.
- Of the students who were assigned a "Goodness Rating" of 1, average quiz scores increase by about six percentile points from post-survey ratings of 0 to 1 to 2.
- Of the students who were assigned a "Goodness Rating" of 2, it is interesting to note that the average quiz scores are not organized quite like the others. Moving from post-survey ratings of 0 to 1 average quiz scores drops 6 points. This could indicate that the two students were incredibly pessimistic about their performance. Since there were only 2 students in this specific category, this doesn't necessarily say a lot about overall self-assessment and teacher assessment.

Finding #2 – Differences in Pre-Survey and Post-Survey

The next finding originated with the following questions: How do student's perceptions of their performance (or expected performance) change from pre-survey to post-survey? Are males' and females' perceptions significantly different? Why might these differences occur (if there are any)? The researcher investigated these questions by computing the difference between post-surveys and pre-surveys for each quiz and then compared these between males and females. These results are shown in the table below. Note that negative average survey differences indicate that students scored themselves higher in the pre-survey than the post-survey.

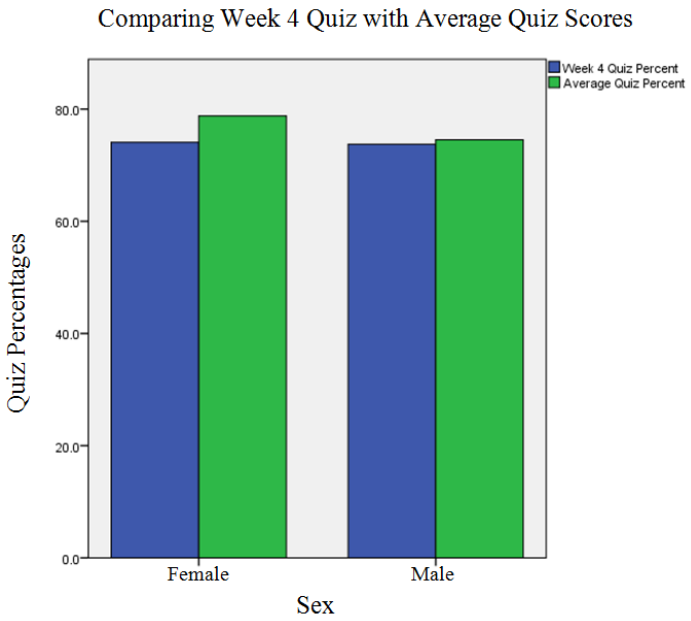
Differences in Pre- and Post- Surveys

	Sex	N	Average Survey Difference (Post-Pre)	95% Confidence Interval
Week 1	F	27	-.1481	$(-0.0359, 0.0631)$
	M	25	-.2800	$(-0.5034, -0.0564)$
Week 2	F	27	-.1481	$(-0.8990, 0.3861)$
	M	25	-.0800	$(-0.2100, 0.3670)$
Week 3	F	27	-.1481	$(-0.2913, -0.0049)$
	M	25	.0000	$(-0.1191, 0.1191)$
Week 4	F	25	-.3200	$(-0.5165\ , -0.1235)$
	M	25	.1600	$(-0.0686, 0.3886)$
Week 5	F	26	-.1538	$(-0.4013, 0.0937)$
	M	24	.0417	$(-0.1544, 0.2378)$
Week 6	F	27	-.0370	$(-0.2099, 0.1359)$
	M	25	.1200	$(-0.0615, 0.3015)$

After conducting a two-sample t-test for each week, the researcher found that only in Week 4 was there a significant difference between the average survey difference between males and females, ($p = .002$ and $t(47) = -3.267$). This is not necessarily enough evidence to suggest that females change their minds most often after a quiz since it was only significantly different once out of six.

