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Effective Methods of Formative Assessment

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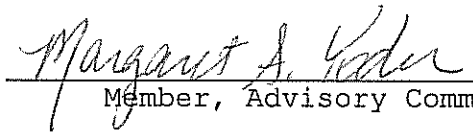

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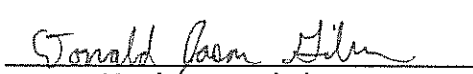

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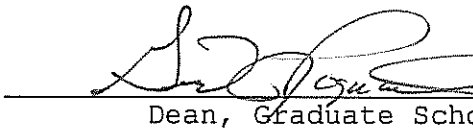

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DEDICATION

This thesis is dedicated to my parents
Everett & Dawn Bugg
for their unwavering love and support.

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There are a number of people who have had a significant impact on my life during my time at EKU. First and most importantly are my parents. I would not be who I am today without their love, support, and encouragement. I strive to make them proud every day. Second, are my friends, who I have leaned on and learned from every step of the way. I am confident I would not have survived without them. Third, are the professors that served on my thesis committee. It is with their guidance, support, and expertise that I have made it through this program. A million thanks would not cover it. I thank the Lord for putting them each in my life.

ABSTRACT

The purpose of this research is to explore the implementation of formative assessment in the mathematics classroom. Formative assessment is considered to be any data-driven activity that an educator uses to help guide and improve instruction. While there is an abundance of research that concludes that formative assessment does indeed improve student achievement, practical methods of implementation are not thoroughly discussed. To partially determine which methods of formative assessment most positively impact student achievement, a study was conducted at Lafayette High School. The researcher compared two popular methods of formative assessment: daily exit slips and unit probing (pre-, middle-, and post-testing). While the data collected through research indicated that the use of unit probing showed more growth over the span of a unit than the use of daily exit slips, the study does not allow generalization as to which method of formative assessment improves student achievement more.

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CHAPTER 1

INTRODUCTION

While there are many methods that can be used to measure student learning, assessment is the tool used most frequently. Assessment is defined as “the systematic basis for making inferences about the learning and development of students. It is the process of defining, selecting, designing, collecting, analyzing, interpreting, and using information to increase students’ learning and development” (Erwin, 1991, p. 1). Assessment is the tool that educators are using in classrooms to understand what students are learning, how students are learning, and where students may need interventions.

There are two different types of assessment used in today’s classrooms—formative and summative. Summative assessment is designed to evaluate student learning at the end of an instructional episode such as a unit or chapter, comparing it to some standard or benchmark (Eberly Center, n.d.). These assessments are meant to be cumulative in nature and are usually in the form of a state-mandated exam, district benchmark, end-of-unit exam, end-of-semester exam, culminating project, or term paper (Coffey, n.d.a). In a typical classroom, students have a summative assessment at the end of each unit or chapter.

Summative assessments are considered to be high stakes because they are of high point value (Eberly Center, n.d.). These types of assessments are typically graded for accuracy and have

significant impact on a student's grade. Summative assessments help determine whether long-range goals for student learning have been met. These results help educators compare student performance and achievement.

Formative assessment is "a process used by teachers and students during instruction that provides explicit feedback to adjust ongoing teaching and learning to improve students' achievement of intended instructional outcomes" (Coffey, n.d.b, para. 1). Formative assessment is designed for an educator to continuously evaluate students through the course of a unit or chapter, for instance. The educator uses the data collected from formatively assessing students to help guide and alter instruction quickly.

Formative assessment is often in the form of questioning, an entry and/or exit slip, a discussion, a probe, or a student observation. These types of assessments are considered to be low stakes because they are of little or no point value (Eberly Center, n.d.). Formative assessments are typically graded simply for data collection and teacher feedback, having no effect on a student's grade. Formative assessment should guide instruction, not assign grades.

While formative and summative assessments are quite different, both play a significant role in the teaching process. The idea of formative assessment is much more elusive to educators and seems to be used less frequently because it is often misunderstood. In order to improve student achievement in

the classroom, formative assessment should be strategically planned and consistently implemented.

In conjunction with creating a unit plan that outlines objectives, standards, agendas, and assignments, an educator must create an assessment plan as well. An assessment plan should identify the following: which student learning outcomes are to be achieved, what evidence will be used to determine how well students are achieving the outcomes, and how the information will be used to improve instruction (Loyola Marymount University, n.d.).

Determining which learning outcomes to address is typically directed by individual schools. In most states, educators follow the new Common Core State Standards for Mathematics which detail the standards that need to be taught at each grade level or in each course (Common Core State Standards, 2010). These standards are then broken down to create a unit outline. The unit outline states which objectives and standards should be taught each day and serves as the starting point for an assessment plan.

When determining what evidence will be used to conclude how well students are achieving the outcomes, the method of formative assessment used for each objective must be decided. There are a plethora of methods that can be included in the assessment plan, and the decision of what method(s) are appropriate is at the educator’s discretion.

Some of the most direct methods of formative assessment include questioning and discussion. Good questioning techniques allow an educator to determine the degree and depth of student understanding. Effective questions do not require students to simply recall or state information, but to explore ideas and provoke thought. These deeper questions open up classroom dialogue that can be used to expand student learning and allow an educator to assess where a student is in the learning process (West Virginia Dept. of Education, n.d.).

There are many ways that an educator can collect data through the use of questioning and class discussions. It is not sufficient for an educator to simply observe and try to remember student information; it must be recorded. According to the West Virginia Department of Education (n.d.), the most common method of data collection when questioning is to keep anecdotal notes with the use of note cards, sticky notes, or a clipboard with paper. Anecdotal notes are short notes written during a lesson as students work in groups or individually, or after the lesson is complete. In these notes, the teacher should reflect on a specific aspect of the learning and make comments on the student's progress toward mastery of that learning target.

Similar to questioning, student observation is another method of formative assessment. The more an educator knows about the students, the more assistance an educator can provide. By observing students throughout instruction, an educator is able to determine what students know and do not know, as well as

individual strengths and weaknesses students may have. The use of anecdotal notes, as described above, is an appropriate method to record data and information collected throughout observation.

Entry and exit slips are a widely used method of formative assessment. These slips require a written answer, explanation, or solution to a question or concept that an educator has presented. Entry slips are given at the beginning of class and typically require students to answer a question similar to one from a previous class or past assignment. An educator may also use questions posed on a norm-referenced assessment such as the ACT, SAT, end-of-course exam, or any other state exam that requires preparation.

Exit slips are given at the end of class and typically require students to answer some type of question based on the day's objective, lesson, or activity. Entry and exit slips allow the educator to "quickly determine which students have it, which ones need a little help, and which ones are going to require much more instruction on the concept" (West Virginia Dept. of Education, n.d., para. 1).

An appropriate form of data collection when formatively assessing through entry and/or exit slips is the use of a spreadsheet. The educator can record whether a student has mastered a particular objective, as determined through review of a student's entry or exit slip. There are a variety of symbols that an educator could use to mark whether a student has

completely mastered an objective, needs a little more help, or needs substantial re-teaching to master the objective.

For instance, if a student has mastered an objective, the educator could place a check mark next to that objective on the spreadsheet. If the student needs a bit more help, the educator could place an X next to the objective. If the student needs substantial re-teaching, the educator could place a 0 next to the objective on the spreadsheet. It is the educator's responsibility to come up with a system that is personalized, user-friendly, and accurate.

Last, students can be formatively assessed through the use of probes. A probe is an assessment based on inquiry and exploration. These assessments allow an educator to measure how much learning has taken place throughout instruction by comparing the scores of a pre-test, middle-test, and post-test (probes). The pre-test helps measure the amount of pre-existing knowledge a student has and can help an educator plan instruction based on the data collected. The middle-test gives a rough idea of where students are and what learning has occurred up to that point. The post-test helps determine the amount of growth throughout the course of an instructional episode, such as a unit or chapter.

To collect data for unit probing, the educator can monitor student scores on the individual probes, using symbols or scores to declare student mastery of objectives. While most unit probes are graded for accuracy to determine objective mastery, the scores must not be used to alter student grades. Formative

assessment should be incorporated to assist students in the learning process, not penalize them for the rate at which they learn. For instance, if a student scores a 10% on the pre-test, they should not be penalized for their lack of pre-existing knowledge. The purpose of incorporating unit probes is to show growth over time.

To conclude the creation of an assessment plan, the educator must decide how the information and data collected from formative assessment will be used to improve instruction. This question identifies the most crucial aspect of formative assessment. Formative assessment becomes meaningless unless the information is used to alter and improve instruction. Essentially, frequent formative assessment provides awareness (Wormeli, 2008).

Once an educator is able to identify the areas in which students are struggling, instruction can be altered for the following class period or entire unit. When an educator is aware of exactly what students are having trouble grasping, an intervention can take place. Pre-tests (probes) allow an educator to plan a unit based on students' pre-existing knowledge. Daily exit slips allow the educator to determine how many students display mastery of the daily objective. Middle-tests (probes) allow an educator to alter the instructional plan once learning has taken place. All of this information can be used in a way that produces appropriate education for each student. Formative assessment is key to planning and monitoring instruction. Without

this assessment, educators are simply covering material, with little regard to whether students are actually learning.

CHAPTER 2

LITERATURE REVIEW

Leading the research on formative assessment are Paul Black and Dylan Wiliam, authors of the article “Inside the Black Box: Raising Standards Through Classroom Assessment.” Black and Wiliam posed three questions that their study aimed to answer:

1. Is there evidence that improving formative assessment raises standards?
2. Is there evidence that there is room for improvement?
3. Is there evidence about how to improve formative assessment?

Black and Wiliam’s extensive review of research, which includes the review of 160 journals and over 250 various articles, gives substantial evidence to conclude that the answer to all of the aforementioned questions was “yes” (Black & Wiliam, 1998, p. 82). Their research concludes that formative assessment is at the heart of effective teaching.

Black and Wiliam used the results of a study conducted by Fontana and Fernandes to solidify their claim. This study included 25 Portuguese teachers and 246 students, with ages ranging from eight to fourteen years. The researchers of this study supported student engagement by providing daily self-assessment, which would be used to improve math performance. The study concluded that the eight- and nine-year-old students’ math

scores showed significant improvement in their math performance after daily self-assessments (Fernandes and Fontana, 1994).

