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Next Generation Online Math I Course Evaluation

Jennifer Francis

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Reagan Curtis, Ph.D., Chair
Johnna Bolyard, Ph.D.
Laura Pyzdrowski, Ed.D.

Department of Learning Sciences and Human Development

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ABSTRACT

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An evaluation was conducted on the Next Generation Online Math I course implemented at Philip Barbour High School in Philippi, West Virginia. These online math modules are considered a blended learning environment as they incorporate some level of online learning in a face-to-face environment. Current research in blended learning has not shown consistent results in student achievement. Pre- post-test data, benchmark data, and summative yearly assessment data were collected. Results show that students had significant learning gains but did not typically score mastery on unit post-tests. Students in the blended learning environment, with a non-certified teacher, scored similarly to students in the traditional learning environment, with a non-math certified teacher, on most benchmarks and the summative assessment. Suggested improvements to the Next Generation online math modules include improved capability to load and run videos and applets and an improved design for pre- and post-test.

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Introduction

The purpose of this evaluation was to gather information on students' learning in three sections of Math I at Philip Barbour High School in Philippi, West Virginia that implemented online math modules developed by the West Virginia Department of Education in partnership with Academic Innovation. The Next Generation Math I online course formative evaluation has examined students' mastery of content standards through the use of the online course and determined possible improvements that can be made to the online course. Further, this evaluation has shed light into the experiences of a teacher in three sections of Math I. Results of the evaluation are of interest to WVU Academic Innovation, Philip Barbour math teachers and principals, Barbour County Schools, and more broadly, teachers and administrators across the state of West Virginia, as well as the WV Department of Education.

This document starts with a review of literature, which covers some background information regarding math education and recent curriculum changes in math education. Blended learning is introduced and defined using models followed by existing research in blended learning. The Centers for Disease Control framework for program evaluation is then given as a guide for this evaluation. Following the steps of that framework, stakeholders, including WVU Academic Innovation and Philip Barbour High School teachers, students, and parents, are recognized and the Next Generation online math modules program is described. Research questions are stated, and the methods are described. Data for all Math I students at Philip Barbour High School were collected although the focus of this evaluation was on the sections of Math I that implemented the use of the online math modules. Several measures were used including pre- post-test data, benchmark assessments, and Smarter Balanced yearly assessment data. Classroom observation field notes also were taken and analyzed. Results show that students in the sections using the online math modules did have significant learning gains from pre- to post-test, however very few of these students scored mastery or above on post-tests. Some sections of Math I scored significantly higher on benchmark assessments, but on the Smarter Balanced yearly assessment all Math I sections except for one did not score significantly different from the section using the online math modules. Conclusions state that teacher certification was likely a key factor in student achievement rather than learning environment. To ensure the use of this evaluation research conversations with WVU Academic Innovation were had about issues the teacher encountered while implementing the Next Generation online math modules. All math teachers at Philip Barbour High School were also informed on the results of this evaluation.

Literature Review

The United States has consistently not scored in the top of international rankings of student achievement in math. In order to try to increase math learning and achievement scores, new standards have been introduced and implemented across the nation including Common Core State Standards Initiative (2011) and the West Virginia Next Generation Standards (West Virginia Department of Education, n.d.). Part of restructuring the standards also included integrating math courses and using blended learning. The key aspect of blended learning is that a variation of both online and traditional learning is used. Several models that incorporate these many variations can be placed in different locations on a blended learning continuum that ranges from traditional learning to online learning. Research has shown mixed results in comparing student achievement using blended learning and traditional, face-to-face or online learning. More research needs to be completed in blended learning environments. This evaluation will add to that research. Once the aspects and research of blended learning are reviewed, the focus of the evaluation including a description of the Centers for Disease Control evaluation framework (2012) with elaboration on how the first steps were completed is given.

International Comparison on Student Achievement in Math

The International Association for the Evaluation of Educational Achievement (IEA) used the Trends in International Mathematics and Science Study (TIMSS) and the PISA (Program for International Student Assessment) assessments in order to compare international students' learning across different content areas. The TIMSS assessment focuses on students' content and cognitive domains in math (Mullis, 2000). The PISA assessment focuses on the ability to apply math to real life situations and is reported as a math literacy score (Lemke, Sen, Pahlke, Partelow, Miller, et al., 2004).

Using these two international assessments, a comparison can be made between the United States' and various other countries' math achievement. In 1995, the first TIMSS assessment was given, and fourth grade students in five countries scored higher than fourth grade U.S. students on the math portion. Fifteen countries' students scored higher than U.S. eighth graders who also performed significantly lower than the international average on this assessment (Mullis, 1997). In the next TIMSS administration, in 1999, 14 countries' students scored significantly higher than the United States on the eighth grade math assessment (Mullis, 2000). Some countries who scored higher than the U.S.

in both the 1995 and 1999 TIMSS assessments included Singapore, Hong Kong, Japan, and Korea.

Reports of the PISA assessment in 2003 showed that 15 year olds (typically 9th or 10th grade) in the U.S. scored lower in math literacy than the international average and lower than 23 of 38 countries (Lemke, Sen, Pahlke, Partelow, Miller, et al., 2004). Also in 2003, on the TIMSS math content assessment, U.S. fourth graders were outperformed by 11 of 24 participating countries, and 9 of 45 countries outperformed U.S. eighth graders (Gonzales, Guzmán, Partelow, Pahlke, Jocelyn, et al., 2004).

In the PISA assessment of 2006, 15 year olds in the United States scored lower than the average of participating countries' students once again. Twenty-three of 29 countries' students outperformed the US on this math assessment putting the nation in the bottom quarter in this category (Provasnik, Gonzales, & Miller, 2009). A year later, on the next TIMMS administration, in 2007, the average U.S. fourth grade mathematics score was lower than those in 8 countries (all 8 were in Asia or Europe). At grade eight, scores were lower than those in 5 countries (all of them located in Asia). (Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2008). With the continuation of U.S. students scoring lower than many countries on these international math assessments, there was a call for education reform, including in math.

Common Core State Standards and Next Generation Standards

In 2009, the Common Core State Standards (2010) were published to give the United States a uniform guide, which the states may use when mandating their own state educational standards. West Virginia adopted the Common Core State Standards by using the guide to mandate their own version of the standards called the Next Generation

Content Standards and Objectives (CSOs). This included standards for mathematical practice as well as standards for mathematical content for kindergarten through high school. The standards for mathematical practice include: make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model with mathematics, use appropriate tools strategically, attend to precision, look for and make use of structure, and look for and express regularity in repeated reasoning (2010).

Prior to the Next Generation CSOs, the state of West Virginia used the 21st Century Content Standards and Objectives. The principals of mathematical practice under this policy were as follows: equity, curriculum, teaching, learning, assessment, and technology. Details and descriptions of these can be found in mathematics - policy 2520.2, which was made effective October 14, 2014. Under the 21st Century CSO's the high school math classes followed a traditional pathway: Algebra I, Geometry, Algebra II, Trigonometry, Pre-Calculus, but this changed with the introduction of the Next Generation standards.

Integrated Math Classes

The West Virginia Department of Education stated that because the Next Generation CSO's are arranged in a way that encourages student learning progression, there needed to be a change in the sequencing of the mathematics courses (WVDE Instruction, n.d.). The Common Core State Standards Initiative developed a guide for the new sequencing of high school math courses based on Appendix A of the Common Core State Standards for Mathematics. These courses are organized by conceptual category including number and quantity, algebra, functions, geometry, modeling, and probability and statistics (Common Core State Standards Initiative, 2010). West Virginia is now offering a new set of sequenced math classes titled Math I, Math II, Math III TR, Math III LA, Math III STEM, Math IV TR, Math IV LA, and Math IV STEM. These sequential courses use the Next Generation content standards and objectives, which, once again, are West Virginia's version of the Common Core State Standards. Previous president of the West Virginia Council of Teachers of Mathematics, Susan Barrett (2011), stated "the mathematics taught at each level has a clear focus, narrowing what students are expected to learn. At the same time, the content addressed at each grade requires an increased depth of understanding." Some background of what these new courses include and how they are organized is necessary to understand how much of a change these courses are from the traditional courses, but because this evaluation is focused on Math I, it alone will be included.

Many of the 21st Century CSO's for Algebra I align with the Grade 8 Next Generation CSO's. Because of this, students in the first high school course, Math I, begin with more advanced content compared to freshman who began with Algebra 1. Some of the topics included in Math I are linear functions, exponential functions and relationships, statistics, transformations, and the use of coordinates to connect algebra and geometry. The WV Department of Education also suggests that students who struggle should not only be enrolled in the heterogeneous Math I class but also attend an additional 45 minute Math I lab class. This would give these students a total of 90 minutes of math each day throughout the school year with the hope that the additional time will allow for additional support and therefore a deeper understanding of Math I concepts (WVDE Instruction, n.d.).

With changes in the math curriculum and how it is taught, other methods besides traditional teaching must be explored and utilized. In classrooms where application of knowledge and the use of technology are now highlighted, blended learning can be used as an appropriate method.

Defining Blended Learning

In today's classrooms, blended learning environments, where students use online technology and a teacher acts as a facilitator for at least part of the time, are rapidly becoming more prevalent (Horn & Staker, 2011). But what exactly is blended learning and what does it look like? "Blended learning should be viewed as a pedagogical approach that combines the effectiveness and socialization opportunities of the classroom with the technologically enhanced active learning possibilities of the online environment" (Dziuban, Hartman, & Moskal, 2004, p. 3).

There are two different aspects to blended learning. The first is that there is some aspect of face-to-face interaction, and the second is a computer-mediated aspect. There are many variations to the amount of either aspect used in a blended learning strategy. Course level blending, as described by Graham (2006), is a method of blended learning in which the instructor decides how much "blending" occurs. Sometimes there will be face-to-face learning and activities while other times the activities will be computer mediated. There also can be activities that are computer mediated but face-to-face in the sense that the activities are completed as a class.

Graham (2006) reviews three of the most popular reasons for using a blended learning approach as found in the literature: improved pedagogy, increased access/flexibility, and increased cost effectiveness. Blended learning is more students centered than teacher centered. The students are more active and they more often participate in peer group activities as compared to traditional lecture style teaching. In addition to that, the teacher is still in the room as a facilitator and content expert. Both increased access and increased cost effectiveness are reasons that allowed the implementation of WVDE's online math modules at Philip Barbour. With mobile computer labs at school and personal computers at home, the majority of students had no problem accessing the online math modules. In addition to that, the fact that this program is free takes away another obstacle and encourages the use of this program.