Though there may not be an overall difference between males' and females' perceptions before and after a quiz, it is interesting to note that all of the average survey differences for females are negative. This means that for every quiz, average female survey scores decrease from the pre-survey to the post-survey. Also, notice that except for week 1, females always go down more than males. This suggests that female students feel worse after the quiz than they did before the quiz. Perhaps the females were optimistic before the quiz and after completing the quiz realized they weren't as prepared as they thought. Notice the Week 4 survey difference. The mean is -.32, which indicates that approximately one-third of the female students lowered their score from pre-survey to post-survey.

As shown in the bar graph, it does not appear that this quiz was unusually hard, though many females believed it was. Notice that the difference between the week 4 quiz and the average quiz scores is slightly different for females. Females scored 4.7 % lower on the week 4 quiz than the overall quiz average for females, whereas males only scored .8 % lower. However, after running a t-test, the researcher concludes that there is no significant difference between how males and females scored on this quiz compared to their average quiz score. That is, the difference between females average quiz score and the week 4 quiz score was not significantly different than the difference between the males average quiz score and the week 4 average quiz score.



Finding #3 – Predicting EOC Results with Weekly Quizzes

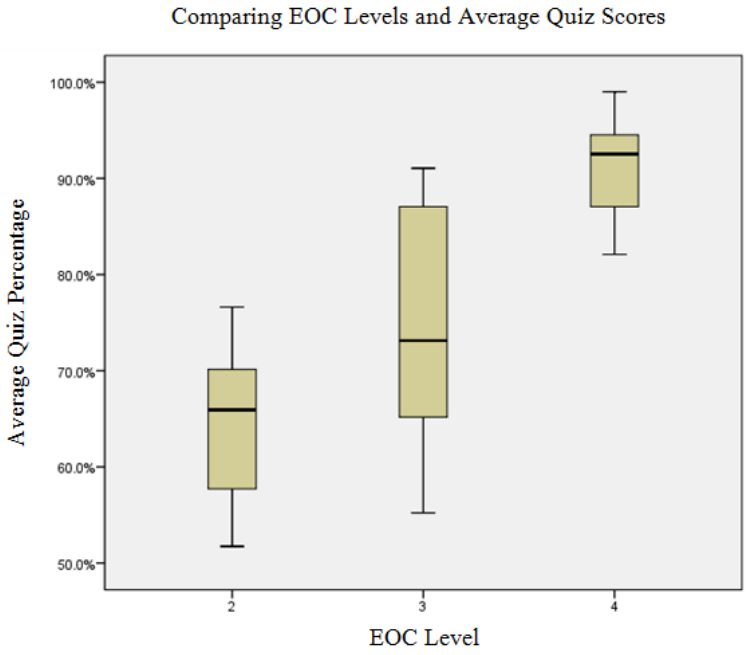
Next, we investigate the relationship between student quiz scores and student performance on the EOC state assessment. The research questions are: Is there a relationship between student performance on classroom quizzes and EOC Levels? Can student performance on classroom quizzes predict performance/scores on the EOC? Students are placed into EOC levels, defined by their scores on the state assessment, where Levels three and four are considered passing. The table below describes the relationship between the EOC Levels and classroom quiz scores. Note: there were no students at Level 1 in the researcher's classes. The table below shows how the state breaks EOC scores into four Levels, how many students in the researcher's classes were placed into each level, and the average quiz score for each of these Levels. The box plot below the table shows the distribution of average quiz percentages and the EOC Levels.