A study conducted in 1992 by Martinez and Martinez was also used by Black and Wiliam. This study utilized a two-by-two experimental design—two groups were taught by an expert teacher, and two groups were taught by a novice teacher (Martinez and Martinez, 1992). The sample size of this study included 120 college algebra students, resulting in manageable groups of 30 per teacher.

Each teacher would teach one class and give students one exam per chapter (the control group), giving the other class three exams per chapter (the treatment group). The class being given three exams was considered to have been formatively assessed. The results declared that the only statistically significant difference in achievement was seen between the treatment group (three tests per chapter) and the control group (one test per chapter) in the novice teacher group (Dunn & Mulvenon, 2009).

Black and Wiliam arrived at an important conclusion after researching various studies on formative assessment, “that improved formative assessment helps low achievers more than other students and so reduces the range of achievement while raising achievement overall” (Black & Wiliam, 1998, p. 83).

Black and Wiliam (1998) outline four steps to implement a policy to improve formative assessment in the classroom. The first step, learning from development, introduces the idea that

an educator may have a difficult time implementing new practices in the classroom. No matter how inviting new practices may sound, implementation may prove challenging if there are not a variety of examples of these practices.

The authors suggest that teachers need to see examples of what effective formative assessment means in practice, not in theory. Black and Wiliam (1998) believe that the first step is to set up small, local groups of educators who can practice various formative assessments where, as a group, they can reformulate issues, develop fundamental insights, and provide support.

The second step, dissemination, becomes increasingly active as results and resources are available after the initial development. Essentially, after assessments are discovered as useful, districts would begin disseminating their information through the use of in-service trainings, professional development training, etc. (Black & Wiliam, 1998, p. 89). Black and Wiliam state that this process will be slow and requires a substantial amount of time.

The third step, reducing obstacles, could be quite cumbersome. “All features of the education system that actually obstruct the development of effective formative assessment should be examined to see how their negative effects can be reduced” (Black & Wiliam, 1998, p. 89). It is well known that educators have a very difficult job, and reducing the pressures and stress created by the job is crucial. While this step may seem trivial,

a huge impact can be made in the classroom when reducing obstacles is taken seriously.

The final step of implementing a policy to improve formative assessment is research. Black and Wiliam understand that while there are many reports and studies that declare formative assessment is effective, most fail to give practical application of how an educator can implement the assessment techniques in the classroom. For instance, “they are often silent about the actual classroom methods used, the motivation and experience of the teachers, the nature of the tests used as measures of success, or the outlooks and expectations of the pupils involved.” (Black & Wiliam, 1998, p. 89)

Black and Wiliam believe that formative assessment needs to be researched further, despite the lengthy and extensive research done. The authors discuss many directions that one could take for future research—studying the way teachers understand the relationship between formative and summative assessment, or studying the validity of teachers’ summative assessments compared to external test results (Black & Wiliam, 1998, p. 90). Regardless of whether a researcher will take on the burden of these studies, it is evident that formative assessment requires much more attention.

PURPOSE OF RESEARCH

While formative assessment has been shown to improve student achievement, the best method of formative assessment has yet to be determined. The purpose of this research is to compare the effects of two methods of formative assessment, daily exit slips and pre-, middle-, and post-testing.

HYPOTHESIS

The hypothesis for this study is that formatively assessing students through the use of daily exit slips and assessing students through the use of unit probing will differ in their impacts on student achievement.

CHAPTER 3

RESEARCH

To determine which method of formative assessment more positively impacts student achievement, the researcher conducted a study to collect data. The research took place at Lafayette Senior High School in Lexington, Kentucky. The study compared two types of formative assessment: daily exit slips and unit probing (pre-, middle-, post-assessments). Two high school mathematics classes were selected to participate in the study and the methods of formative assessment in question were implemented over a span of two mathematics units.

The research was conducted in the context of a Geometry classroom; the majority of the classes consisted of 10^{th} grade students, but also included 9^{th} and 11^{th} grade students. This study commenced mid-August, the beginning of the 2013-2014 school year, and continued through October. The Geometry classes were chosen because the students in them were similar in age, demographic and academic characteristics. The classes also met on the same day (A-day).

Classes at Lafayette High School ran on an A/B day block rotation schedule. The first Geometry class, A1 (A day, 1^{st} block), ran from 8:25 to 9:57 and had 28 students. The second Geometry class, A3 (A day, 3^{rd} block), ran from 11:37 to 1:40 and had 28 students. The participating classes had Geometry class every other day for a period of 90 minutes.

The first unit of Geometry was titled “Unit A: The Basics of Geometry,” which had a duration of nine days. This unit began on the third day of class, after students had been given an Algebra review and pre-assessment for the course. The delay of the unit start time assisted with the issue of students adding and dropping courses during the first week of school. The second unit of Geometry was titled “Unit B: Parallel and Perpendicular Lines,” which had a duration of six days. Unit B began immediately after Unit A ended.

One research method of formative assessment that was used for the units was a series of three probes, assessing students at the beginning, middle, and end of the unit. Probe 1 was given to students approximately one day before unit instruction began. Probe 1 was created by determining the most essential objectives for the unit. The probe was comprised of multiple-choice questions, one for each unit objective, with choices A through D for possible answers. Choices A, B, and C contained one correct solution and two incorrect solutions, while answer D was “I don’t know.” Although option D was counted as incorrect when scoring, students were instructed to choose this option when needed, to discourage guessing answers. Students were, however, encouraged to make an attempt before choosing D as the final answer.

Students were given approximately twenty minutes to complete Probe 1, giving the classes over one minute to answer each question. Students were allowed to use a TI-Nspire CX calculator to help with any basic calculations. When students

were finished answering the questions on the probe, they were required to enter their answers on a document created using the TI-Nspire Navigator System. The navigator system was used to organize and categorize the submitted data from students.

After the answers to Probe 1 were submitted, the researcher ran an analysis report for the class that provided a variety of information, as described below, that was used to guide instruction. The TI-Nspire Navigator provided an individual score breakdown for each student, per question, and identified the most frequently missed question. This information allowed the researcher to plan instruction for the unit based on skills in which the students were proficient, allowing extra instructional time for the objectives most often missed.

Probe 2 was given to students on the last day of instruction after each unit objective had been taught, and feedback had been given through returned homework assignments. Probe 2 was a variation of the first probe, with similar questions. The answers were collected through the TI-Nspire Navigator system, as before, and the data were collected in the same manner mentioned for Probe 1.

The results of Probe 2 were used to determine an instructional plan for the review day, where students reviewed all unit objectives before the end-of-unit exam (Probe 3). The researcher designed the review activity around the objectives that students most frequently answered incorrectly. These results

provided the researcher with a detailed list of the objectives each individual student had mastered.

The final assessment, Probe 3, was given to students as part of the end-of-unit exam. Multiple-choice questions, similar to those used for Probes 1 and 2 were placed on the exam, before a series of short-answer and constructed-response questions. Students were again given possible answers A through D, *without* the option of “I don’t know.” The multiple-choice options contained one correct solution and three incorrect responses.

While this probe, embedded in the end-of-unit exam, was graded as part of the exam in order to determine a final grade, the data from this assessment were used for the researcher to determine growth throughout the unit as well as what significant learning occurred. The researcher calculated the growth from Probe 1 to Probe 3.

Other important aspects of this method of formative assessment were student involvement and teacher feedback. After Probe 1, students were given a list of the essential objectives (Appendices A and G) for the unit, included as part of their note packet. Throughout instruction, the researcher guided students to check off objectives when they felt they had mastered them, typically after the daily lesson. This process allowed students to take ownership of their learning and to track their own progress.

In addition to this tracking process throughout instruction, students received their probe results with

meaningful feedback in a timely manner, with the mastered objectives identified. This process allowed for students to see their growth over the span of the unit. While the data and scoring for the probes were monitored by the researcher through an Excel spreadsheet, students were expected to track their progress individually.

To summarize, students were formatively assessed throughout the duration of the unit through the use of three probes. The results of the probes were used to create a plan that guided instructional methods and techniques. Students received meaningful feedback throughout the duration of the unit and used the information, along with the essential objectives for the unit, to track their progress.

Another method of formative assessment that was used for the study consisted of a pre- and post-assessment designed to track growth, with the use of daily exit slips to plan and alter instruction. To begin the unit, students were given a pre-test before instruction began. Similar to a unit probe, the pre-test was created by determining the most essential objectives for the unit. Multiple-choice questions were then created, one for each essential objective. The pre-test was comprised of multiple-choice questions with choices A through D for options. Choices A, B, and C contained one correct solution and two incorrect solutions, while option D was “I don’t know.” Again, the purpose of this was to discourage students from simply guessing an answer. The pre-test identified a starting point for instruction

and was compared to the post-test/end-of-unit exam score to show any growth throughout the unit.

The essential objectives that were identified to create the pre-test were used to create exit slips. The daily exit slip, given to students approximately 10 minutes before the end of class, consisted of one to four questions. The exit slips were created using Infinite Geometry software and were presented to students in paper format. Students were instructed to complete the exit slip in the 10-minute time frame and were allowed to use their TI-Nspire CX calculator for basic calculations.

Unlike unit probing which occurs three times over the span of a unit, students were formatively assessed each day after instruction, over the objectives(s) taught that day. The researcher collected data after each student had turned in their exit slip, determining common misconceptions and most frequently missed questions. Students were given meaningful feedback on each exit slip, which was returned the next class period.

The data collected each day by the researcher was used to plan future instruction. For instance, had 11 out of 28 students not grasped a specific objective after instruction, the researcher would have provided necessary re-teaching to the class in order to remediate. It was important that the researcher track each objective carefully throughout instruction so that when students began reviewing for an exam, there were sufficient data to determine where students needed assistance.

On the last day of the unit, students were given a post-test as part of the unit exam. Multiple-choice questions, similar to those from the pre-test, were placed on the unit exam. Students had choices A through D, with one correct answer and three incorrect responses. While this section was graded as part of the end-of-unit exam, the data from this assessment were used for the researcher to determine growth throughout the unit as compared to the pre-test score.