> In the same way that online teaching is recognized as different than face-to-face teaching, blended learning is also unique and requires new methods of instruction, content development, and professional development ... Because blended learning can vary in many ways, it may present challenges for research and policy. Because it does not make sense to attempt to fit education into pre-set conceptions based on old methods of teaching and learning, state education policies should allow innovation in directions that may not be foreseeable at this time (Watson, 2008, p.14).

Although there are no strict methods to blended teaching and learning, there are several key aspects to implementing a blended learning strategy, as described by Baldwin-Evans (2006). Some of them are similar to other successful teaching strategies, such as demonstration through modeling, practice, and appropriate assessment, while others are unique. The first suggestion states that the instructor ensures learner readiness. The students should be trained on and made familiar with the online component of their class. The presentation of the online material is also key in implementing a blended learning technique. It is important that the students are engaged in the online material and it is relevant to them. Another key step in the blended learning strategy is that the teacher provides support and assistance. This is a distinct description of what the teacher should be doing, and insinuates that blended learning is not teacher centered.

Models of Blended Learning

Watson (2008) provides a scale called the blended learning continuum that can be used to distinguish between different variations of blended learning. At the bottom of the scale is traditional, face-to-face learning and the top is fully online learning with no face-to-face component. Each level in between is a mixture of those two.

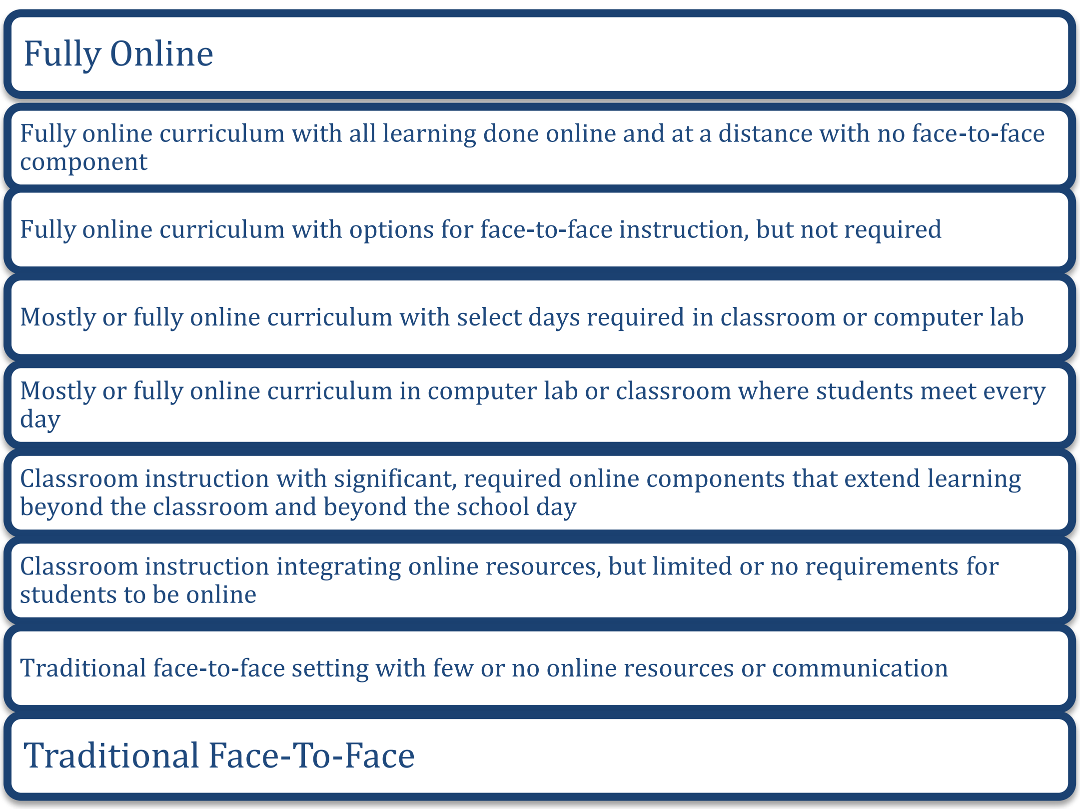

Figure 1. Blended Learning Continuum (Watson, 2008)

Staker and Horn (2012) provide four specific models of blended learning, the rotation model, the flex model, the self-blend model, and the enriched-virtual model. Within some of these models there are sub-models in which there are different ways to implement the model. The rotation model is a model in which students rotate between the methods in which they are learning. There are at least four rotation models described in Staker and Horn and there may be others. In one rotation model, the station rotation, students have different stations at different points during class. They may have teacher led instruction, collaborative activities, or online learning. This model would most likely be one or two levels up from traditional face-to-face learning in the Watson scale. In another rotation model, the lab rotation, students meet in classrooms and computer labs for online learning. Because this model includes online learning in a face-to-face environment it would fall directly in the middle of traditional learning and online learning in the Watson scale. In a flipped classroom, the school day time is used for students to work on projects or assignments while the instruction is given online at home placing the flipped model two levels up from traditional learning. There is also an individual rotation in which students have an individualized schedule for direct instruction, collaborative time, and online learning. Because this model is on an individual basis, it will use a number of levels from the Watson scale.

The second model described in Staker and Horn (2012) is the flex model. In this model the primary source of content and instruction is the online program, and students work on an individual schedule. Face-to-face support is given on an as needed basis. This consists of direct instruction, group activities, or individual tutoring. There may be more or less face-to-face support depending on the program. Teachers may use a data dashboard to gather information about how much support students need. The flex model is just one step down from online learning on the Watson scale as there is an option for face-to-face instruction, but it is not necessary. The self-blend model is the third model. Students take a mixture of online courses and face-to-face courses in this model. Similar to the individual rotation model, this model could fall on a number of levels in the Watson scale because it varies based on the individual student. The last model as described by Staker and Horn (2012) is the enriched-virtual model. In this model students' time is divided between online learning and face-to-face meetings in each course. Because there is both required time online and face-to-face, this model could fall either directly in the middle of traditional and online learning (three levels down from online learning) or two levels down from online learning on the Watson scale.

Research in Blended Learning Environments

Research in blended learning environments has compared student achievement in blended learning to student achievement in traditional face-to-face and online learning environments. In comparing blended learning to traditional face-to-face learning, there have been mixed results. The first section of the review of research in blended learning environments will give examples of four studies, two of which concluded that students in blended learning environments achieve significantly higher than traditional face-to-face learning students (Kulik, 2003; Verrett, 2015) and two of which that found no significant differences between the two groups (Bolley, 2012; Johnson, Aragon, & Shaik, 2000). Then, a study that compared two sections of a course, an online learning section and blended learning section, show that the degree of effective communication is varied between groups of online learning and blended learning (Schweizer, Paechter, &

Weidenmann, 2003). Finally, two studies are given that examine differences between all three groups: blended learning, online learning, and traditional face-to-face learning. The first study concludes that blended learning students score significantly lower than the other two groups (Ashby, 2011) while the second finds evidence that blended learning environments are beneficial to students (Rovai & Jordan, 2004).

Before the term blended learning environment existed there were integrated learning systems. Kulik (2003) reviewed many studies in which schools were using integrated learning systems for math and reading. These integrated learning systems were lessons that targeted specific learning objectives and were run through a computer. The only difference between the integrated learning systems and blended learning environments is that blended learning environments are not just software, but an online system. A review for the effect of the integrated learning systems on student performance was completed by Kulik, and five studies showed that the systems were effective on the students' learning compared to groups without the integrated learning systems with an effect size between 0.27 and 0.56.

More recently, Verrett (2015) explored the effects of a blended learning math program on ninth grade (Algebra I) minority students in California. She focused on 14 schools, seven of which had implemented the blended learning math program and seven that had not. An ANOVA was used to compare the scores on the California Standards Test (a yearly assessment) between the students in the blended learning environment and those not in the blended learning environment. The results of this study showed that students who were in the blended learning math program scored significantly higher on the California Standards Test that the students not in the program.

Johnson, Aragon, and Shaik (2000) did a comparison study between an online class and a face-to-face class. As part of the comparison, course grades and self-assessment questions were examined from both groups. It was found that the distribution of class grades was equal between the two groups. Furthermore, there were only five out of 29 self-assessment items that had a significant difference between the two groups. As a conclusion, Johnson et al. (2000) stated that the two groups performed equally and are also equally comfortable in the instruction tasks. This supported the continued development of online learning.

Bolley (2012) focused her study on three Foundations of Algebra classes in Arizona at a school that had demographics of 80% white and zero economically disadvantaged students. Two teachers' classes were used in this study. One teacher with two classes implemented blended learning in her classroom while another teacher, with one class, used traditional face-to-face style teaching. Pre- post-test data, benchmark data, field notes, and focus groups were all analyzed. An ANOVA was used to examine the differences in post-test scores among the three different classes and no significant difference was found. There were also no significant differences found among the classes with blended learning and those with traditional face-to-face learning on the benchmark test as well. From the qualitative data analysis, this statement was listed as information learned from the focus groups: "Most students do not view technology as a medium for learning math." (Bolley, 2012, p. 83). Lack of motivation was self reported by students and reported by observations of the researcher as a potential cause of negative responses to blended learning.

Schweizer, Paechter, and Weidenmann (2003) did a comparison of students taking the same course but in different environments, e-learning and blended learning. Students were grouped and told to complete various tasks using their medium of communication, newsgroup, chat room, and videoconference were the three types of online learning communication, and the blended learning environment met for face-to-face communication. Using a MANOVA, it was found that the achievement in these groups did not solely rely on the communication setting, but also on the actual task itself. However, it was also concluded that students in the face-to-face setting were much better at sharing a coherent discussion on the tasks.

Ashby (2011) conducted comparison research on 167 students in a community college developmental math class that was offered online, face-to-face, and in a blended environment. Using a one-way ANOVA, the results showed that the students in the blended learning environment had significantly lower scores on the Intermediate Algebra Competency Exam and course average than the online and face-to-face classes. Rovai and Jordan (2004) examined the sense of connectedness and learning between three groups taking the same course, a face-to-face group, an online group, and a blended learning group. Using a MANOVA, it was found that the blended learning group had a significantly higher sense of connectedness than the face-to-face group and the online group with a large effect size. It was also found that the blended learning group had a significantly higher learning score than the other two groups with a medium effect.