EOC Year 2 Data

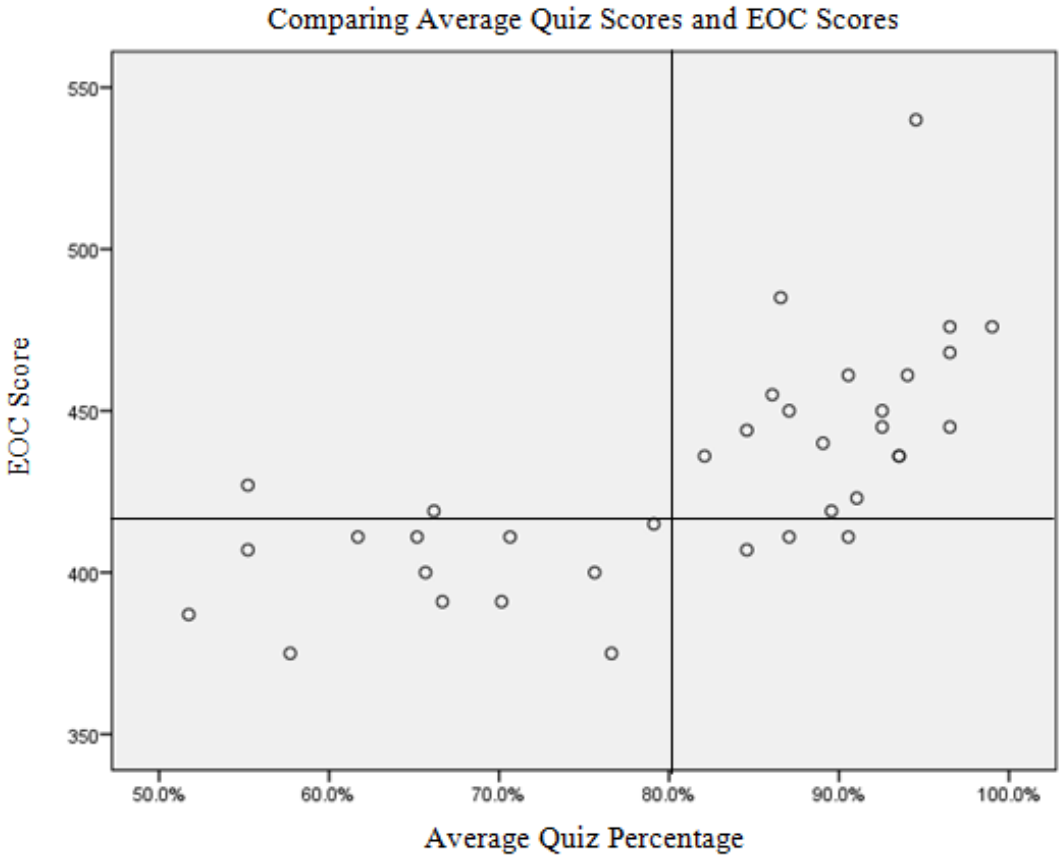
EOC Level	EOC Score Ranges (as defined by the state)	Average EOC Scores	Standard Deviation in EOC Scores	Number of Students	Range of Quiz Scores	Average Quiz Score	Standard Deviation in Quiz Scores
2	375-399	380.6	7.8	5	55.7%-78.1%	67.7%	9.8%
3	400-435	413	7.7	14	53.6%-91.1%	76.8%	11.7%
4	436-600	458	26.2	17	85.2%-98.7%	92.7%	4.1%

Note: The standard deviation is very high for Level 4 EOC Scores; after removing one student with a score of 540, the average dropped to 454 and the standard deviation dropped to 15.7.

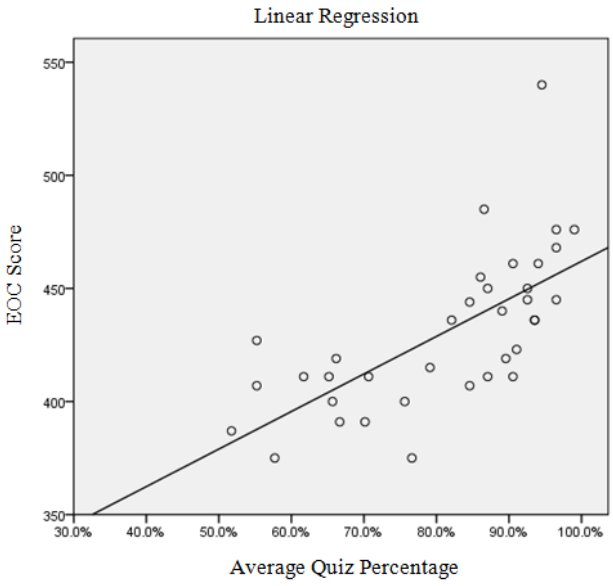
As shown in both the box plot and table, there is a relationship between EOC Level and average quiz scores. Visually, we can see that the median quiz percentage increases as each EOC level increases. It is interesting to note that the lowest average quiz score for students who earned a Level 4 was an 85.2%. Though there is some overlap in the average quiz score ranges for each of the Levels, the average quiz scores for each level behave as we would imagine they should. The higher quiz scores were placed into higher levels on the EOC. The average quiz score for students scoring a level 2 on the EOC was 67.7%, for those scoring a level 3 was 76.8% and for those scoring a level 4 was 92.7%.