Similar to formatively assessing students with unit probing, students were also given a list of the essential objectives (Appendices A and G) for the unit, included as part of their note packet. Throughout instruction, the researcher guided students to check off objectives when they felt they had mastered them, typically after the daily lesson. This process allowed students to take ownership of their learning and to track their own progress.

To summarize, students were formatively assessed throughout the duration of the unit through the use of daily exit slips that were meant to guide instructional methods and techniques. The pre- and post-assessments were given to determine growth. Students received meaningful feedback throughout the duration of the unit upon return of exit slips.

For the study, the researcher’s A1 Geometry class was formatively assessed throughout Unit A with unit probing, while the researcher’s A3 Geometry class was formatively assessed with daily exit slips. For Unit B, the researcher’s A1 class was

formatively assessed with daily exit slips, while the researcher’s A3 class was formatively assessed with unit probing.

CHAPTER 4

RESULTS

Throughout Unit A, students in A1 Geometry were formatively assessed through the use of three probes. Students in A3 Geometry were formatively assessed through the use of a pre- and post-test with the use of daily exit slips in between. Both Probe 1 and the Pre-Test (A1 and A3, respectively) were given to students two days before unit instruction began. The identified objectives were as follows:

1. Identify coplanar points
2. Use the Segment Addition Postulate to solve for x
3. Use a ruler to measure a segment in centimeters
4. Classify an angle by degree measure
5. Use the Angle Addition Postulate to find a missing angle
6. Use a protractor to measure an angle in degrees
7. Name lines, rays, and planes
8. Use angle bisectors to find a missing angle
9. Identify angle relationships (linear pairs)
10. Identify angle relationships (vertical angles)
11. Use vertical angles to solve for x
12. Find the complement & supplement of an angle
13. Find the length of a segment using the distance formula
14. Find the midpoint of a segment given two points

The Unit A Probe 1 (Appendix B) and Unit A Pre-Test (Appendix C) were identical assessments that included 14 multiple-choice questions created using the objectives listed previously. These scores, calculated as the number of questions answered correctly, were used as a starting point for the data. The mean Unit A Probe 1 score was a 5.96, with a median score of 6. The mean Unit A Pre-Test score was a 5.57, with a median score of 5.5.

As instruction began, both classes were required to complete the same daily class activities. A1 and A3 were exposed to identical lessons and assignments, with A3 being formatively assessed by completing exit slips (Appendix D) at the end of each lesson. To formatively assess A1, the researcher gave the students a second probe, Probe 2 (Appendix E), on the last day of instruction, in which the results were used to create a review of all unit material, designed around student need.

The mean Unit A Probe 2 score was an 11.46, with a median score of 11.5. Compared to the mean Probe 1 score of 5.96, this indicated a growth of 5.5 after students received instruction. The most frequently missed questions on Probe 2 were numbers 2, 10, 11, and 14. In addition to the paper study guide for the unit exam, the researcher created a group work activity specifically for A1 Geometry that included extra review of using the segment addition postulate (question 2), identifying vertical angles (question 10), using vertical angles to solve for x (question

11), and finding the distance between two points (question 14). Students completed the group work in class.

After being formatively assessed through either exit slips or unit probing, students in both A1 and A3 Geometry were given an identical end-of-unit exam (Appendix F), including questions similar to those on Probe 1 and the Pre-Test. This portion was graded as their Probe 3 and Post-Test score. The mean Unit A Probe 3 score was 11.96, with a median score of 12.

The amount of growth between Probe 2 and Probe 3 throughout Unit A (the review day) was 0.5. The amount of growth throughout the entire unit after instruction and unit probing was 6, with a standard deviation of 2.48.

The mean Unit A Post-Test score was a 10, with a median score of 10.5. The amount of growth throughout the entire unit after instruction and exit slips was 4.43, with a standard deviation of 3.13. The use of unit probing showed a growth of 6, while the use of exit slips showed a growth of 4.43.

To analyze the data, the researcher conducted two two-sample t tests, one for Unit A and one for Unit B. Treating the students as units in the study is justified because of the individual feedback that students received on graded formative assessment. The first compared the mean growth of A1 Geometry to the mean growth of A3 Geometry for the span of Unit A. The calculated p-value for Unit A growth was 0.042. Thus, the results of Unit A were significant at the 0.05 level. In comparison between A1 and A3 Geometry classes, the use of unit probing

showed more growth throughout Unit A than the use of exit slips (Figure 1, Appendix M[1]).

Throughout Unit B, students in A1 Geometry were formatively assessed through the use of a pre- and post-test with the daily exit slips in between. Meanwhile, students in A3 Geometry were formatively assessed through the use of three probes. Both the Pre-Test and Probe 1 (A1 and A3, respectively) were given to students one day before unit instruction began. The identified objectives were as follows:

1. Identify parallel lines
2. Identify perpendicular lines
3. Identify skew lines
4. Identify same-side interior angles
5. Identify alternate-interior angles
6. Identify corresponding angles
7. Identify alternate-exterior angles
8. Use angle relationships to solve for x
9. Find the value of x that makes lines parallel
10. Find slopes of parallel lines
11. Find slopes of perpendicular lines

The Unit B Pre-Test and Probe 1 were identical assessments that included 11 multiple-choice questions created using the objectives listed previously. These scores, calculated by the number of questions answered correctly, were established as a baseline for the data. The mean Unit B Pre-Test (Appendix I)

[1] All figures are located in the appendix.

score, taken by A1 Geometry, was a 5.36, with a median score of 5. The mean Unit B Probe 1 (Appendix H) score, taken by A3 Geometry, was a 4.39, with a median score of 4.5.

As instruction began, both classes were required to complete the same daily activities. A1 and A3 were exposed to identical lessons and assignments, with A1 Geometry completing daily exit slips (Appendix J) at the end of each lesson. To formatively assess A3, the researcher gave students a second probe on the last day of instruction, in which the results were used to create a review of all unit material, designed around student need.

The mean Unit B Probe 2 (Appendix K) score, taken by class A3 Geometry was 7.93, with a median score of 9. Compared to the mean Probe 1 score of 4.39, this indicated a growth of 3.54 after students received instruction. The most frequently missed questions on Probe 2 were numbers 3, 8, 9, and 11. In addition to the paper study guide for the unit exam, the researcher created a group work PowerPoint assignment specifically for A3 Geometry that included extra review on identifying skew lines (question 3), using angle relationships to solve for x (question 8), finding the value of x that makes lines parallel (question 9) and finding the slope of a line perpendicular to a given line (question 11). Students completed the group work in class.

After being formatively assessed through either exit slips or unit probing, students in both A1 and A3 Geometry were given the same end-of-unit exam (Appendix L), with a portion of

questions similar to those on the Pre-Test and Probe 1. This portion was graded as their Post-Test and Probe 3 score. The mean Unit B Post-Test score, taken by A1 Geometry was 8.79, with a median score of 9.5. The amount of growth throughout the entire unit after instruction and exit slips was 3.43, with a standard deviation of 1.95.

The mean Unit B Probe 3 score, taken by A3 Geometry was 8.68, with a mean score of 9.5. The amount of growth between Probe 2 and Probe 3 throughout Unit B (the review day) was 0.75. The amount of growth throughout the entire unit after instruction and unit probing was 4.29, with a standard deviation of 2.62.

The second t test was conducted to compare the mean growth of A1 Geometry to the mean growth of A3 Geometry for the span of Unit B. The calculated p-value for Unit A growth was 0.172. Hence, the results of Unit B were not significant at the 0.05 level.

In comparison between A1 and A3 Geometry classes, the use of unit probing showed slightly more growth throughout Unit B than the use of exit slips (Figure 2, Appendix N). To summarize, unit probing showed more growth throughout the entire study.

In conclusion, the results of Unit A were significant at the 0.05 level. Thus, unit probing showed more growth over the duration of Unit A. The results of Unit B were not significant at the 0.05 level. Thus, neither method of formative assessment had significantly more growth than the other for Unit B.

It must be acknowledged that the evidence collected does not allow generalization as to which method of formative assessment consistently impacts student achievement. Although the study revealed findings consistent with the expected outcomes, no generalization can be made.

CHAPTER 5

LIMITATIONS

One of the limitations of this study was that the research was conducted with a small sample. Given that the researcher only taught two sections of Geometry, it was impossible to expand the research any further. Within the context of the two Geometry classes, there were important differences to note.

The time difference in classes was a crucial factor. The A1 Geometry class was in the morning, while the A3 Geometry class was in the afternoon. The 90-minute class period in A1 was without daily disruption, while A3 was interrupted daily by lunch. Students in the researcher’s A3 class were in class for 1 hour, and then 30 minutes, divided by a 25-minute break for lunch.

It is also important to note that students were not randomly assigned to the researcher’s classes. Scheduling was done three months prior to the beginning of school by the student’s counselor. The researcher had no control over what students would be in the classes, and therefore, which students would receive what treatment.

Another limitation was the units chosen for the study. While the researcher had no control over the unit choice or order that Lafayette Senior High School follows in Geometry, the

content within the units may have impacted the data. Unit A: The Basics of Geometry began almost immediately after the new school year started, which may have affected how comfortable students felt with their new surroundings, new classmates, and new teacher.

Unit A also involved a substantial amount of algebra, which students had not been exposed to since the previous school year. This alone may have impacted the data, as students were not prepared algebraically.

Unit B: Parallel and Perpendicular Lines followed Unit A, after students were more comfortable with their new schedule at school. The heavy amount of algebra review in Unit A was extremely beneficial in that it helped students with the algebra required in Unit B. This was a limitation of the study.

A third limitation of the study was the means of formative assessment chosen to research. Although well thought out and organized, the multiple-choice format of the formative assessments (pre-testing, post-testing, and probes) could not prevent students from guessing. Even with the letter D “I don’t know” being an option for students, the researcher had no control over whether or not a student chose D or simply guessed. When a student guessed an answer correctly, it appeared that the student had mastered an objective, when in reality, they had not.

A fourth limitation of the study was that treatments were not randomly assigned to the classes. A random number generator

could have been used to determine which formative assessment treatments were assigned.