Call for Blended Learning Research

Graham and Dziuban (2008) encouraged the investigation of blended learning environments due to the fact that the design of such blended environments is highly context dependent. Watson (2009) suggested measuring learning growth and reporting the percentage of students who demonstrate proficiency in order to evaluate online and blended learning programs. In addition, the implementation of the blended learning should be described, as different variations of blended learning may not see the same results.

The research done on blended learning has given some insight into student achievement in blended learning environments as compared to other learning environments. However, the results have been mixed on whether or not a blended learning environment is effective for student achievement, therefore more research should be conducted. Research should focus also on the student demographics. It would be beneficial to have a set of participants who are from typically low scoring backgrounds as well as rural areas. This evaluation, of the blended learning environment at Philip Barbour High School, will add to the current research in this area.

Evaluation Framework

This study will follow the CDC's framework for program evaluation. This model was chosen because the six steps (engage stakeholders, describe the program, focus the evaluation design, gather credible evidence, justify conclusion, and ensure use and share lessons learned) are simple, yet substantial for this evaluation. The rest of this document is organized based on this model using the six steps in sequential order.

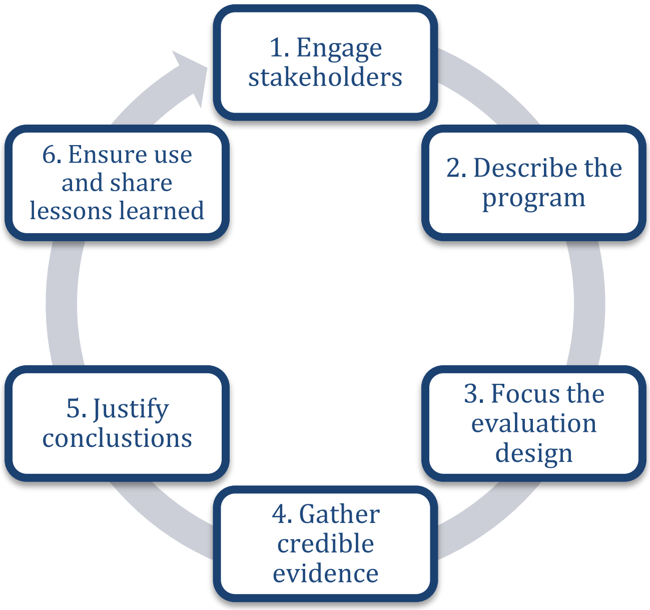

Figure 2. Centers for Disease Control framework for program evaluation

Engage Stakeholders

The first group of stakeholders is the WVU Academic Innovation department. The department created the online math modules for the Next Generation math courses in collaboration with the West Virginia Department of Education. Before this evaluation research was planned, the researcher met with some members of the WVU Academic Innovation department as they were seeking assistance through the Program Evaluation and Research Center (PERC) at WVU. It was later discovered that Academic Innovation was interested in gaining information about the experiences teachers and students have while using the program. They wanted to know how they can improve the website to meet the needs of teachers and students in the Next Generation math classes.

Because Philip Barbour High School agreed to use the WVDE online math modules as a guide for teaching and learning in one math classroom, it is also a stakeholder in this research. The math teacher of the classroom implementing the online math modules was trained to use the website by the researcher who had previously met with Academic Innovation in order to effectively do so. Other math teachers were informed on the program and were continually informed on how students performed as the various assessments were collected. Teachers may make changes to their teaching style in the future by using the online math modules in order to suit their students best to this new curriculum. The school administration also gained information on the various groups of students from this evaluation so that they can provide support to those groups most at risk.

Students and parents are also major stakeholders in this research. The students are the ones who are receiving the service of education. Because these students had never used the online math modules before, the researcher spent a class period with them familiarizing them with the online math modules and showing them how to navigate the website. Students and parents alike relied on the department of education, administrators, teachers, and researchers to make the best decisions regarding the students' education. It is important to them that with this new implementation of pathways for mathematics courses there are sufficient resources that will allow students to be successful and reach goals that have been set for them.

Describe the Program: WVDE's Online Math Modules

In the spring of 2013, WVU Academic Innovation partnered with the West Virginia Department of Education to begin creating online math modules for the newly implemented Next Generation math courses, Math I, Math II, Math III LA/STEM, Math III TR, Math IV LA/STEM, and Math IV TR. The content for the digital courses was designed by 30 West Virginia teachers and reviewed and validated (through comparison to the West Virginia Next Generation standards and the Common Core standards) by higher education mathematics faculty at West Virginia University, Marshall University, and Bethany College (WVU Academic Innovation K12, 2013).

Once the content for the courses was established, the designers at WVU Academic Innovation began creating interactive learning modules. At the writing of this evaluation, the modules for Math I and Math II were complete. Within each course are a course overview and a list of units. Within each of these units is a unit overview with a number of lessons. The lessons contain several tabs. The "overview" tab is where an overview video, driving question, and the specific state standards being addressed can be found. One click over to the "lesson" tab is where the activities are. These can include built in applets, simulations, videos, images, career application investigation, and a brief assessment. There is also a "resources" tab in which additional resources, including instruction from teachers, can be found. The final tab, "teachers" contains access to a lesson plan and assessment materials and data for registered teachers. Each unit also contains a built in pre- post-test that teachers can administer and collect data from their account (WVU Academic Innovation K12, 2013).

Focus the Evaluation Design: Methodology

The design of the evaluation on the Next Generation online math modules was developed considering the information that the online math modules provide, the information that teachers want to know, and the methodology from previous studies. The online math modules have pre- and post-tests embedded in them. These are used in order to gain information about the student learning gains and overall content mastery. Benchmark assessments along with Smarter Balanced assessment data were beneficial for making comparisons across learning environments similar to Ashby (2011), Bolley (2012), and Verrett (2015). Due to the nature of evaluation research it was also important to gain insight from the teacher on specific parts of the Next Generation online math modules. The evaluation research questions were determined from these things.

Evaluation Research Questions

- Is there a significant increase in student test scores from pre-test to post-test for the online units?
- What percentage of students score mastery or above on the post-test for units?
- How do benchmark and yearly assessment scores from students using the online math course compare to other Math I students at PBHS?
- What comments/concerns does the teacher of the online math modules have for specific activities, lessons, and units as well as the program in general?

Participants

The participants of this evaluation are all Math I students and teachers at Philip Barbour High School during the 2014-2015 school year. Philip Barbour High School is a class AA high school and is the only high school in Barbour County. Approximately 93% of Barbour County students are white, and about 63% of students are low-income. In 2013, only 36% of ninth graders at Philip Barbour reached mastery or above on West Test 2 (Barbour County District Report Card, 2013). There were 164 students enrolled in Math I at Philip Barbour during the 2014-2015 school year. Of this group of students, 41 were in the three sections that used the online math modules with a non-certified teacher, 26 were enrolled in New Tech with two certified math teachers, 41 in a traditionally taught classroom with a certified math teacher, and 56 in the traditional class with a non-math certified teacher.

Measures

In order to answer the research questions, several measures were examined. One type of measure that was used is the pre- and post- tests for each unit of Math I. These tests are multiple choice, and are administered through the online math modules on the Academic Innovation website. Benchmark tests were also administered. Typically benchmark tests are made available to teachers to practice for the yearly assessment. The benchmarks test a group of content from the standards at appropriate grade levels. Because of the recent change in yearly assessment from WestTest2 to Smarter Balanced in the state of West Virginia, there was a lack of benchmark tests to prepare students. Due to this, the researcher created a set of three benchmark tests (see Appendix). Each benchmark focused on two units within the Math I curriculum. The questions for the benchmarks were largely taken from the Mathematics Assessment Resource Service (MARS) website (2015). In addition, some questions from textbook resources were used. Various types of questions were included in the benchmarks, such as short task, multiple choice, and short answer with written response. The researcher shared the benchmarks with certified math teachers at Philip Barbour High School, including the math department leader, for editing before the administration of the tests. Because these tests were created for the purpose of this study, there have been no reliability or validity data. The third measure that was collected and analyzed is the Smarter Balance yearly assessment data, which covers all content in Math I. The test was administered in two different parts. In one part the students answer a variety of content related questions on the testing portal. These questions were either multiple choice or short answer. The other portion required a classroom activity prior to the questions being asked. Testing administers described to students situations and provided them with any definitional information that they needed. The students then answered several math questions using the specific context. This was the first year in which students in West Virginia took this test so there is also no reliability or validity data on it.

Procedures

Philip Barbour High School in Philippi, WV agreed to use the online math modules during the 2014- 2015 school year in one classroom with three sections of Math I. Within the first eight weeks of the school year, the school was not able to hire a consistent long-term substitute for this classroom; however the school was able to hire a permanent, non-certified teacher for the remainder of the year. The Barbour County Board of Trustees agreed that the Next Generation online Math I course would be an appropriate tool in this particular classroom because it was hoped that the online math courses would be able to provide structure and consistency in the class where there had been a lack of both for a significant portion of the school year. The Next Generation online Math I course also would provide the teacher (who is not certified) a central resource for plans and materials, as there is not a Math I book like there is an Algebra book for Algebra I.

Once the plan for using the Next Generation online Math I course was set, the researcher spent time with the teacher and students familiarizing them with the online math modules. This set of three classes, that implemented WVDE's online math modules, is the main focus of this study. Because of the way the online math modules are set up, as described earlier, this type of blending seems to fit into level 2 on the continuum. The "classroom instruction is integrating online resources, but there are limited or no requirements for students to be online" (Watson, 2008).

In addition to the three sections of Math I using the online math modules, this study included two comparison classes that used traditional style learning with the main instructional tool being lecture, which was considered level 1 on the Blended Learning Continuum, and one comparison class called a New Tech class. The New Tech program at Philip Barbour High School was considered a school within a school. Students who apply and are accepted into the New Tech program each have access to their own laptop. New Tech uses a project-based learning approach in which students complete projects and give presentations collaboratively. The New Tech classes also used an online learning management system, ECHO, in which teachers post links, assignments, and agendas so that students can be more independent in the classroom. Because the students still meet and come to school, the New Tech program would fall under level 3 on the Blended Learning Continuum. They have "classroom instruction with significant, required online components that extend learning beyond the classroom and beyond the school day" (Watson, 2008, p.6).

Once the stakeholders had been engaged and a description of the program had been given, the evaluation design began to take shape. An IRB protocol was submitted through West Virginia University for non-human subject research based on the stance that the purpose of this research was to evaluate and improve the Next Generation online Math I course module, and that protocol submission was accepted. Research questions were decided upon and data were collected for each. The specific data was then determined, and the researcher collaborated with the classroom teacher in order to gather this evidence.