To further investigate the relationship between classroom quizzes and EOC performance, it is important to ask the question, how well classroom quizzes can predict student performance on the EOC. Shown below is a plot of students' average quiz scores and their EOC scores.

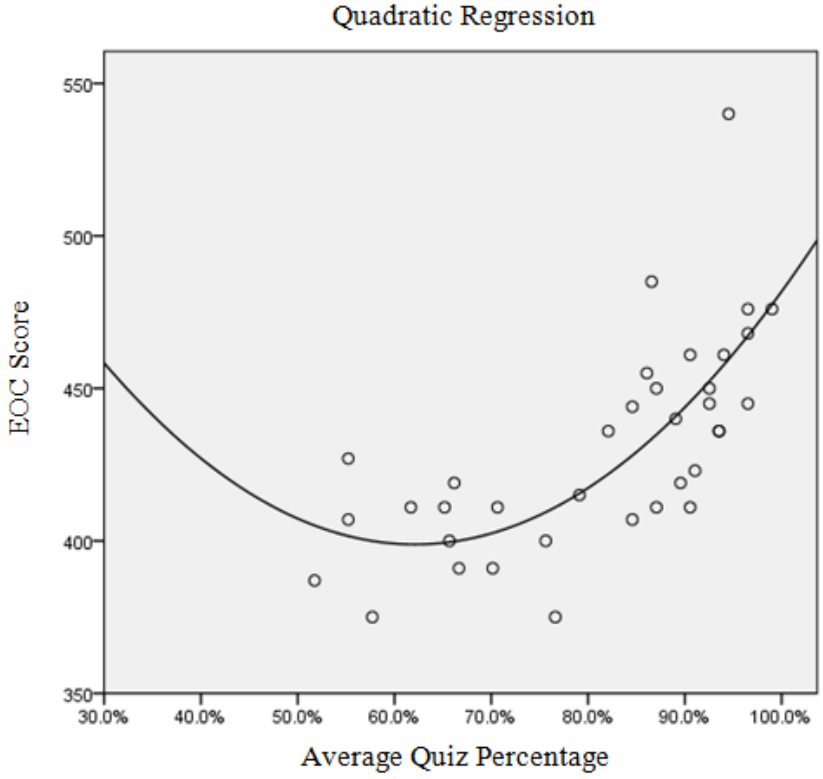


Notice that for the most part, the points are in quadrants one and three as divided by the 80% quiz score axis and an EOC score of 417. If a student's average quiz percentage was above 80%, then they will pass the EOC with more than 417 about 86% of the time (6 times out of 7). If a student's average quiz score is below 80% then they will score less than 417 on the EOC 86% of the time (6 out of 7, again!). We conclude that classroom quizzes can be used as an accurate predictor of passing the EOC, especially for students with average quiz scores of 80% or more.



To use this data to predict students' scores on the EOC, we start by looking at a linear model. Using regression, we get the line $y = 1.66x + 296$ and an R-squared value of 0.459. The slope of our line, $m = 1.66$, indicates that if a student were to improve their average quiz score by one percentage point, their EOC score would improve by 1.66 points.