To correct many of the limitations and continue the pursuit of identifying which method of formative assessment more positively impacts achievement, the researcher will continue to collect data for the remainder of the 2013-2014 school year. The researcher will continue to alternate the described methods of formative assessment, exit slips and unit probing, over the next 6 units of Geometry.

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APPENDIX A:
Unit A Objectives

UNIT A LEARNING OBJECTIVES

_____☐ **A1** Identify basic geometric symbols
_____☐ **A2** Identify and describe collinear, coplanar points, and intersecting lines
_____☐ **A3** Accurately measure a segment with a ruler
_____☐ **A4** Use the Distance Formula to find the length of a line segment
_____☐ **A5** Describe the difference between a theorem and a postulate
_____☐ **A6** Use the Segment Addition Postulate to find the measure of a segment
_____☐ **A7** Copy a segment using construction tools
_____☐ **A8** Find the midpoint of a line segment
_____☐ **A9** Bisect a segment using patty paper
_____☐ **A10** Correctly name geometric figures
_____☐ **A11** Accurately measure an angle with a protractor
_____☐ **A12** Classify angles as right, acute, obtuse, or straight
_____☐ **A13** Use the Angle Addition Postulate to find the measure of an angle
_____☐ **A14** Copy an angle using construction tools
_____☐ **A15** Solve problems involving angle bisectors
_____☐ **A16** Bisect an angle using patty paper
_____☐ **A17** Identify and sketch examples of vertical angles and linear pairs
_____☐ **A18** Solve problems involving the measures of vertical angles and linear pairs
_____☐ **A19** Solve problems involving complementary and supplementary angles
_____☐ **A20** Logically order the steps in a proof

A1---Student Progress (Beginning–Middle–End of Unit)

Probe #1	Probe #2	Probe #3 (Unit Exam)

A3---Student Progress (Beginning–Middle–End of Unit)

Pre-Test	Post-Test (Unit Exam)

APPENDIX B:

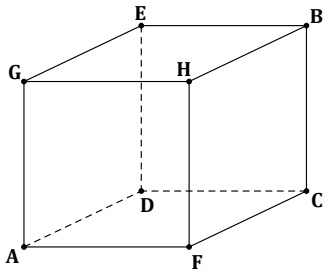
Unit A Probe 1

Unit A: Probe #1
Geometry

Name: _____
Date: _____
 # Correct: ____/14

_____ **1**. Which point is contained in plane *BHF*?

a) E
b) C
c) A
d) I don't know

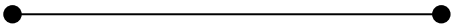


_____ **2.** If DE = 12x + 7, and EF = 9x – 4, and DF = 66. Find the value of *x*.

a) 1
b) 3
c) 5
d) I don't know

_____ **3.** Using a ruler, measure the segment below to the nearest *tenth* of a centimeter.

a) 2.2
b) 5.7
c) 6.0
d) I don't know

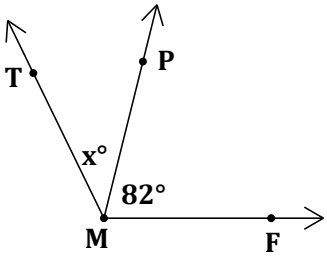


_____ **4.** Classify the following angle by degrees: **100°**

a) Straight
b) Acute
c) Obtuse
d) I don't know

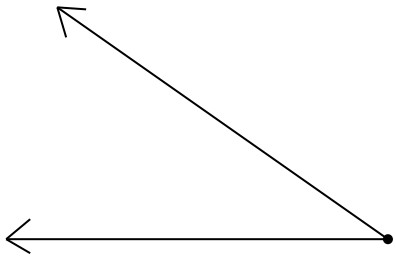
_____ **5.** If $m\angle TMF = 134°$, find the value of *x*.

a) 216°
b) 67°
c) 52°
d) I don't know



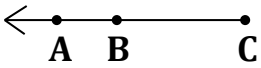
_____ **6.** Using your protractor, find the measure of the angle below to the nearest degree.

a) 35°
b) 145°
c) 90°
d) I don't know



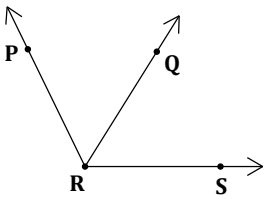
_____ **7.** Which of the following describes the figure below?

a) $\overrightarrow{AC}$
b) $\overrightarrow{CB}$
c) $\overrightarrow{CBA}$
d) I don't know



_____ **8.** In the figure below, $\overrightarrow{RQ}$ bisects ∠PRS and $m\angle PRS = 120°$. Find the $m\angle QRS$.

a) 120°
b) 60°
c) 45°
d) I don't know

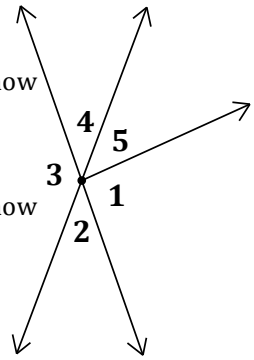


_____ **9.** In the diagram to the right, name a linear pair.

a) 2 and 3 **b)** 1 and 4 **c)** 1 and 2 **d)** I don't know

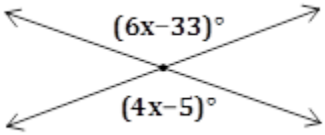
_____ **10.** In the diagram to the right, name a pair of vertical angles.

a) 3 and 5 **b)** 1 and 3 **c)** 2 and 4 **d)** I don't know



_____ **11.** Find the value of *x*.

a) 6
b) 14
c) 15
d) I don't know



_____ **12.** Find the complement of a 32° angle.

a) 148° **b)** 64° **c)** 58° **d)** I don't know

_____ **13.** Find the length of the segment with endpoints (–3, –6) and (3, 2).

a) 2
b) 4
c) 10
d) I don't know

_____ **14.** Find the midpoint of the segment with endpoints (–7, 3) and (3, –3).

a) (–2, –3)
b) (–2, 0)
c) (–5, 0)
d) I don't know

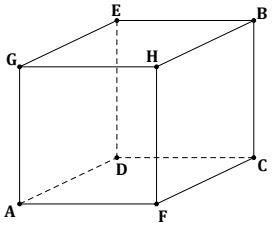
APPENDIX C:

Unit A Pre-Test

Unit A: Pre-Test **Name:** _____
Geometry
Date: _____
 # Correct: ____/14

_____ **1**. Which point is contained in plane *BHF*?

a) E
b) C
c) A
d) I don't know

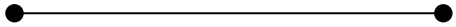


_____ **2.** If DE = 12x + 7, and EF = 9x – 4, and DF = 66. Find the value of *x*.

a) 1
b) 3
c) 5
d) I don't know

_____ **3.** Using a ruler, measure the segment below to the nearest *tenth* of a centimeter.

a) 2.2
b) 5.7
c) 6.0
d) I don't know

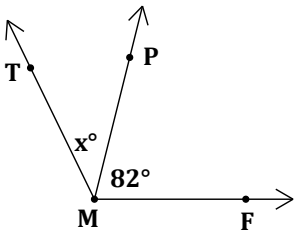


_____ **4.** Classify the following angle by degrees: **100°**

a) Straight
b) Acute
c) Obtuse
d) I don't know

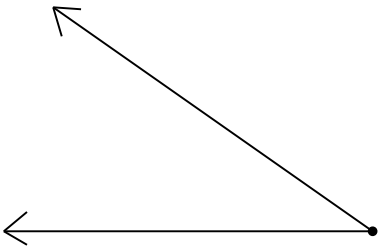
_____ **5.** If $m\angle TMF = 134°$, find the value of *x*.

a) 216°
b) 67°
c) 52°
d) I don't know



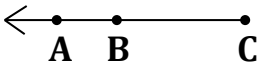
_____ **6.** Using your protractor, find the measure of the angle below to the nearest degree.

a) 35°
b) 145°
c) 90°
d) I don't know



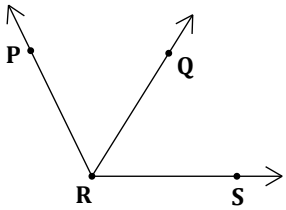
_____ **7.** Which of the following describes the figure below?

a) $\overrightarrow{AC}$
b) $\overrightarrow{CB}$
c) $\overrightarrow{CBA}$
d) I don't know



_____ **8.** In the figure below, $\overrightarrow{RQ}$ bisects ∠PRS and $m\angle PRS = 120°$. Find the $m\angle QRS$.

a) 120°
b) 60°
c) 45°
d) I don't know

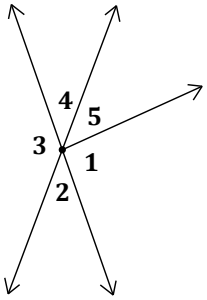


_____ **9.** In the diagram to the right, name a linear pair.

a) 2 and 3 **b)** 1 and 4 **c)** 1 and 2 **d)** I don't know

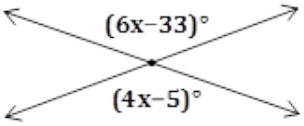
_____ **10.** In the diagram to the right, name a pair of vertical angles.

a) 3 and 5 **b)** 1 and 3 **c)** 2 and 4 **d)** I don't know



_____ **11.** Find the value of *x*.

a) 6
b) 14
c) 15
d) I don't know



_____ **12.** Find the complement of a 32° angle.

a) 148° **b)** 64° **c)** 58° **d)** I don't know

_____ **13.** Find the length of the segment with endpoints (−3, −6) and (3, 2).

a) 2
b) 4
c) 10
d) I don't know

_____ **14.** Find the midpoint of the segment with endpoints (−7, 3) and (3, −3).

a) (−2, −3)
b) (−2, 0)
c) (−5, 0)
d) I don't know

APPENDIX D:

Unit A Exit Slips

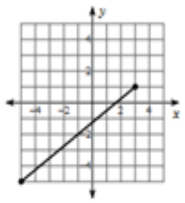
Geometry Name_____

Unit A Exit Slip #1

Find the distance between each pair of points.

1) (1, −5), (4, −2)

2)



3) Collinear points are points that lie on the _____ _____.