Gather Credible Evidence

Data Collection

Pre- post-test data were collected for the Math I units for the sections of Math I that used the Next Generation online math modules during the 2014-2015 school year. This data was used to make inferences about the students' learning gains and the percentage of students that showed mastery for each of the six defined units in Math I. Benchmark data for all Math I students in Philip Barbour High School were also collected during this school year. The benchmark data consisted of three benchmarks that covered all six major units in Math I. Benchmarks were administered throughout a week in all Math I classes at the end of the 2nd nine weeks, 3rd nine weeks, and 4th nine weeks. Finally, math scores from the Smarter Balanced yearly assessment for the 2014-2015 school year were collected for all students who took the 9th grade assessment.

The researcher visited the classroom approximately once every two weeks throughout the year once the long-term substitute started her position. Fourteen observations were conducted, and the researcher kept a journal for field notes during each of these visits. In order to better understand the implementation of the online math modules in this classroom, informal conversation was held between the researcher and the teacher. Specific interview questions were not asked, but conversation included recent activities that were done in class and any comments or concerns the teacher had.

These conversations were typically held between classes, at the end of classes, or during planning periods.

Analysis

Table 1 shows the analysis for each research question. In order to analyze the learning gains for each of the six units in the online math modules classes dependent samples *t* tests were used for the pre- post-test data that was previously collected from all available students in the three sections of classes using the online math modules. The percentage of students in these three sections who have reached mastery or above is reported for each of six post-tests as well. In order to examine the differences between the sections using the online math modules and each of the other sections an ANOVA within a Regression framework was performed on the benchmark data that were collected during the 2014-2015 school year as well as the Smarter Balanced yearly assessment data. Dummy codes were applied to the four different classes using three codes. The four classes are naturally separated based on the teachers of Math I; students who have the non-certified teacher using the online math modules, students who have a non-math certified teacher in a traditional-lecture style environment, students who have a certified math teacher in a traditional-lecture style environment, and students who have two math certified teachers in the New Tech classroom. All students that were in a class using the online math modules were assigned a '0' for each of the three codes. The remainder of the groups received a '1' in separate codes in order to examine the differences individually (New Tech gets 'l' in code 1, certified/traditional '1' in code 2, and non-math certified/traditional '1' in code 3). This analysis was conducted four times; the first using Benchmark 1 as the dependent variable, the second using Benchmark 2, the third using Benchmark 3, and the fourth using Smarter Balanced yearly assessment math data.

The data from notes of informal conversations and observations were transcribed and preliminarily thematic analysis was conducted. The researcher highlighted for common occurrences throughout the transcriptions in order to develop codes. Once the codes were applied the researcher analyzed them for emerging themes. These themes were used to give explicit information on the implementation of the online math modules as well as pros and cons of the use of the online math modules in this setting. Through this, suggestions for the improvement of the design and future implementation of these modules are made.

Table 1
Research Question to Data Analysis Relationship

Research Question	Data Analysis
Is there a significant increase in student test scores from pre-test to post-test for the online units?	Dependent samples *t* test on pre- post- tests
What percentage of students score mastery or above on the post-test for units?	Descriptive statistics on post-tests
How do benchmark and yearly assessment scores from students using the online math course compare to other Math I students at PBHS?	ANOVA within a Regression framework using dummy codes on all benchmarks and yearly assessment data
What comments/concerns does the teacher of the online math module classes have for specific activities, lessons, units as well as the program in general?	Thematic analysis of field notes and observations

Justify Conclusions

Results

Data analysis to answer research question one, "Is there a significant increase in student test scores from pre-test to post-test for the online units?", examined the students' learning within each unit that was taught using the online math modules through pre- and post-test scores for each of the units completed in the 2014 - 2015 school year. A dependent samples *t*-test was completed on each of the four units that were taught using the online math modules. There was a significant learning increase on Unit 1, Unit 3, and Unit 4, but there was not a significant difference between the pre- and post-test for Unit 2 (see Table 2).

Table 2

Percentage Scores of Pre- and Post- Unit Tests

	Pre-test		Post-test			
	n	M*(SD)*	*n*	M*(SD)*	*t*	*p*
Unit 1	40	23.0*(18.9)*	40	37.6*(20.9)*	-3.54	.001
Unit 2	30	24.9*(18.2)*	30	21.5*(18.5)*	0.86	.400
Unit 3*	26	24.4*(23.4)*	26	46.0*(19.9)*	-3.75	.001
Unit 4*	24	29.2*(12.9)*	24	45.8*(18.9)*	-5.27	>.001

*Sample sizes are decreased on Unit 3 and Unit 4 due to missing data.

In order to examine research question two, "What percentage of students score mastery or above on the post-test for units?", basic descriptive statistics were used on the four unit posttests' percentage scores. For the purpose of this research, mastery was defined for these students as scoring at least a 75% - C. On the Unit 1 post-test only one out of 40 students scored mastery. In fact, 87.5% of students failed (scored below 65%), and the mean percentage score was 37.6%. Again, on the Unit 2 post-test, only one out of 30 students scored mastery or above. 97.5% of students failed, and the mean percentage score was 21.5%. Two of 26 students scored mastery or above on the Unit 3 post-test, while 84.6% of students failed, and the mean percentage score was 46.0. Unit 4 was very similar as two of 24 students scored mastery, 83% of students failed, and the mean percentage for this post-test was 45.8. Once again it is noted that the sample sizes are decreased in Units 3 and 4 due to missing data.

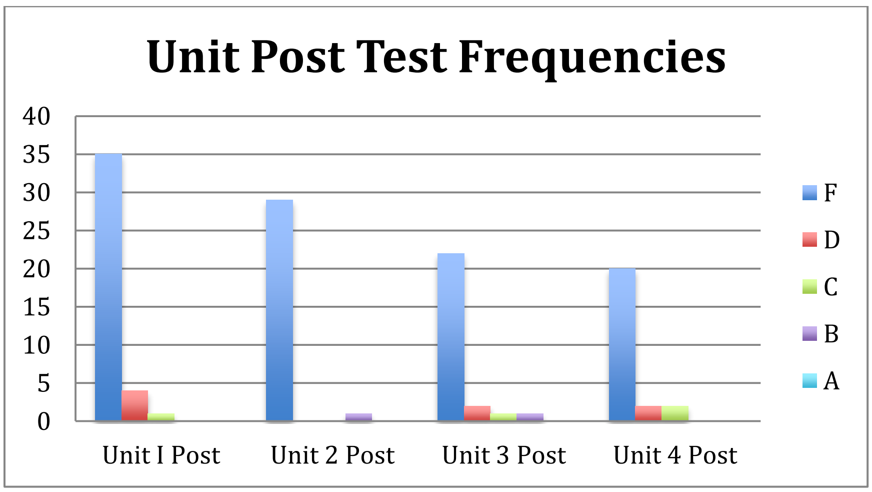

Figure 3. Unit Post Test Score Frequencies

In order to answer research question three, "How do benchmark and yearly assessment scores from students using the online math course compare to other Math I students at PBHS?", the differences between the classroom using the online math modules with a non-certified teacher and each of the other three classes- traditional teaching with a non-math certified teacher, traditional teaching with a certified teacher, and a New Tech class taught by two math certified teachers were examined (see Table 3 for descriptive statistics).

In looking at Table 3 and Figure 4, the gap between benchmark scores of the classes using the online math modules and both traditional classes closed as time progressed. On Benchmark 1 and Benchmark 2 students in the online math modules class scored much lower than all classes, but on Benchmark 3 students in the online math modules class scored very similar to both traditional classes. It can also be seen in Table 3 that students in the online math modules classes have a similar score on the Smarter Balanced yearly assessment to both traditionally taught classes. New tech students scored higher on all assessments than the other Math I students.

Table 3
Benchmark and Smarter Balanced Assessments Descriptive Statistics

	B 1		B 2		B 3		SB	
	n	M*(SD)*	*n*	M*(SD)*	*n*	M*(SD)*	*n*	M*(SD)*
Online math modules/ non-certified	29	1.74*(2.16)*	27	7.85*(6.45)*	32	10.47*(6.52)*	37	2437*(88.9)*
Traditional/ non-math certified	50	4.54*(4.65)*	53	12.63*(5.57)*	50	10.00*(7.40)*	51	2464*(104.6)*
Traditional/ math certified	35	6.20*(5.19)*	33	12.65*(6.22)*	35	9.51*(6.09)*	36	2425*(83.1)*
New Tech/ co-tau ght/ math certified	24	9.85*(6.97)*	22	15.84*(5.01)*	22	14.64*(7.27)*	23	2539*(104.6)*

B1: Benchmark 1, B2: Benchmark 2, B3: Benchmark 3, SB: Smarter Balanced

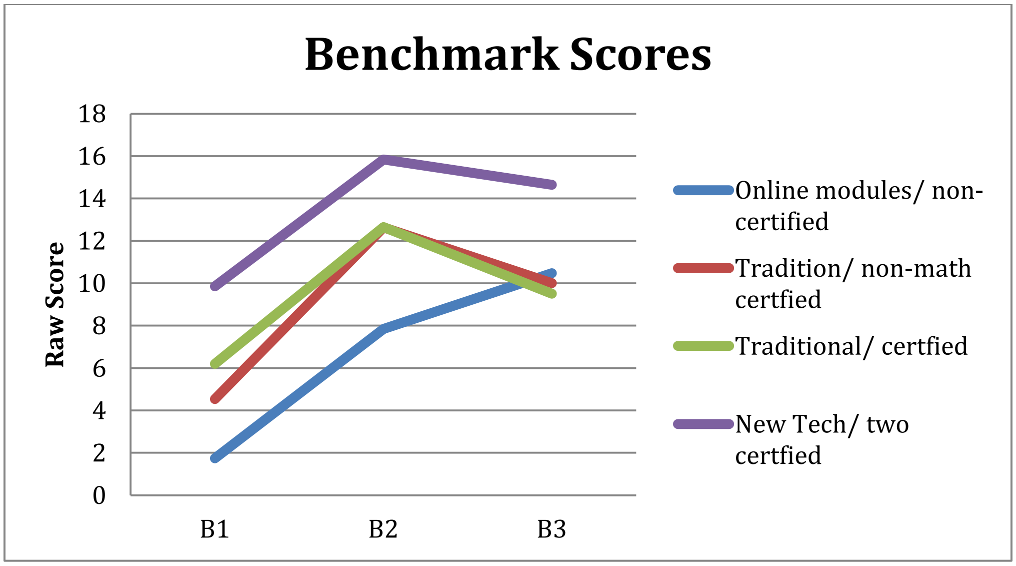

Figure 4. Benchmark Scores Across Time for All Classes

Dummy codes were used to test the other three classes of Math I students against the class using the online math modules within a multiple regression (see Table 4). Each overall regression model, Benchmark 1, Benchmark 2, Benchmark 3, and Smarter Balanced Assessment, was statistically significant. The New Tech class scored statistically higher on every measure than the class using the online math modules. The traditionally taught class with a math certified teacher scored statistically higher than the class using the online math modules on Benchmark 1 and Benchmark 2, but on Benchmark 3 and the Smarter Balanced assessment these two groups were not statistically different. The traditionally taught class with a non-math certified teacher only scored significantly higher than the online math modules class on Benchmark 2; these two groups did not have statistically different scores on any other measure.