Since the R-squared value is not very impressive for the linear model, we will also look at a quadratic model. The equation for our quadratic curve is $y = 0.058x^2 - 7.17x + 621.5$ and the r-squared value is 0.531. Visually, we can see that this curve fits the data better than the linear model. It is important to note that the coefficient of our x-squared term is positive, showing that our curve is concave-up. Note that when comparing this model to our linear model, there is one average quiz percentage (76.12%) for which our quadratic model is increasing at the same rate as our entire linear model. The rate at which our function is increasing will be greater than our linear model at every quiz score beyond 76.12%. For example, the instantaneous rate of change or the slope of the tangent line for an average quiz score of 85% is 2.69. This can be interpreted the same way as in our linear model.



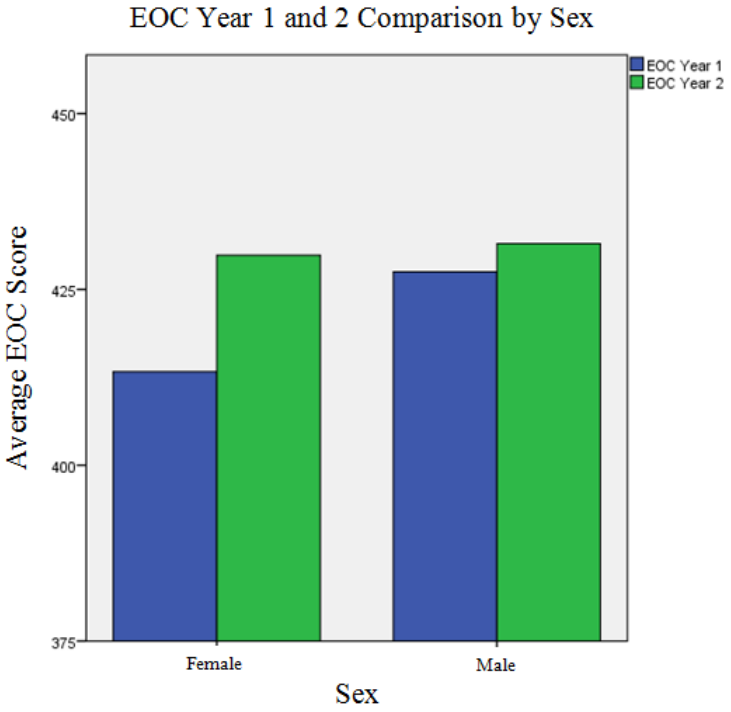
Our quadratic model suggests that for any small change in average quiz percents (especially quizzes 80% and above) there is a larger change in EOC Score. For example, if a student's average quiz score was 80%, our model indicates that their EOC score would be 419.10. If this student was to score an average of 83% on classroom quizzes, the model indicates that the student's EOC score would be 425.95. For this 3% increase in average classroom quiz scores, a student would improve 6.85 on the EOC. Since this is a quadratic model, a student's EOC score would improve at a greater rate if the average quiz score was higher than the 80% or 83% in average quizzes. Similarly, this model suggests that there is approximately no relationship when quiz scores are between about 50% and 70%, which seems to be the case. Using our linear model, if a student was to improve by 3% in average quiz scores, the student would see an improvement of 4.98 points on the EOC, regardless of current average quiz percentage. Not only does the quadratic model represent the data better, it also predicts greater growth for students above 76%.

Finding #4 – Overall Student Growth

The final finding will look at overall student performance on the state assessment, the MAP test, and the daily classroom quizzes. The research questions were: Did students improve throughout the year by way of EOC Scores and MAP scores? Is this improvement significant? Did one perform significantly better than the other on the EOC, MAP, or classroom quizzes? The average quiz percentage for females was 78.8% and for males it was 74.5%, making a difference of 4.3%. The results of a t-test show that this difference is not significant.

