


Fall 12-10-2015

Implementing Technology in an Algebra Classroom

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Implementing Technology in an Algebra Classroom

by Jennifer Damick

A thesis submitted to the department of Education and Human Development of the
College at Brockport, State University of New York, in partial fulfillment of the
requirements for the degree of Master of Science in Education

December 10, 2015

Abstract

The drive to place technology in the secondary mathematics classrooms has been on the rise and has shown overtime to improve learning outcomes. How to support teachers with the implementation of technology in the midst of the Common Core State Standards (CCSS) reform and teacher accountability is important. This thesis provides varied use of technology along with different technological instructional strategies for an Algebra I course. Presenting technological pedagogical content knowledge (TPCK) in the Algebra I context can support teachers' implementation of technology into their instruction.

Keywords: Common Core State Standards (CCSS), NCTM Standards, Pedagogical Content Knowledge (PCK), Technological Pedagogical Content Knowledge (TPCK), Zone of Proximal Development (ZPD).

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Chapter 1: Introduction

Purpose

The purpose of this thesis is to integrate technological pedagogical content knowledge (TPCK) from mathematics education research into the mathematics curriculum, primarily focusing on algebra. The integration of technology into the mathematics classroom has had many changes over the years. For example: For New York teachers, one change that has occurred is the use of graphing calculators on the NYS Regents examination. Not long ago, graphing calculators were not permitted in part I of the Algebra Regents exam. Now, certain graphing calculators can be used throughout the examination. A second major change is that students can instantly and directly interact more with algebraic ideas through technology than with paper and pencil alone. While the implementation of technology in classrooms is dependent upon that which is available, there are many different methods and strategies educators can integrate to support their development of TPCK. With the development of TPCK, teachers' must use pedagogy to provide instruction to the students learning the content.

According to National Council of Teachers Mathematics (NCTM), (2000), "technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning," (Lin, 2007, p. 24). Lin also states how teacher's attitudes may hinder the implementation of technology. It is important to improve teachers' attitudes toward using technology in the classroom because it may enhance mathematics teaching and learning. However, many preservice and in-service teachers are inexperienced with the technology available for classroom use (Lin, 2007). Furthermore, many teachers lack the knowledge of how to properly incorporate technology in the classroom (Doering, Huffman, & Hughes, 2003). Research on technology integration in mathematics education has examined the effectiveness of

spreadsheets and dynamic geometry software on achievement (Isikal & Askar, 2005), computers and 2D geometric learning (Olkun, Altun, & Smith, 2005), and dynamic geometry sketches (Sinclair, 2004). The findings of the studies support computers in mathematics teaching and learning. For example, Isikal and Askar (2005) investigated the effect of spreadsheet and dynamic geometry software on mathematics achievement and mathematics self-efficacy. The results indicate that using technology effectively as a learning tool improves students' mathematics achievement.

The connection between technology and achievement implies that educators should adapt instruction to incorporate computer-based, electronic technologies within the context of the academic subject areas. Niess (2005) discussed the importance of teaching mathematics and science and noted that regardless of how teachers first learned the specific content, they can teach the content in a different way than how it was learned. Furthermore, learning content through the use of technology is different from learning to teach that content with the use of technology (Niess, 2005, p 509). Niess (2005) further discussed how the implementation of technology and preparing science and mathematics teachers is essential to the NCTM standards:

Shortages of mathematics and science teachers in concert with massive retirements of teachers over the next 10 years raise the concern about the preparation of teachers for a changing curriculum that integrates technology. Mathematics and science standards (NCTM, 2000; National Research Council, 1996) point toward a scientifically and mathematically rich curriculum where technology is an essential component of the learning environment, not only in the curriculum but also in the instruction (Niess p 510).

In algebra, in particular, many educators are incorporating technology on a daily basis. Technologies such as plickers and socrative can be used on a daily basis as a quick warm-up or

exit ticket in algebra classes. Plickers and Socrative is an app that can be used by both the teacher and the student. Kahoot! is an app that can be used during review classes before quizzes or exams generated by the teacher. Edmodo is an education app very similar to facebook. This app allows teachers to post reminders and notes right on the website. It can also be used to assess students on common core standards by using Edmodo's snapshot. Remind101 is a texting service that allows teachers to send reminders to students via text messaging. The most common technology used in a mathematics classroom is the TI Instrument Calculators. The graphing calculator has many different features that elaborates on the conceptual understanding in mathematics. The new technology from TI Instrument is the TI-Nspire which functions like a small computer. These technologies are being used more often in mathematics classrooms.