Table 4

Predictors of assessment scores for Online Math Modules/ Other Sections of Math I

	B1 *B*(Beta)	B2 *B*(Beta)	B3 *B*(Beta)	SB *B*(Beta)
Constant	3.16*	8.83**	10.47**	2436.9**
Traditional/ non-math certified	*2.66*(.237)	*3.80***(.308)	*-0.47*(-.032)	*27.38*(.128)
Traditional/ math certified	*3.63**(.305)	*3.82**(.274)	*-0.68*(-.042)	*12.20*(-.052)
New Tech/ co-taught/ math certified	*6.70***(.513)	*7.01***(.432)	*4.17**(.219)	*102.00***(.364)
R^2	.146	.118	.059	.137
F	6.10**	5.72**	2.80*	7.57**

* $p < .05$. ** $p < .01$.

B1: Benchmark 1, B2: Benchmark 2, B3: Benchmark 3, SB: Smarter Balanced

In order to answer research question four, “What comments/concerns does the teacher of the online math module classes have for specific activities, lessons, units as well as the program in general?”, the researcher conducted a preliminary thematic analysis of field notes taken in the three sections of classes using the online math modules during the 2014-2015 school year. Codes were applied to the transcribed field notes. Codes were then examined to form general themes across the school year (See Table 5). These themes provide insight into the implementation of the online math modules in this setting as well as information on the concerns to be aware of during the implementation of the online math modules.

Table 5
Example Quotes for Emerging Themes

Theme	Date	Quote from transcription
Inappropriate behavior	10/28/14	"During the lecture many students put their head down and did not seem to be listening."
Technology problems	11/05/15	"The volume on the video was so low that it made it hard to hear if all of the students were not still and quiet." "It appears that because the volume was so low the students did not really pay attention to the video."
Inappropriate behavior	11/12/14	"During the video many students were either talking or sleeping."
Technology problems	11/19/14	"The video that Mrs. M wanted to show would not work."
Pre- Post-test problems	12/03/14	"Some questions do not load properly. This causes the students to have to restart the test."
Inappropriate behavior	01/14/15	"Some students in the class constantly say inappropriate things and make sound effects that distract the class."
Not ideal implementation	01/14/15	"Mrs. M does the activities on the online modules but they are always done as a whole group by projecting the activity."
Inappropriate behavior	2/11/15	"The students are having non-class related conversations."
Inappropriate behavior	03/03/15	"They are not allowed to have hand graphing calculators because they have damaged calculators and laptops earlier in the year."
Not ideal implementation	3/17/15	"Mrs. M printed off worksheets for the students to complete. These worksheets are actually from Activities 2 and 3 from Lesson 3 in Unit 3 of the online modules."

There were a couple of general concerns for this classroom even before the implementation of the online math modules. At the beginning of the school year, there were a dozen substitute teachers within the first eight weeks. This was a significant portion of the 200-day calendar year, which meant that students' learning was already behind. Once a long-term substitute was hired for the school year, Mrs. M., she was not certified in either math or secondary education.

Once Mrs. M was settled in the classroom she began having discipline issues especially with inappropriate behavior. At times students would be disruptive by talking during lecture, getting out of their seat without asking, or making a joke out of the discipline system that Mrs. M was using (they thought it was for younger students). They talked excessively, slept in class, and did not respect Mrs. M. A large number of students did not complete their activities on the online modules nor did they take notes during lecture. Eventually, students lost technology privileges because they broke laptops and calculators by pulling off keys.

There were also some concerns during the implementation of the online math modules in regards to the lessons, activities, and assessments. Because of the discipline issues and loss of technology privileges in Mrs. M's classrooms, lesson videos and activities had to be projected. Students were expected to listen to videos as an entire class, which they were not engaged in. Students tended to sleep or talk to each other during this time. When Mrs. M would project activities for the class to do as a whole, students were once again uninterested and disengaged. There was little to no participation in completing the activities. Sometimes, the activities were such that Mrs. M could print them, in which case there was more participation, but it was still not implemented in the way it was designed to be.

Technology problems also interfered with the instruction using the online math modules. At times videos and activities were difficult for Mrs. M to load and use, therefore her plans were interrupted and there would be long breaks of waiting. Also, she had difficulty with sound. When students could not hear the content of the audio they would become even more disruptive and disengaged. However, these concerns were not always a problem, but when they were it greatly interfered with the students' learning.

Another concern for the program included issues with the pre- and post-tests on the online math modules. When students logged in to take their test not all questions would load properly. If this occurred, which it did frequently, and the student did not notice, they would have to start the assessment over. When they started the assessment over they generally had new questions. This was problematic in the classroom because it could take days for a student to complete the test. Mrs. M was frustrated after trying to resolve the problem several times and decided to print off the assessments and give them to students as a hard copy.

Ensure Use and Share Lessons Learned

After collecting and analyzing data in a Math I classroom at Philip Barbour High School in order to conduct an evaluation on the West Virginia Department of Education online math modules results do give insight into student learning while using this program.

The context of classes using the online math modules is important to understand before discussing the student learning and achievement. These sections had many substitute teachers during the first eight weeks of the school year. During this time there was very little expectation for students and therefore very little learning occurred during this time. Mrs. M, the long-term substitute hired for the remainder of the school year, was not certified in either math or secondary education.

Throughout the school year, classroom management was the biggest deterrent of student learning. Mrs. M had a lot of trouble discovering an effective discipline system for her classes. This made it difficult for her to teach. The lack of motivation in this blended learning environment could be consistent with the lack of motivation found by Bolley (2012). The behavior problems led to a loss in technology privileges, which was a major obstacle to over come in a classroom that was implementing online math modules. However, Mrs. M was able to still use the online math modules in an adapted style by projecting overview videos and activities as well as providing hard copies of activities, assignments, and assessments. All of this information should be considered when looking at student learning and achievement from this evaluation study.

As Graham and Dziuban (2008) stated that research results are highly context dependent, there are several factors that influenced the results of this evaluation. It seems likely that teacher certification, not the learning environment and teaching resources, could have an impact on student achievement in this evaluation research. The gap between the classes using the online math modules and all of the other classes lessens with the amount of math certified teachers. The largest student achievement gap being with the New Tech class having two math certified teachers, the second largest with one math certified teacher, and the least student achievement difference with the non-math certified teacher. Because of the decrease in difference of scores between the classes using the online math modules and other Math I classes across time, it is possible that the structure of the online math modules was beneficial to the non-certified teacher. It would be of interest to see if this trend continued or how it would change over a longer period of time. Future comparisons of student achievement between different learning environments should attempt to have teachers of similar certification in order to control for this factor.

In regards to student learning, the classes using the online math modules did show significant learning gains in three of four units. However, in looking at the frequencies of letter grades on each of the unit post-tests it is obvious that very few students showed mastery. So although students tended to have significant learning gains, it would be beneficial for students to also show mastery on post-tests.

When comparing this set of classes to other Math I classes at Philip Barbour High School with different teachers, the New Tech class always scored significantly higher, and the traditional class with a math certified teacher scored higher on the first two measures but not the second two. The two classes with teachers who are not math certified (the classes using the online math modules and one set of traditional classes) were only significantly different on Benchmark 2. This is somewhat consistent with Bolley (2012) where no significant differences in student learning were found.

In the study by Rovai and Jordan (2004), students in the blended learning environment scored significantly higher than online and traditional learners. The New Tech classes are a blended learning environment as well as the online math modules. Taking that into consideration, this research is mixed as to how it fits with the literature because the New Tech classes did score higher than the traditional classes, but the online math modules classes did not.

The major assessment of students throughout West Virginia is the Smarter Balanced yearly assessment. The data analysis in this evaluation shows that there was no significant difference between the classes using the online math modules and the two sets of traditionally taught classes. Once again, these results are consistent with Bolley (2012) and similar to Johnson, Aragon, and Shaik (2000). This evidence will support the use of the online math modules in the future.

Conclusion

For the conclusion of this paper, the final lessons learned are shared along with the suggestions for use of this evaluation research. The results of this study have shown that students in classes that implemented the WVDE's online math modules program had significant learning gains but did not typically score mastery or above on post-tests. They scored similarly to traditionally taught classes by a non-math certified teacher on most Benchmark assessments and the Smarter Balanced yearly assessment. The students using the online math modules also scored similar to the traditionally taught student by a math certified teacher on the Smarter Balance yearly assessment. Because this was accomplished even with having a non-certified teacher who had to adapt her teaching methods to an undesirable style due to behavior problems, it can be said that the WVDE's online math modules was a relatively effective tool in this classroom at Philip Barbour High School.

As the evaluation was conducted the researcher was in constant communication with Academic Innovation at WVU. The researcher told them about the problems with the videos and applets not running smoothly. They were also made aware of the issues with pre- and post-test questions loading and the impact that it had on testing the students as a whole. WVU Academic Innovation can make improvements to the online math modules by improving the capability to load videos and activities in a timely manner. They also can ensure that assessment questions load properly or develop another method of assessing students on the unit tests.

The results of this evaluation have been shared personally from the researcher to the math teachers of Philip Barbour High School. Teachers and administrators at Philip Barbour High School, as well as teachers across West Virginia, can learn from this evaluation that blended learning environments, such as the WVDE's online math modules, can be effective on student learning in certain contexts. This evaluation shows results of an implementation by a non-certified teacher in a less than ideal environment due to the lack of individual laptops. Because of this, all teachers should be encouraged to explore the online math modules and use them in their own classrooms. Teachers can build on this evaluation by implementing the Next Generation online math modules in a way that they were intended to be. Future research and evaluation on the Next Generation online math modules should explore diverse classroom contexts.