4) Coplanar points are points that lie on the _____ _____.

5) What is the difference between a segment and a ray?

Geometry **Name:** _____

Unit A Exit Slip #2

Write the Segment Addition Postulate for the points described. Use a diagram.

1. S is between D and P.

2. B is between A and C.

In the following problems, suppose J is between H and K. Use the Segment Addition Postulate to solve for x. Then, find the length of each segment.

3. HJ = 5x, JK = 7x, KH = 96

4. HJ = 2x + 5, JK = 3x - 7, KH = 18

Geometry Name_____

Unit A Exit Slip #3

Find the midpoint of the line segment with the given endpoints.

1) $(-8, 3), (0, -3)$

2) $(-4, -9), (-6, 7)$

Given the midpoint and one endpoint of a line segment, find the other endpoint.

3) Endpoint: $(-1, 9)$, midpoint: $(0, -4)$

Geometry Name_____

Unit A Exit Slip #4

Classify each angle as acute, obtuse, right, or straight.

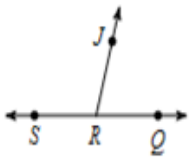
1) 159°

2) 180°

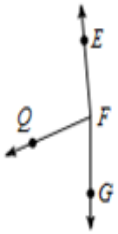
3) 90°

4) 

5) Find x if $m\angle SRJ = x + 108$, $m\angle SRQ = 180°$, and $m\angle JRQ = x + 78$.



6) $m\angle GFQ = 70°$ and $m\angle QFE = 104°$. Find $m\angle GFE$.



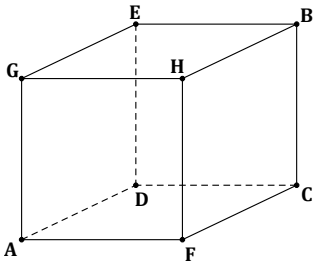
APPENDIX E:

Unit A Probe 2

Unit A: Probe #2
Geometry

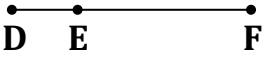
Name: _____
Date: _____
 # Correct: ____/14

_____ **1**. Which point is contained in plane EGB?



a) C
b) D
c) H
d) I don't know

_____ **2.** If DE = 2x + 10, and EF = 6x – 9, and DF = 41. Find the value of *x*.



a) 4
b) 5
c) 17
d) I don't know

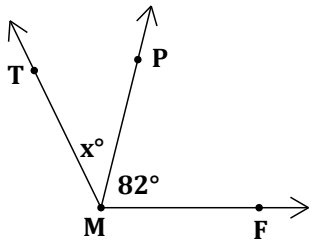
_____ **3.** Using a ruler, measure the segment below to the nearest *tenth* of a centimeter.

a) 2.25
b) 4.0
c) 4.2
d) I don't know

_____ **4.** Classify the following angle by degrees: **89°**

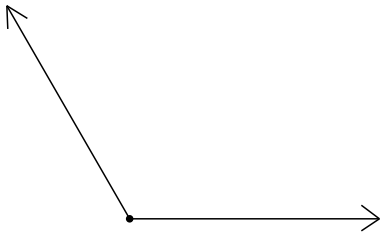
a) Straight
b) Acute
c) Obtuse
d) I don't know

_____ **5.** If $m\angle TMF = 156°$, find the value of *x*.



a) 238°
b) 78°
c) 74°
d) I don't know

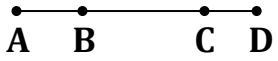
_____ **6.** Using your protractor, find the measure of the angle below to the nearest degree.



a) 120°
b) 60°
c) 135°
d) I don't know

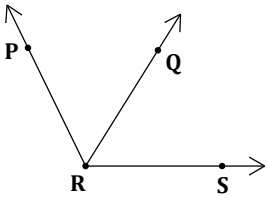
_____ **7.** Which of the following describes the figure below?

a) $\overline{ABCD}$
b) $\overline{ABD}$
c) $\overline{AD}$
d) I don't know



_____ **8.** In the figure below, $\overrightarrow{RQ}$ bisects ∠PRS and $m\angle PRS = 140°$. Find the $m\angle PRQ$.

a) 140°
b) 50°
c) 70°
d) I don't know

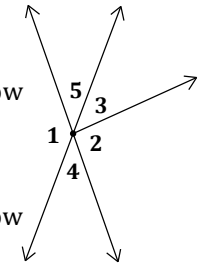


_____ **9.** In the diagram to the right, name a linear pair.

a) 4 and 5 **b)** 1 and 4 **c)** 2 and 3 **d)** I don't know

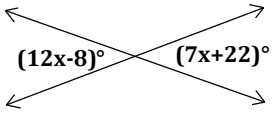
_____ **10.** In the diagram to the right, name a pair of vertical angles.

a) 3 and 4 **b)** 1 and 2 **c)** 4 and 5 **d)** I don't know



_____ **11.** Find the value of *x*.

a) 4
b) 6
c) 8
d) I don't know



_____ **12.** Find the supplement of a 32° angle.

b) 148° **b)** 64° **c)** 58° **d)** I don't know

_____ **13.** Find the length of the segment with endpoints (6, 1) and (6, -3).

a) 2
b) 4
c) 14
d) I don't know

_____ **14.** Find the midpoint of the segment with endpoints (1, 7) and (–1, 5).

a) (0, 6)
b) (–3, 3)
c) (1, 1)
d) I don't know

APPENDIX F:

Unit A Exam

Unit A Exam (Basics of Geometry) **Name: _____**

Geometry **Date: _____Block: _____**

Section 1 – Multiple Choice

Directions: Read the directions for each question carefully. Choose the correct response and place the corresponding letter on the blank provided.

_____ 1) Use the mid-point formula to find the mid-point between the points C(8, 2) and D(-6, -8).

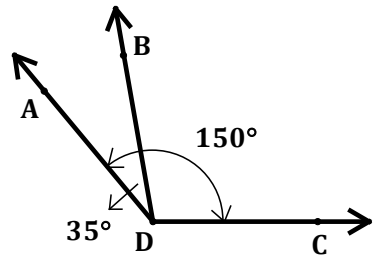
a. (-1, -3)
b. (-3, -1)
c. (1, 3)
d. (3, 1)

_____ 2) Point *H* is between point *G* and point *I*. If $GH = 8x + 7$, $HI = 3x - 2$, and $GI = 38$, find the value of *x*.

a. 3
b. 5
c. 31
d. 39

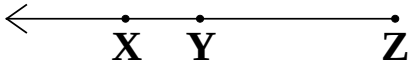
_____ 3) If $m\angle ADC = 150°$ and $m\angle ADB = 35°$, find $m\angle BDC$.

a. 185°
b. 115°
c. 100°
d. 25°

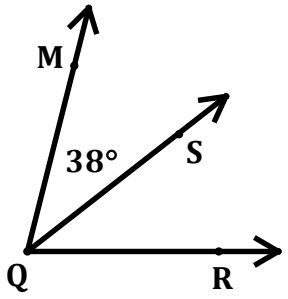


_____ 4) Choose the correct name for the ray.

a. $\overrightarrow{XYZ}$
b. $\overrightarrow{ZYX}$
c. $\overrightarrow{ZX}$
d. $\overrightarrow{XZ}$



_____ **5)** $\overrightarrow{QS}$ bisects ∠MQR. What is the $m\angle MQR$?



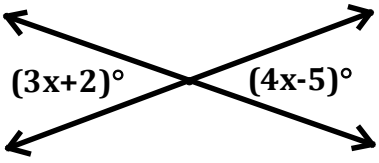
a. 26°

b. 38°

c. 76°

d. 104°

_____ **6)** Find the value of *x* in the diagram to the right.



a. 7

b. 14

c. 25

d. 26

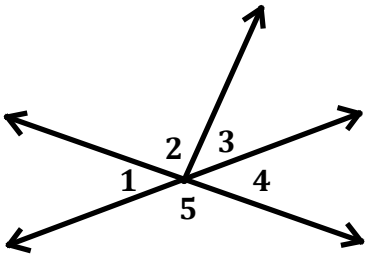
_____ **7)** Which angles form a linear pair?

a. ∠1 and ∠2

b. ∠2 and ∠3

c. ∠1 and ∠4

d. ∠4 and ∠5



_____ **8)** Which angles are vertical angles?

a. ∠1 and ∠2

b. ∠3 and ∠5

c. ∠1 and ∠4

d. ∠4 and ∠5

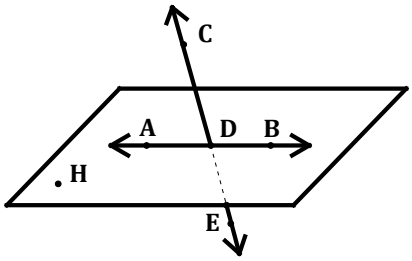
_____ **9)** What point is noncollinear with points D and B?

a. H

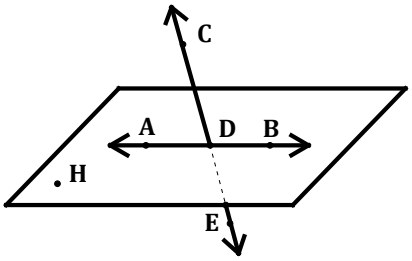
b. E

c. Both H and E

d. Neither H nor E



_____ **10)** What point is coplanar with points A, D, and B?



a. C

b. E

c. H

d. None of the above

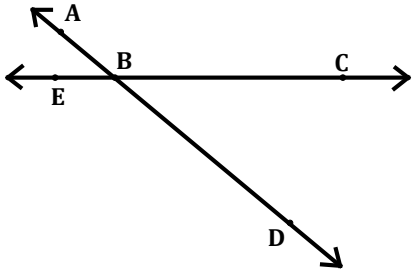
_____ **11)** Which of the following is an obtuse angle?