State Assessments: EOC Year 1 and EOC Year 2

Shown in the bar graph, there is a visual difference between the EOC Year 1 mean score and the EOC Year 2 mean score regardless of sex. The overall average for the EOC Year 1 was 419 and the overall average for the EOC Year 2 was 430.5, for an overall growth of 11.5. The results of a paired samples t-test show us that the EOC Year 2 scores were significantly different than the EOC Year 1 scores, ($p < .001$ and a correlation of 0.725). So, the overall growth of 11.5 points is significant.



EOC Year 1 and Year 2 Scores

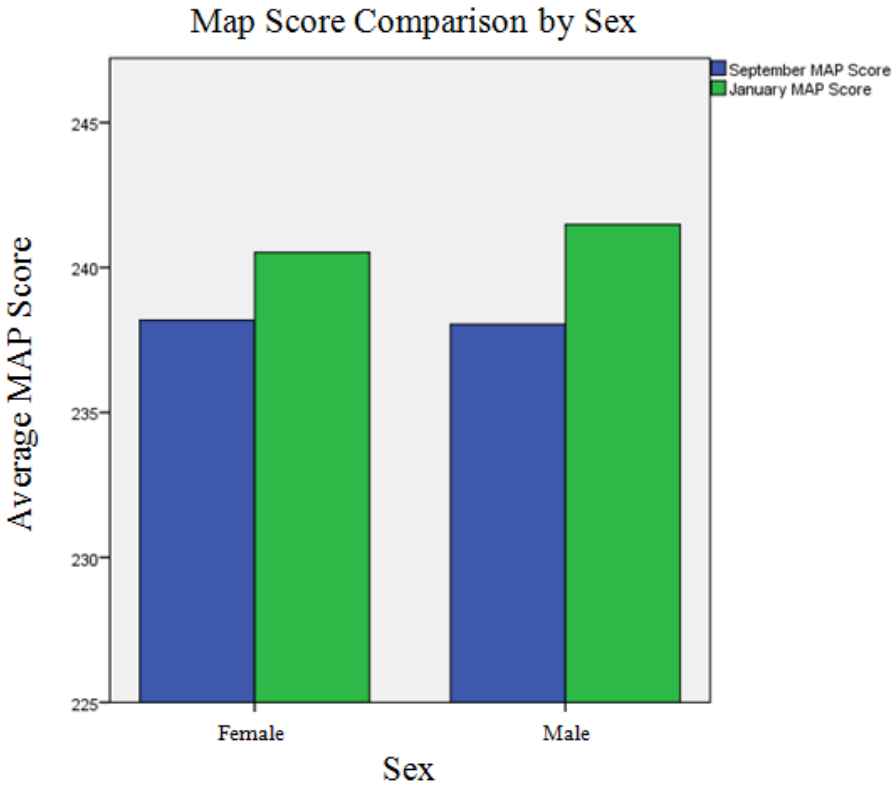
	Males	Females	Difference (Males –Female)
Average EOC Year 1 Score	418.1	411.8	6.3
Average EOC Year 2 Score	431.2	429.9	1.3
Difference (Year 2-Year 1)	13.1	18.1	

Looking at sex differences for the EOC Year 1, it appears that the male's average score is higher than the average female's. Visually, the same cannot be said for the EOC Year 2 scores. The average EOC Year 1 score for males was 418.1 and the average for females was 411.8, for a total difference of 6.3 points. The average EOC Year 2 score for males was 431.2 and the average for females was 429.9, making a difference of only 1.3. After running two t-tests, for EOC Year 1 and Year 2, it appears that the difference between males and females is not significant in either year.

District-Wide Assessments: MAP September 2012 and MAP January 2013

District-wide, students take a MAP test in the Fall, Winter, and sometimes Spring of each year. The MAP test is an adaptive test that is used to show growth of students throughout an academic year or the high school experience.