Students and parents can use this information to broaden their horizons on methods of teaching and learning. Blended learning uses a variety of traditional learning and online learning. Not only do students receive face-to-face instruction, but they also are encouraged to use technology. This evaluation shows that student learning is not necessarily significantly different throughout blended learning and traditional learning environments. Students and parents should embrace these different environments as they continue to be refined for the improvement of teaching and learning.

In closing, the classroom using WVDE’s online math modules was not perfect by any means. However, they lessened an achievement gap throughout the school year and scored similarly to a traditionally taught class with a non-math certified teacher on most assessments. There is room for improvement on the Next Generation online math courses website and how they can be implemented. It is encouraging to see how high student achievement can be using some variation of blended learning and this website in a variety of settings, including non-certified teachers to veteran teachers and classrooms with limited to limitless resources.

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Appendix

Sample pre- post- test questions from WV Next Generation Online Math I Course

Olivia is training to run a marathon. She's pretty intense. If a marathon is about 26.2 miles and there are 63,360 inches in a mile, how many inches will Olivia be running?

- 1,620,000 in
- 1,660,00 in
- 1760000
- 2,100,000

In December, Phineas is trying to predict the cost of gasoline in his hometown for the summer. Which will give him the most accurate prediction?

- Finding the current cost at every station in a three-block radius
- Finding the cost on every Memorial Day in the past fifteen years
- Finding the percent increase between Regular and High Octane
- Asking the gas station attendant

Convert the following mathematical expressions into statements: 4 + (300/x)

- The sum of 300 and the quotient of 4 hundred and a number
- The sum of 4 and the quotient of 300 hundred and a number
- The sum of a number and the quotient of 300 hundred and 4
- The sum of a number and the quotient of 4 hundred and 300

Convert the following statements into mathematical expressions: The difference of seven times a number x and the quotient of that number and 3.

- 7(x/3)
- 3x-(x/7)
- 3(x/7)
- 7x-(x/3)

There are 60 students going on a field trip to the chocolate factory. The students are from three different classes. Mrs. Hooper's class has 24 students and Mr. Gomez's class has 18 students. Which of the equalities correctly describes the students and could be used to solve for how many students are from Mr. Anderson's class? (Let A = the number of students in Mr. Anderson's class.)

- 60 – 18 = A – 24
- A + A + A = 60
- 24 + 18 + A = 60
- A + 18 = 24

A total of 66 people attended a field trip to a chocolate factory for a tour. A

maximum of 15 people are allowed to tour at one time. What is the minimum number of tour groups that can be formed?

- 4
- 5
- 13
- 56

Dr. Frankenstein thinks he knows more than you about what is true and false world just because he's a doctor. (Just because he brought a corpse back to life, he thinks he's hot stuff.) He says that the equation $y = 17x + 1$ also includes the point (1, 8). Is Dr. Frankenstein right or wrong?

- He is right
- He is wrong
- We need more information before we can say if he is right or wrong
- None of the answers are correct

The Kooky Dough Company makes cookie dough, but it takes a little time for it to start reeling in the dough. The equation $y = 2x – 8$ models the profits y after making x pounds of cookie dough. What are the x and y coordinates of their break-even point?

- (4, 0)
- (0, 4)
- (2, 0)
- (0, 2)

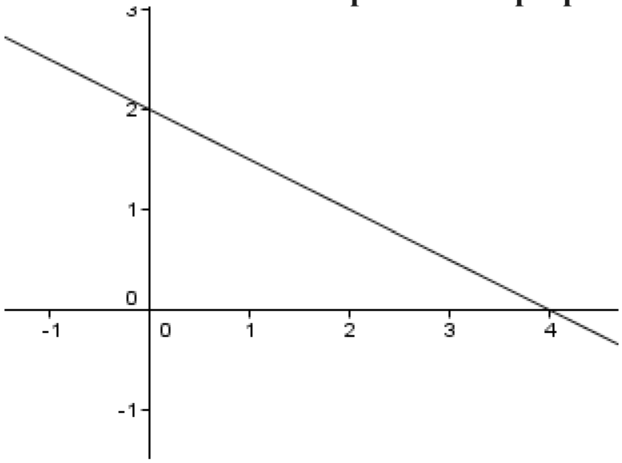
Do the two inequalities $y > x2 – 2$ and $y < -x2 + 2$ overlap?

- Yes, they overlap
- No, they do not overlap
- No, but their boundaries touch
- Maybe, but not enough information is provided

Which point could not be part of a function that includes (-1, 6), (2, 2), (3, 4), (0, -4), and (1, -2)?

- (-2, 4)
- (4, 5)
- (6, 3)
- (1, 4)

Choose the correct description of the properties of the graph below.



- Increasing; odd; x-intercept: (4, 0); y-intercept: (0, 2); Domain: all natural numbers
- Decreasing; neither odd nor even; x-intercept: (4, 0); y-intercept: (0, 2); Domain: all real numbers
- Decreasing; even; x-intercept: (2, 0); y-intercept: (0, 4); Domain: all real numbers
- Decreasing; neither odd nor even; x-intercept: (4, 0); y-intercept: (0, 2); Domain: [-1, 4]

Benchmark Assessments

Math I Benchmark 1

Name:_______________________

Date:_______________________

Teacher:_____________________

Period:______________________

1. Jane, Maria, and Ben each have a collection of marbles. Jane has 15 more marbles than Ben, and Maria has 2 times as many marbles as Ben. All together they have 95 marbles. Find how many marbles Maria has.

____

2. If x and y are integers and x + y < 11, and x > 6, what is the smallest possible value of x – y?

____

3. A. One of these tables represents a linear relationship and one represents an exponential relationship. Label each table's relationship correctly.

x	y
1	6
2	9
3	12
4	15

x	y
1	6
2	9
3	13.5
4	20.25

_________________ _________________

B. Write an equation representing the linear relationship.

____

4. Dave sold 40 tickets for a concert. He sold x tickets at $2 each and y tickets at $3 each. He collected $88. Write an equation using x and y to .. a) represent how many tickets Dave sold and b) represent how much money Dave collected. Then c) solve these two equations to find how many of each kind of ticket he sold.

a. ___________________ b. ___________________

c. ____________ $2 tickets ____________ $3

5. For each of the following equalities and inequalities, find two values for x that make the statement true.

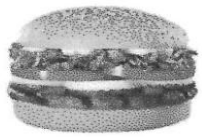
a. $x^2 = 121$ ____________ ____________

b. $x^2 < x$ ____________ ____________

c. $21x + 1066 \geq 1969$ ____________ ____________

Giantburgers

This headline appeared in a newspaper.



Every day 7% of Americans eat at Giantburger restaurants

Decide whether this headline is true using the following information.

- There are about 8×10^3 Giantburger restaurants in America.
- Each restaurant serves about 2.5×10^3 people every day.
- There are about 3×10^8 Americans.

Explain your reasons and show clearly how you figured it out.

[redacted]

Sale!

The following price reductions are available.

Two for the price of one

Buy one and get 25% off the second

Buy two and get 50% off the second one

Three for the price of two

1. Which of these four different offers gives the biggest price reduction?

Explain your reasoning clearly

2. Which of these four different offers gives the smallest price reduction?

Explain your reasoning clearly.

Printing Tickets

Susie is organizing the printing of tickets for a show.

She has collected prices from several printers and these two seem to be the best.

SURE PRINT
Ticket printing
25 tickets for $2

BEST PRINT
Tickets printed
$10 setting up
plus
$1 for 25 tickets

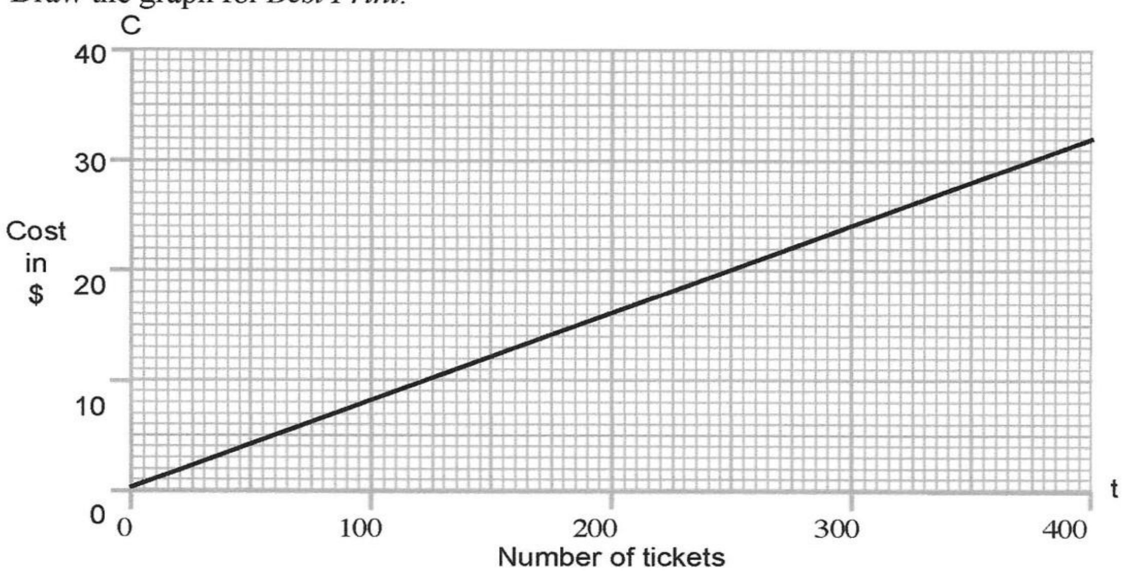
1. Using **C** for the cost of the printing and **t** for the number of tickets, Susie writes a formula for each of the printers. Here is her formula for *Sure Print*:

   Sure Print $C = \frac{2t}{25}$

   Write the formula for Best Print:

   Best Print C =

2. Susie's brother Rob has drawn *Sure Print*'s graph on a grid.
   Draw the graph for *Best Print*.



3. Susie uses algebra to find the values of C and t when the cost of printing the tickets is the same for both of the printers.

C = ____________ t = ____________

Show how Susie may have calculated C and t.

4. What do Rob's graphs and Susie's calculations tell us about the cost of the tickets? Which company should Susie choose under what circumstances?