a. ∠ABE

b. ∠ABC

c. ∠CBD

d. ∠ABD



_____ **12)** Which of the following is an acute angle?

a. ∠ABE

b. ∠ABC

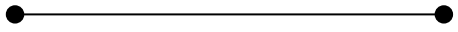
c. ∠CBE

d. ∠EBD

_____ **13)** Find the length of the segment with endpoints (7, –7) and (7, 2).

a) 2
b) 9
c) 10
d) 4

_____ **14)** Using a ruler, measure the segment below to the nearest *tenth* of a centimeter.



a) 2.2
b) 5.7
c) 6.0
d) 6.3

APPENDIX G:
Unit B Objectives

UNIT B LEARNING OBJECTIVES

I can…

_____☐ **B1** Identify parallel, perpendicular, and skew lines

_____☐ **B2** Identify four pairs of angles formed by transversals

_____☐ **B3** Solve problems involving the measures of special angle pairs

_____☐ **B4** Prove that two lines are parallel

_____☐ **B5** Find the slope between two points

_____☐ **B6** Use slope to identify parallel and perpendicular lines in the coordinate plane

_____☐ **B7** Construct a perpendicular line through a point not on a given line using construction tools

_____☐ **B8** Construct a parallel line through a point not on a given line using patty paper

A1---Student Progress (Beginning–Middle–End of Unit)

Pre-Test	Post-Test (Unit Exam)

A3---Student Progress (Beginning–Middle–End of Unit)

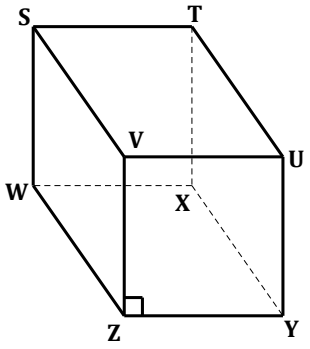
Probe #1	Probe #2	Probe #3 (Unit Exam)

APPENDIX H:

Unit B Probe 1

Unit B Probe #1 **Name:** _____
Geometry **Date:** _____ **# Correct:**
____/11

For #'s 1–3, refer to the figure to the right.



___ 1) Identify the pair of lines that appear to be parallel.

a. $\overleftrightarrow{ST}$ and $\overleftrightarrow{ZY}$
b. $\overleftrightarrow{ST}$ and $\overleftrightarrow{UY}$
c. $\overleftrightarrow{UY}$ and $\overleftrightarrow{WZ}$
d. I don't know

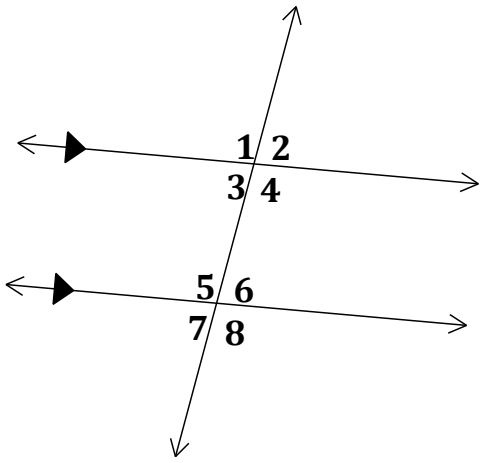
___ 2) Identify the pair of lines that appear to be perpendicular.

a. $\overleftrightarrow{ST}$ and $\overleftrightarrow{ZY}$
b. $\overleftrightarrow{ST}$ and $\overleftrightarrow{UY}$
c. $\overleftrightarrow{UY}$ and $\overleftrightarrow{WZ}$
d. I don't know

___ 3) Identify the pair of lines that appear to be skew.

a. $\overleftrightarrow{ST}$ and $\overleftrightarrow{ZY}$
b. $\overleftrightarrow{ST}$ and $\overleftrightarrow{UY}$
c. $\overleftrightarrow{UY}$ and $\overleftrightarrow{WZ}$
d. I don't know

For #'s 4–5, refer to the figure to the right.



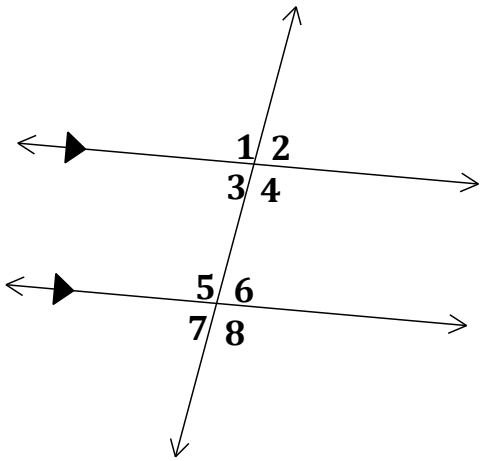
___ 4) What type of angles are $\angle 3$ and $\angle 5$?

a. alternate interior angles
b. corresponding angles
c. same–side interior angles
d. I don't know

___ 5) What type of angles are $\angle 4$ and $\angle 5$?

a. alternate interior angles
b. corresponding angles
c. same–side interior angles
d. I don't know

For #'s 6–7, refer to the figure to the right.



___ 6) What type of angles are ∠2 and ∠6?

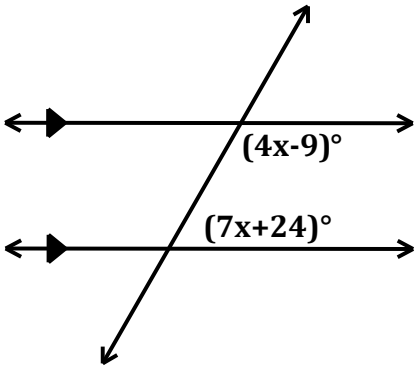
- **a.** alternate exterior angles
- **b.** corresponding angles
- **c.** same–side interior angles
- **d.** I don't know

___ 7) What type of angles are ∠2 and ∠7?

- **a.** alternate exterior angles
- **b.** corresponding angles
- **c.** same–side interior angles
- **d.** I don't know

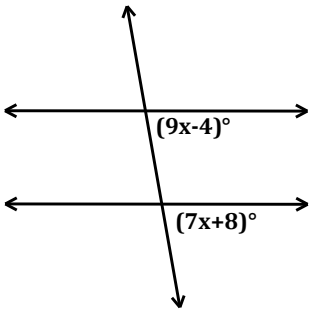
___ 8) Find the value of x.

- **a.** 3
- **b.** 11
- **c.** 15
- **d.** I don't know



___ 9) Find the value of x that makes the lines parallel.

- **a.** 2
- **b.** 6
- **c.** 11
- **d.** I don't know



___ 10) Find the slope of a line parallel to y = 2x – 9.

- **a.** 2
- **b.** -1/2
- **c.** -2
- **d.** I don't know

___ 11) Find the slope of a line perpendicular to y = -3/4x + 2.

- **a.** -3/4
- **b.** 4/3
- **c.** -4/3
- **d.** I don't know

APPENDIX I:

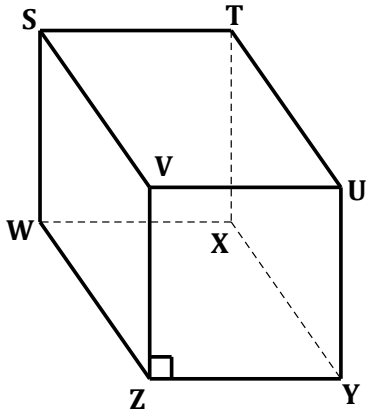
Unit B Pre-Test

Unit B Pre–Test **Name: _____**
Geometry **Date: _____ # Correct:**
____/11

For #'s 1–3, refer to the figure to the right.

___ 1) Identify the pair of lines that appear to be parallel.

a. $\overleftrightarrow{ST}$ and $\overleftrightarrow{ZY}$
b. $\overleftrightarrow{ST}$ and $\overleftrightarrow{UY}$
c. $\overleftrightarrow{UY}$ and $\overleftrightarrow{WZ}$
d. I don't know



___ 2) Identify the pair of lines that appear to be perpendicular.

e. $\overleftrightarrow{ST}$ and $\overleftrightarrow{ZY}$
f. $\overleftrightarrow{ST}$ and $\overleftrightarrow{UY}$
g. $\overleftrightarrow{UY}$ and $\overleftrightarrow{WZ}$
h. I don't know

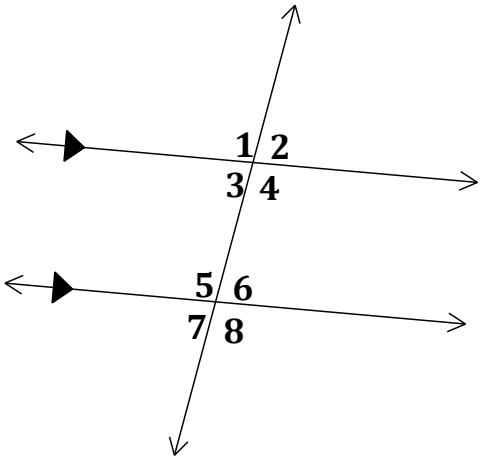
___ 3) Identify the pair of lines that appear to be skew.

a. $\overleftrightarrow{ST}$ and $\overleftrightarrow{ZY}$
b. $\overleftrightarrow{ST}$ and $\overleftrightarrow{UY}$
c. $\overleftrightarrow{UY}$ and $\overleftrightarrow{WZ}$
d. I don't know

For #'s 4–5, refer to the figure to the right.

___ 4) What type of angles are $\angle 3$ and $\angle 5$?

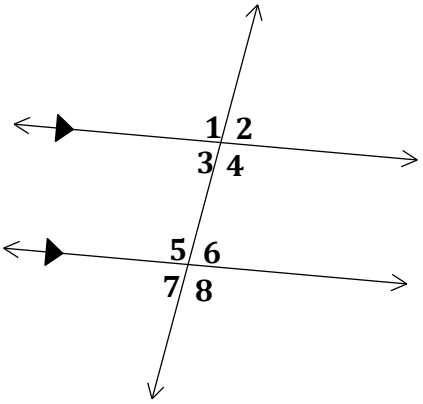
a. alternate interior angles
b. corresponding angles
c. same–side interior angles
d. I don't know



___ 5) What type of angles are $\angle 4$ and $\angle 5$?

a. alternate interior angles
b. corresponding angles
c. same–side interior angles
d. I don't know

For #'s 6–7, refer to the figure to the right.