Shown in the bar graph, there is a visual difference between the MAP scores from September and the scores from the following January. The overall average for the September MAP was 238.1 and the overall average for the January MAP was 241.0, for an overall growth of 2.9. The results of a paired samples t-test shows us that the MAP scores from September to January were significantly different, ($p < .001$ and a correlation of 0.934). So, after just five months of school, the researcher's students made an significant growth of 2.9 points on average.



Visually, it appears that males and females are fairly even in their MAP scores in September and January. A t-test shows there is no significant difference between males and females in either MAP scores. Shown below are the results for each MAP test for males and females.

September and January MAP Scores

	Males	Females	Difference (Males –Female)
Average September MAP Score	237.1	238.2	-1.1
Average January MAP Score	241.5	240.5	1.0
Difference (January – September)	4.4	2.3	

As shown in the table above, male students made an average improvement of 4.4 points on the MAP test and female students made an average improvement of 2.3 points on the MAP test. In September, females had a higher MAP score than males on average, indicated by the negative 1.1. In January, however, males were ahead of females by 1.0. Again, these differences are not significant.

CONCLUSION

Over the last seven years, the students at the researcher's school have been underperforming compared to the state average on the EOC. In 2011, the year before the researcher worked at KHS, 59.2% of students passed the Geometry EOC at the researcher's school compared to the Washington State average of 73.5%. One year later, in 2012, 85.2% of the students at KHS passed the Geometry EOC compared to the Washington State average of 79.1% passing. Clearly, something enacted over the last year was effective in increasing student achievement at the researcher's school, with an improvement of 26 percentage points. Since the researcher taught all Geometry classes at KHS, one could suggest that this improvement is a result of the students' experiences over the course of the academic year in Geometry.

The original purpose of this study was to determine the effectiveness of communicating learning targets on student achievement in Geometry. Though the data collected does not provide proof that learning targets were effective in increasing student achievement in Geometry, the researcher learned a lot about her Geometry classes.

The first finding analyzed how well students can assess themselves. Overall, student quiz scores and post-survey scores had a clear relationship; the higher the students rated themselves, the higher their average quiz score. This indicates that students have a generally good idea of how they perform on quizzes. After creating a "Goodness Rating" the researcher was able to compare student and teacher perception of good and poor performance. The data showed, using the measure of the "Goodness Rating", students can correctly assess themselves about 60% of the time.

The second finding analyzed how student perceptions of their performance change before and after a quiz. Though there was no significant difference between overall change in perception between males and females, for each of the six quizzes, females had a lower perception of their performance after the quiz compared to before the quiz. The week 4 quiz

showed that nearly one third of the females had a negative perception of their performance, even though female performance on this quiz was not significantly different than average female quiz performance.

The third finding analyzed the relationship between student performance on classroom quizzes and student performance on the EOC. As one might expect, there was a clear relationship between quiz scores and EOC results. To predict EOC scores using classroom quizzes, the researcher used both a linear model and a quadratic model. For the students with an average quiz score of about 76% in our quadratic model, the rate at which they improve their EOC score (by improving their average quiz score) was equivalent to our linear model. For the students with an average quiz score greater than 76%, improving their average quiz score would increase the rate at which their EOC score would improve. In other words, for these students, one small change in average quiz scores would create a larger change in EOC scores.

The fourth finding analyzed whether or not students made a significant improvement over the course of the school year based on EOC results and MAP results. The data showed that students made a significant improvement in EOC results from Year 1 to Year 2, improving by over 11 points. The data also showed that students made a significant improvement in MAP scores from September 2011 to January 2012 with an average growth of about 2.8 points. For both the EOC and MAP, there was no significant difference in improvement when comparing males and females.

Through the analysis of these findings, there is evidence to support that communicating learning targets with students can increase student achievement in Geometry. By communicating these learning targets, the researcher was able to communicate clear expectations with students. The researcher was able to create assessments based on the learning targets, which simplified the process of deciding what to assess. Also, students were able to successfully assess themselves compared to the learning targets and their understanding of these targets.

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