Math I: Benchmark 2

Name: ____________________

Teacher: __________________

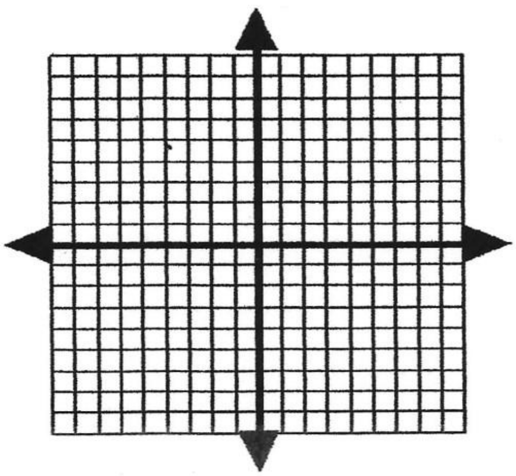
Period: ____________

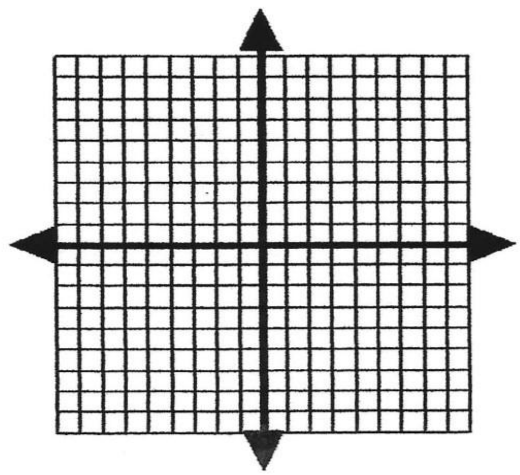
Short Tasks

For problems 1 and 2, solve each system of inequalities by graphing and shading.

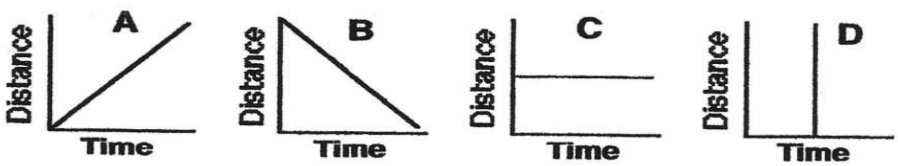
1. $y > x - 2$
   $y \leq x$

2. $y \geq x + 2$
   $y > 2x + 3$





3.



These graphs show the distances traveled from home.

Which graphs go with each of the following statements?

Graph(s)

A) The car is not moving. ____________________

B) The car is traveling at a constant speed ____________________

4. If the slope of a line is $\frac{1}{2}$ and the y-intercept is 3, what is the x-intercept of the same line?

____

5. If $3x + y = 19$, and $x + 3y = 1$, what does $2x + 2y$ equal?

____

Stopwatch

Four friends try to see who can make the closet estimate of 30 seconds. One person starts a stopwatch while one of the others tries to guess when 30 seconds has passed without looking or counting and says 'Stop' when they think it has been 30 seconds. The timekeeper writes down the time

Aaron's guesses	31	25	32	27	28
Ben's guesses	37	19	40	36	22
John's guesses	32	38	24	32	32
Zack's guesses	36	26	26	42	33

What is the mean of all the guesses? ____________________

What is the median of all the guesses? ____________________

What is the mode of all the guesses? ____________________

Which estimate (mean, median, or mode) would the group want to report if they were competing against another group of friends in estimating 30 seconds?

____

Which friend was the best at estimating 30 seconds? Why did you make that decision?

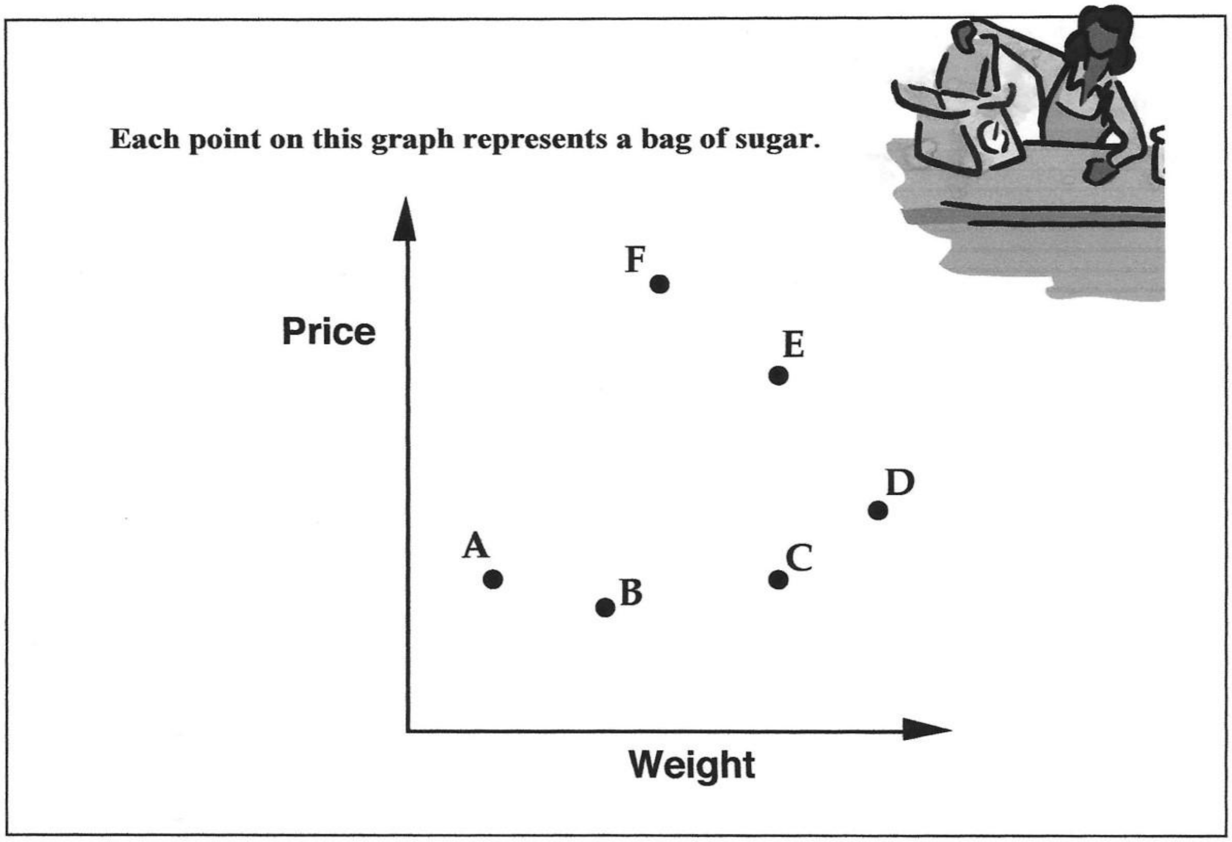
____

____

____

____

Sugar Prices



1. Which point shows the heaviest bag? __________

2. Which point shows the cheapest bag? __________

3. Which points show bags with the same weight? __________

4. Which points show bags with the same price? __________

5. Which of F or C gives the best value for money? __________
   How can you te

Zoo Animals

The table below shows the average age at death and the maximum age of various animals in captivity.

		Age	(years)					
Avg.	12	25	15	8	35	40	41	20
Max.	47	50	40	20	70	77	61	54

A) Draw a scatter plot for the data on the graph.

B) Is there a positive, negative, or no correlation? ____________________

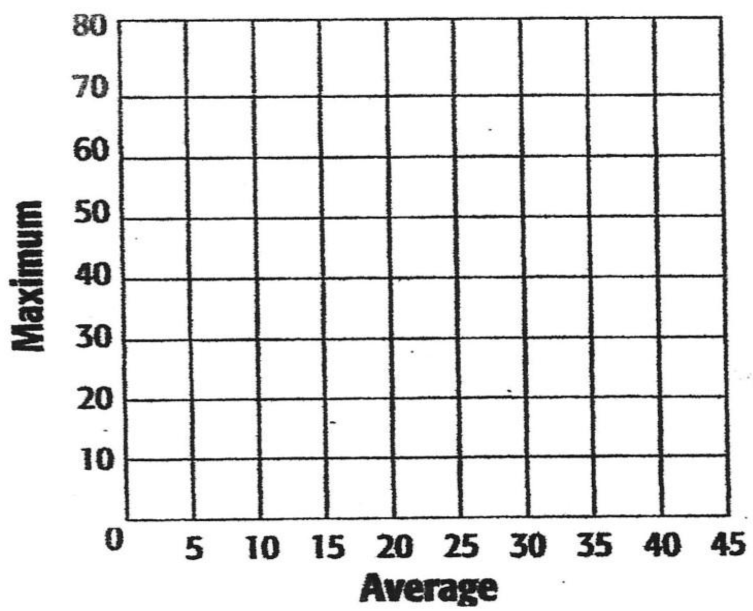
C) Draw a line of fit for the scatter plot.

D) Write the slope-intercept form of an equation for the line of fit.

____

E) Predict the maximum age for an animal with an average age of 33 years.

____



Yogurt

A food company produces yogurt in half-cup tubs.

2 cups	= 1 pint
2 pints	= 1 quart
4 quarts	= 1 gallon

1. The tubs of yogurt are sold for 75¢ each.

   Twenty percent of this is profit for the food company.

   How much profit does the company make on each tub? ____________________

   Show your work.

The machine that fills the half-cup tubs with yogurt runs 10 hours a day for 5 days a week. It fills 1600 tubs an hour.

2. How many gallons of yogurt are needed to fill 1600 tubs? ____________________

   Show your calculations.

3. How many gallons of yogurt are needed each week? ____________________

   Show your work.

4. What is the percent increase in production if the machine runs for 7 days a week instead of 5 days a week? ____________________

   Show how you figured it out.

Math I Benchmark 3

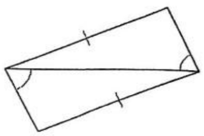
Name:____________________________

Teacher:__________________________

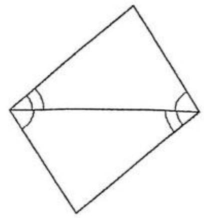
Period:________________

For problems 1-4, state if the two triangles are congruent. If they are, state whether it is by SSS, SAS, ASA, or AAS congruence.