___ 6) What type of angles are ∠2 and ∠6?

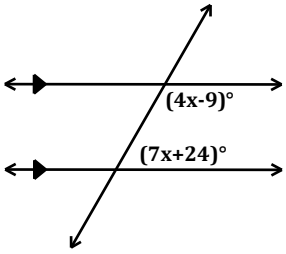
- **a.** alternate exterior angles
- **b.** corresponding angles
- **c.** same–side interior angles
- **d.** I don't know

___ 7) What type of angles are ∠2 and ∠7?

- **a.** alternate exterior angles
- **b.** corresponding angles
- **c.** same–side interior angles
- **d.** I don't know

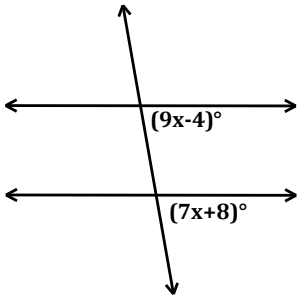
___ 8) Find the value of x.

- **a.** 3
- **b.** 11
- **c.** 15
- **d.** I don't know



___ 9) Find the value of x that makes the lines parallel.

- **a.** 2
- **b.** 6
- **c.** 11
- **d.** I don't know



___ 10) Find the slope of a line parallel to y = 2x – 9.

- **a.** 2
- **b.** -1/2
- **c.** -2
- **d.** I don't know

___ 11) Find the slope of a line perpendicular to y = -3/4x + 2.

- **a.** -3/4
- **b.** 4/3
- **c.** -4/3
- **d.** I don't know

APPENDIX J:

Unit B Exit Slips

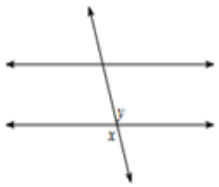
Geometry Name_____

Unit B Exit Slip #1

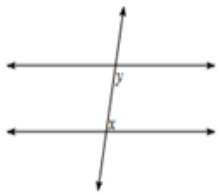
Date_____

Identify each pair of angles as corresponding, alternate interior, alternate exterior, same-side interior, or vertical.

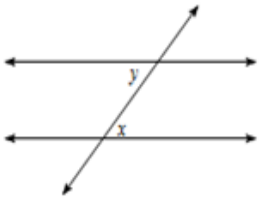
1)



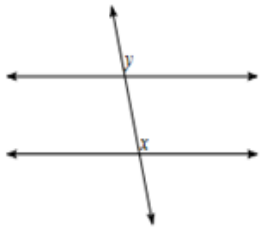
2)



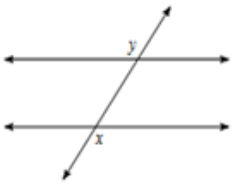
3)



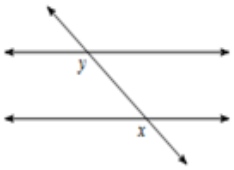
4)



5)



6)



Geometry

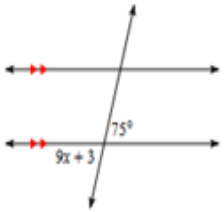
Name_____

Unit B Exit Slip #2

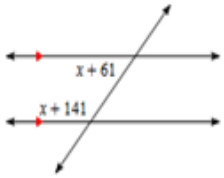
Date_____

Solve for *x*.

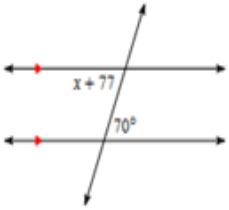
1)



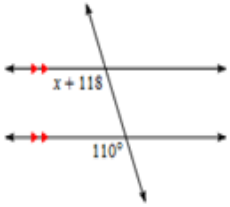
2)



3)



4)



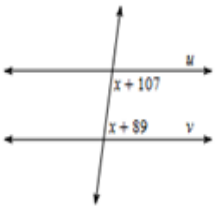
Geometry Name_____

Unit B Exit Slip #3

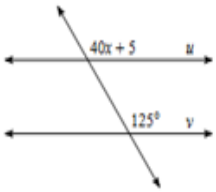
Date_____

Find the value of *x* that makes lines u and v parallel.

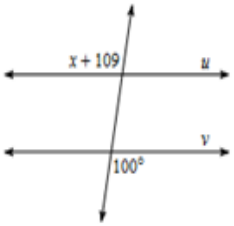
1)



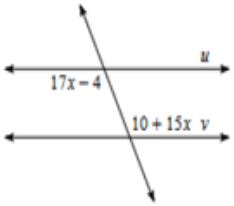
2)



3)



4)



Algebra 1 Name_____

Unit B Exit Slip #4

Date_____

Find the slope of the line through each pair of points.

1) $(14, 10), (-6, 6)$

2) $(17, -20), (3, -17)$

Find the slope of a line parallel to the given line.

3) $y = \frac{6}{5}x - 4$

4) $y = -\frac{4}{5}x + 1$

Find the slope of a line perpendicular to the given line.

5) $y = \frac{4}{3}x + 2$

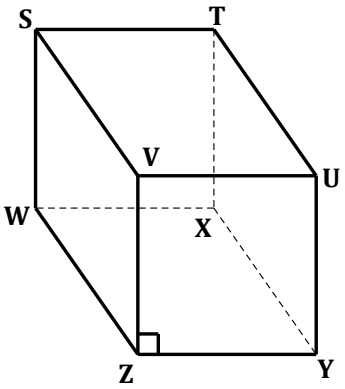
6) $y = \frac{4}{5}x - 2$

APPENDIX K:

Unit B Probe 2

Unit B Probe #2 **Name:** _____
Geometry **Date:** _____ **# Correct:**
____/11

For #'s 1–3, refer to the figure to the right.



___ 1) Identify the pair of lines that appear to be parallel.

- **a.** $\overleftrightarrow{SV}$ and $\overleftrightarrow{TU}$
- **b.** $\overleftrightarrow{ST}$ and $\overleftrightarrow{WZ}$
- **c.** $\overleftrightarrow{UY}$ and $\overleftrightarrow{YZ}$
- **d.** I don't know

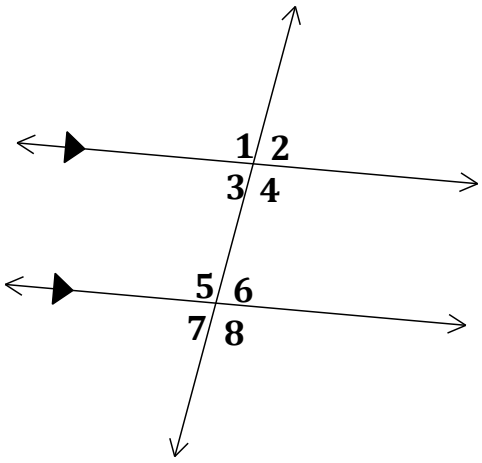
___ 2) Identify the pair of lines that appear to be perpendicular.

- **e.** $\overleftrightarrow{SV}$ and $\overleftrightarrow{TU}$
- **f.** $\overleftrightarrow{ST}$ and $\overleftrightarrow{WZ}$
- **g.** $\overleftrightarrow{UY}$ and $\overleftrightarrow{YZ}$
- **h.** I don't know

___ 3) Identify the pair of lines that appear to be skew.

- **i.** $\overleftrightarrow{SV}$ and $\overleftrightarrow{TU}$
- **j.** $\overleftrightarrow{ST}$ and $\overleftrightarrow{WZ}$
- **k.** $\overleftrightarrow{UY}$ and $\overleftrightarrow{YZ}$
- **l.** I don't know

For #'s 4–5, refer to the figure to the right.



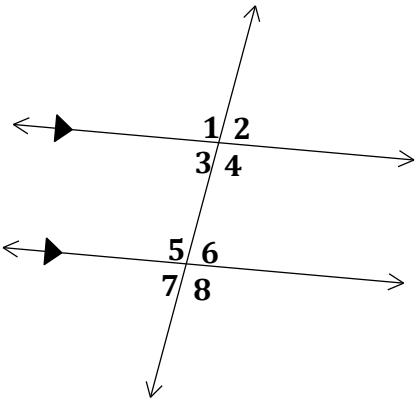
___ 4) What type of angles are $\angle 1$ and $\angle 5$?

- **a.** alternate interior angles
- **b.** corresponding angles
- **c.** same–side interior angles
- **d.** I don't know

___ 5) What type of angles are $\angle 3$ and $\angle 5$?

- **a.** alternate interior angles
- **b.** corresponding angles
- **c.** same–side interior angles
- **d.** I don't know

For #'s 6–7, refer to the figure to the right.



___ 6) What type of angles are ∠3 and ∠6?

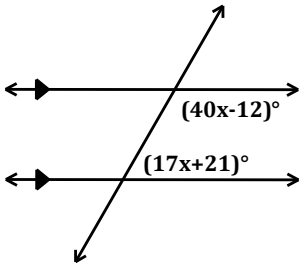
- **a.** alternate interior angles
- **b.** corresponding angles
- **c.** same–side interior angles
- **d.** I don't know

___ 7) What type of angles are ∠1 and ∠8?

- **a.** alternate exterior angles
- **b.** corresponding angles
- **c.** same–side interior angles
- **d.** I don't know

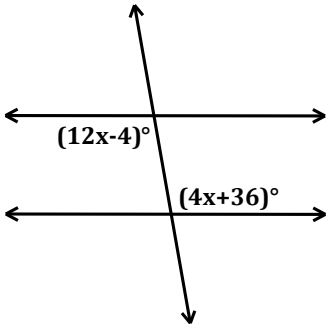
___ 8) Find the value of x.