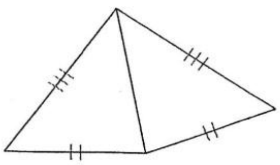
1)



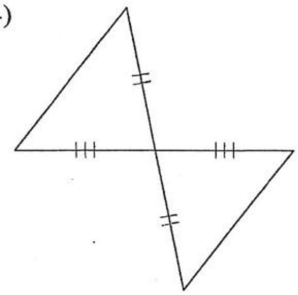
2)



3)

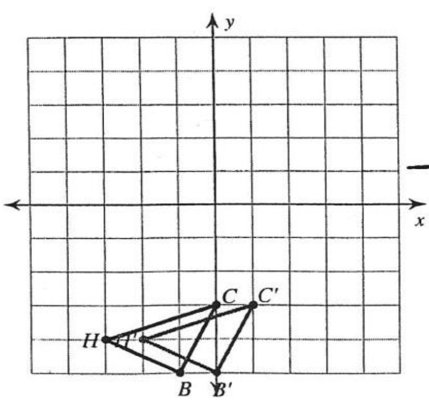


4)

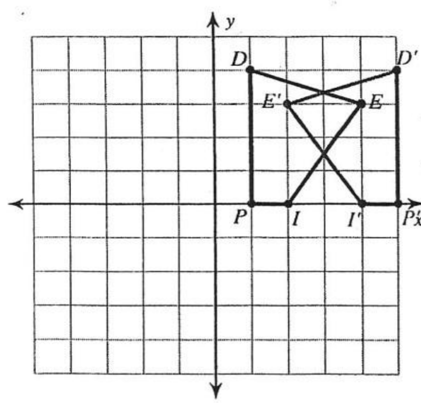


For problems 5-6, write a rule to describe the transformation.

5)

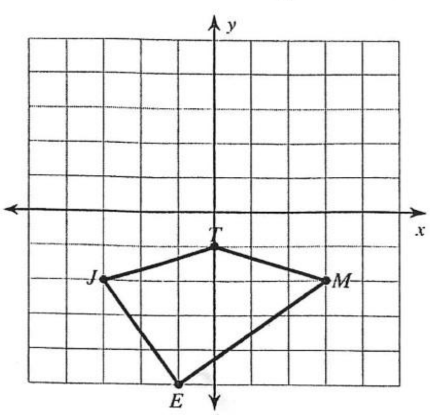


6)

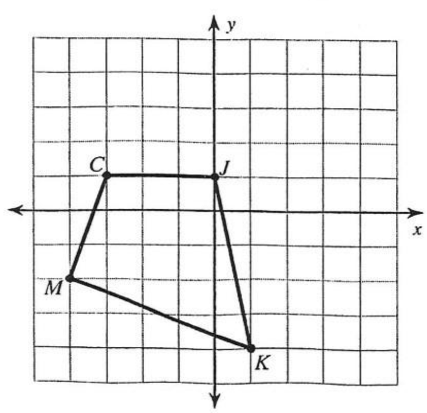


For problems 7-8, perform the specific transformation.

7) translation: 1 unit right and 1 unit up

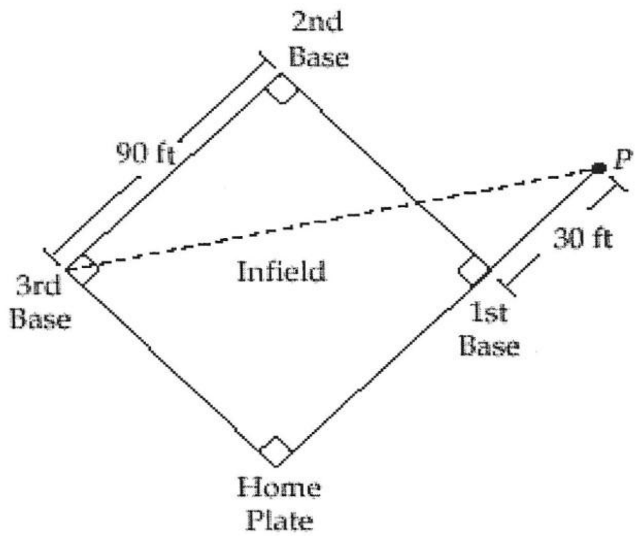


8) reflection across the x-axis



Pythagorean Theorem / Distance Formula

1. A diagram of a baseball field is show below. The infield is a square that measures 90 feet on each side.



Note: The figure is not drawn to scale.

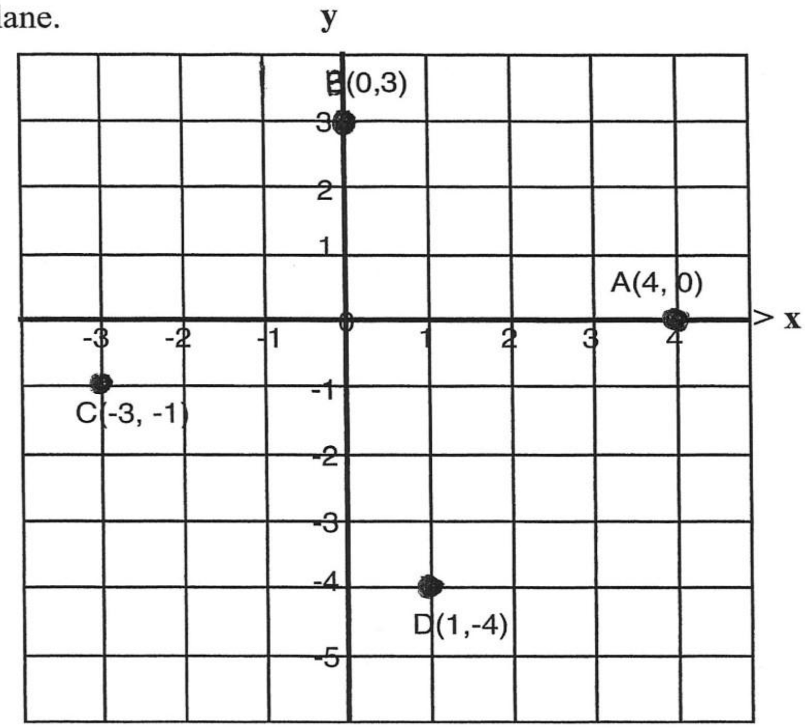
A player threw a ball from point *P* to third base. How far did the player throw the ball? Round the answer to the nears foot.

A. 79 ft B 127 ft C. 150 ft D. 210 ft

Show your work below.

Square

Four points, **A(4, 0), B(0, 3), C(-3, -1), and D(1, -4)** are drawn on the x/y co-ordinate plane.



1. Find the length of the line AB.

____

2. Find the slope of the line AB.

____

3. Join the sides of the quadrilateral ABCD. Prove that ABCD is a square.

Show your work below.

Aaron's Designs

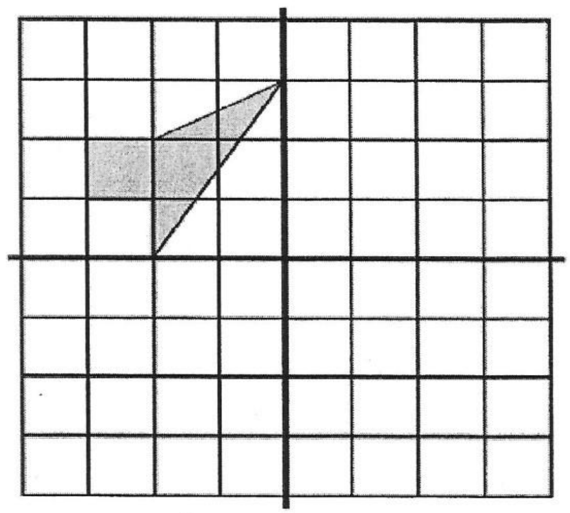
This problem gives you the chance to:
- draw reflections and rotations of a given figure on a grid
- describe transformations needed to make a given pattern

Aaron is drawing some designs for greetings cards.
He divides a grid into 4 quadrants and starts by drawing a shape in one quadrant.
He then reflects, rotates or translates the shape into the other three quadrants.

1. Finish Aaron's first design by reflecting the gray shape over the vertical line.

   Then reflect both of the shapes over the horizontal line.

   This will make a design in all four quadrants.

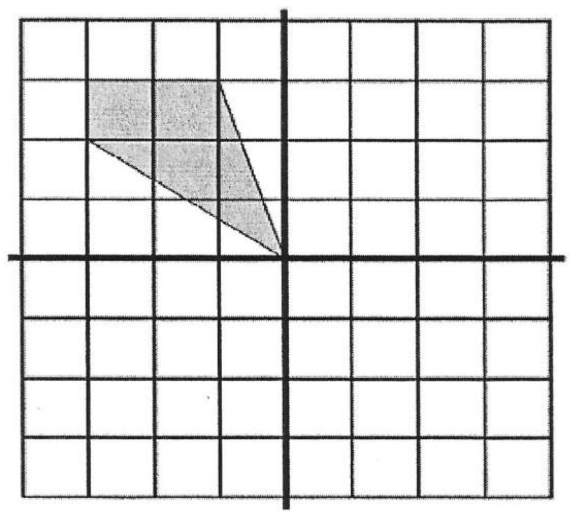


2. To finish drawing Aaron's second design, rotate the gray shape 1/4 of a turn in a clockwise direction about the origin. Then draw the second shape.

   Rotate the second shape 1/4 of a turn in a clockwise direction about the origin. Then draw the third shape.

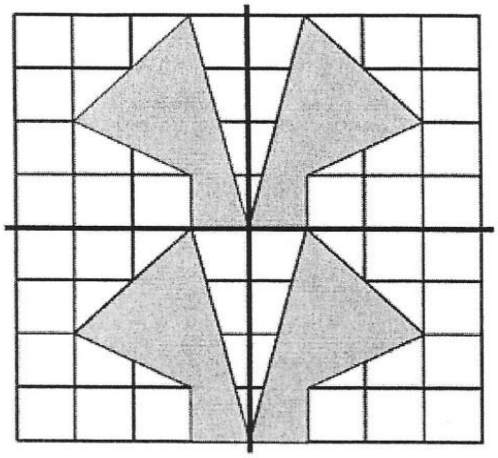
   Rotate the third shape 1/4 of a turn in a clockwise direction about the origin. Then draw the fourth shape.

   This will make a design in all four quadrants.



3. This is Aaron's third design.

He started with one gray shape in the top left hand quadrant of the grid and transformed it to make the design.



Describe the transformations that Aaron may have used to draw this design.

___

___

___

___

___