- **a.** 1
- **b.** 3
- **c.** 5
- **d.** I don't know



___ 9) Find the value of x that makes the lines parallel.

- **a.** 2
- **b.** 5
- **c.** 9
- **d.** I don't know



___ 10) Find the slope of a line parallel to y = 4x – 1.

- **a.** 4
- **b.** -1/4
- **c.** -4
- **d.** I don't know

___ 11) Find the slope of a line perpendicular to y = -3/2x + 2.

- **a.** -3/2
- **b.** 2/3
- **c.** -2/3
- **d.** I don't know

APPENDIX L:

Unit B Exam

Unit B Exam (Parallel & Perpendicular Lines) **Name: _____**

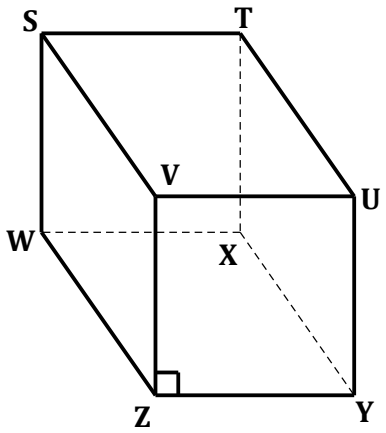
Geometry **Date: _____ Block: _____**

Section 1 – Multiple Choice

Directions: Read the directions for each question carefully. Choose the correct response and place the corresponding letter on the blank provided.

___ 1) Identify the pair of lines that appear to be parallel.

a. $\overleftrightarrow{SV}$ and $\overleftrightarrow{TU}$
b. $\overleftrightarrow{ST}$ and $\overleftrightarrow{WZ}$
c. $\overleftrightarrow{UY}$ and $\overleftrightarrow{YZ}$
d. None of the above



___ 2) Identify the pair of lines that appear to be perpendicular.

e. $\overleftrightarrow{SV}$ and $\overleftrightarrow{TU}$
f. $\overleftrightarrow{ST}$ and $\overleftrightarrow{WZ}$
g. $\overleftrightarrow{UY}$ and $\overleftrightarrow{YZ}$
h. None of the above

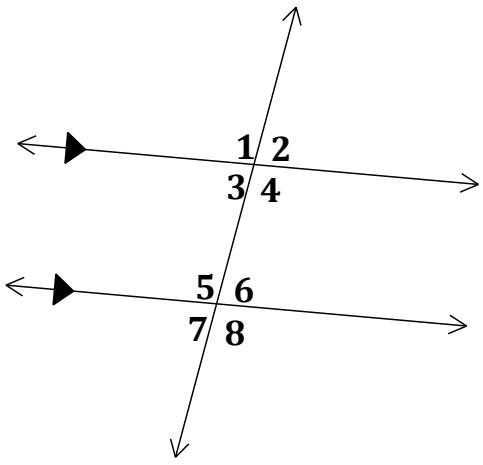
___ 3) Identify the pair of lines that appear to be skew.

i. $\overleftrightarrow{SV}$ and $\overleftrightarrow{TU}$
j. $\overleftrightarrow{ST}$ and $\overleftrightarrow{WZ}$
k. $\overleftrightarrow{UY}$ and $\overleftrightarrow{YZ}$
l. None of the above

For #'s 4–5, refer to the figure to the right.

___ 4) What type of angles are $\angle 2$ and $\angle 6$?

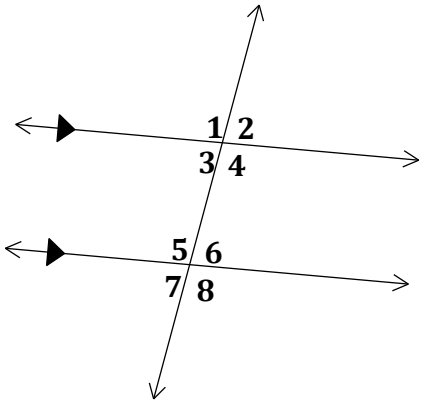
a. alternate interior angles
b. corresponding angles
c. same–side interior angles
d. alternate exterior angles



___ 5) What type of angles are $\angle 4$ and $\angle 6$?

a. alternate interior angles
b. corresponding angles
c. same–side interior angles
d. vertical angles

For #'s 6–7, refer to the figure to the right.



___ 6) What type of angles are ∠4 and ∠5?

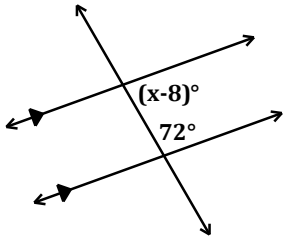
- **a.** alternate interior angles
- **b.** corresponding angles
- **c.** same–side interior angles
- **d.** alternate exterior angles

___ 7) What type of angles are ∠2 and ∠7?

- **a.** alternate exterior angles
- **b.** corresponding angles
- **c.** same–side interior angles
- **d.** alternate exterior angles

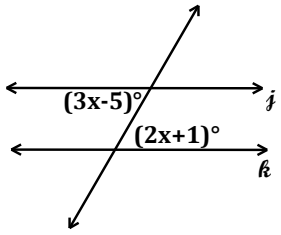
___ 8) Find the value of x.

- **a.** 116
- **b.** 13
- **c.** 72
- **d.** 80



___ 9) Find the value of x that makes the lines parallel.

- **a.** 2
- **b.** 5
- **c.** 6
- **d.** 13



___ 10) Find the slope of a line parallel to y = -5x – 2.

- **a.** -5
- **b.** -1/5
- **c.** 1/5
- **d.** 6

___ 11) Find the slope of a line perpendicular to y = -3/4x + 9.

- **a.** -3/4
- **b.** 4/3
- **c.** -4/3
- **d.** -4/3

APPENDIX M:

Figure 1

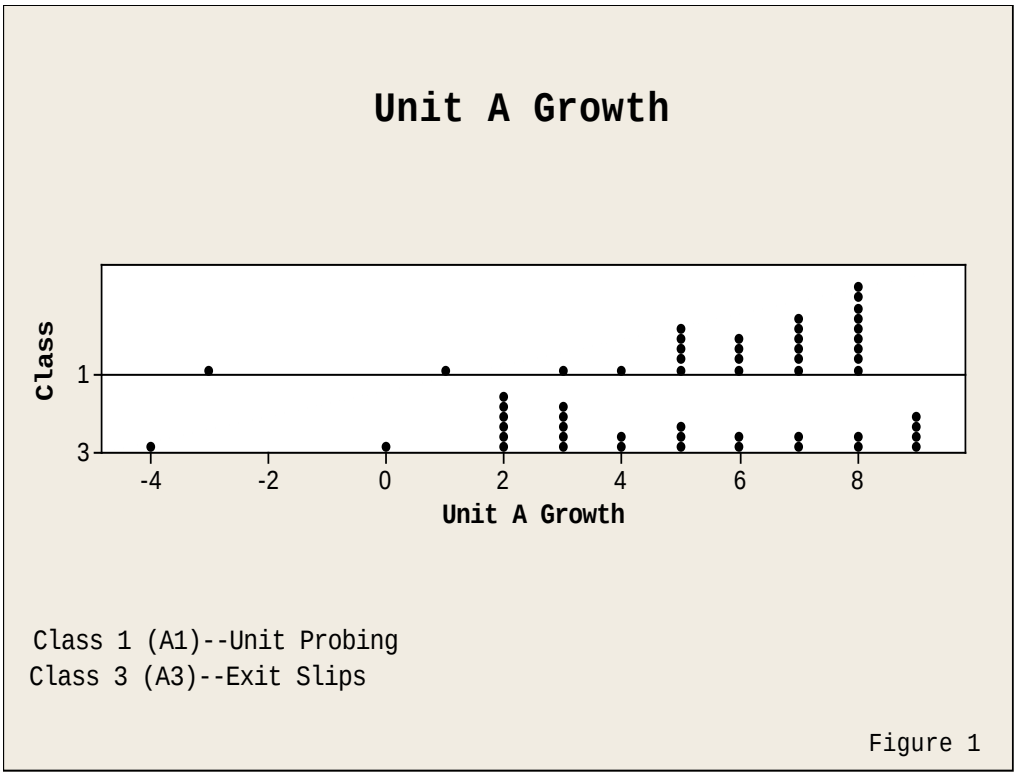


Figure 1: Stacked Dot Plot Comparing Unit A Growth

APPENDIX N:

Figure 2

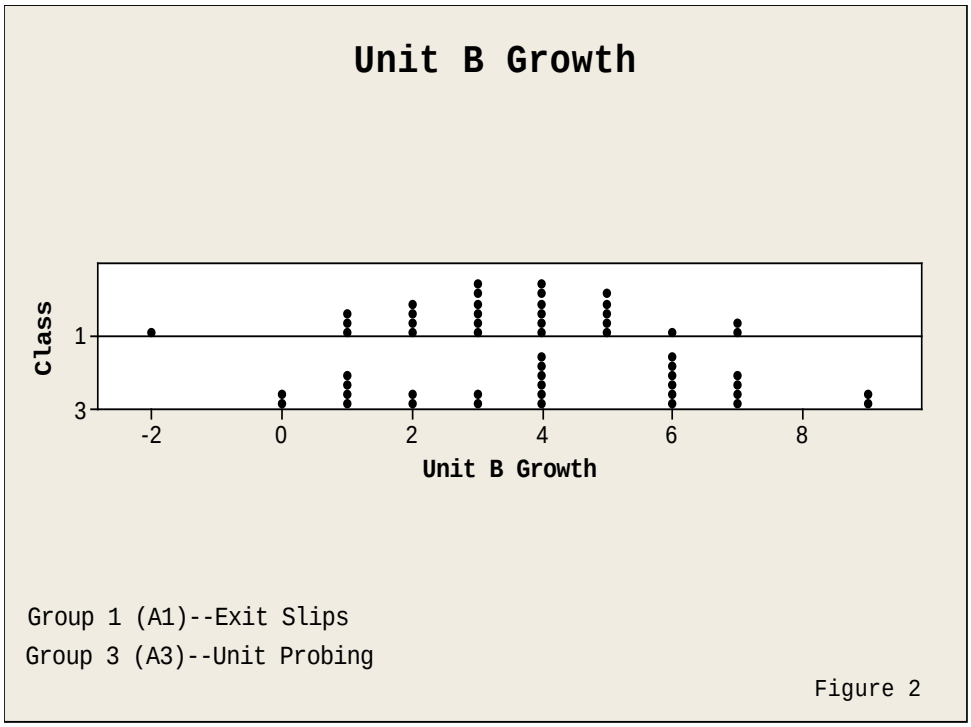


Figure 2: Stacked Dot Plot Comparing Unit B Growth