Chapter 2: Survey of Literature

Implementing Technology

Implementing technology into the classroom can be a challenge for teachers, especially those who are accustomed to the traditional style of teaching, as seen in the Bailey study (2007). Bailey et al. (2007) conducted a study of a high school mathematics teacher implementing technology in different ways during three mathematics periods. They state: "As the project progressed, it became obvious that the teacher was having difficulty in switching between the traditional teaching method and the technology-integrated approach. Altering his teaching methodology on a favorite mathematics topic, especially when he had taught this way for many years, created a degree of stress based on his uncertainty regarding the 'quality' of the mathematics education he was providing" (Bailey et al., 2007, p. 86). The results of the study showed that integrating technology did not negatively affect student learning. Moreover, grades

on the unit test increased on certain topics that had more benefit to the use of technology. Thus, teachers need to continue creating lessons that promote student-centered learning and lessons that allow the students to use their prior knowledge to discover concepts on their own. When students discover a concept on their own, they are more likely to make it their own and be able to transfer that knowledge to other problems (Beal, 2008). Teachers will be able to take those concepts learned in previous lesson to enhance student learning through the use of technology.

With little time to prepare students for state assessments, teachers feel rushed to get through all of the content. Many teachers do not think there is enough time in the school year to investigate and explore using software, thus they tend to rely on traditional teaching methods. Mitchell (2007) stated it was hard for teacher to transition from traditional teaching methods to a technology-integrated approach. The teacher in the Mitchell study was convinced that using a technology-integrated approach would not be sufficient enough to maintain the results he had in previous years. At first the traditional teaching methods had the best results, but after the teacher had more experience and became more knowledgeable, the results shifted towards the technology developed lessons. This indicates that if teachers work towards effectively implementing technology into the classroom, student performance results will increase and they will still be able to cover the content.

Common Core State Standards

This thesis will examine the similarities and differences between technological demands within the NCTM and CCSS. Porter et al (2011), illustrated the differences between the CCSS and previously used standards in each state. There are many notable differences between the CCSS and the NCTM Standards. For example, the CCSS placed a much greater emphasis on basic algebra, NCTM standards placed a much greater emphasis on advanced algebra. Similarly,

CCSS placed greater emphasis than on geometric concepts, but less emphasis on advanced geometry (146). There is a large difference on implementation of instructional technology (e.g., calculator use); in the NCTM standards, nearly 26% of content is on instructional technology, compared with none in the Common Core standards (146). However, from the CCSS website, there are several standards that involve the usage of technology such as *S-ID: Computer (using technology) and interpret the correlation coefficient of a linear fit*. Therefore, there should be a change in the way technology is implemented to continue to modernize the classroom that address the standards.

Finally, the Common Core standards put more importance on the concept of “demonstrate understanding” and “conjecture” than do the NCTM Standards, (Porter et al., 2011, p 105). However, the CCSS does not place more emphasis on demonstration of understanding through the use of instructional technologies even though there is a higher demand on modern technology. This thesis will examine ways to use technology to enhance student learning of the CCSS. Furthermore, the demand of conceptual understanding has increased due to the Common Core State Assessments.

Lassek (2014) described how technology ultimately supports the implementation of the CCSS in mathematic classrooms. In 2014, NCTM stated the importance of the implementation of technology in student learning of mathematics. Lassek (2014) states: “Fulfilling this promise by integrating technology into a mathematics curriculum requires that one believes technology enhances and changes mathematics learning as well as mathematics teaching,” (p. 180). The NCTM standards implemented technology because of the connection to student learning. Lassek provided examples of using technology in the CCSS by connecting mathematical practices to use appropriate tools strategically (Lassek p 181).

Lassek (2014) provided example of success by making connections between the mathematical practices and concludes:

Add to this the promotion of technology in the CCSSM and one should see that technology has much to offer to students' mathematical experiences of the future.

However, the CCSSM are only words, it is up to teachers to implement them to their fullest potential. (200)

Both the NCTM standards and the CCSS had some technology embedded in their curriculum. Research has shown that the CCSS has less technology than the NCTM Standards (Porter et. al., 2010, p 146). Moreover, the use of technology needs to be more imminent in the CCSS. As teachers are continuing to adapt to the CCSS in their lesson plans, they should be implementing current mathematical practices, such as technology, to enhance student learning.

Zone of Proximal Development

The zone of proximal development (ZPD) is defined as the distance between what a students can and cannot do independently (Zone of Proximal Development, n. d.). Throughout this zone are the tasks that students can reach when they receive support from another person. This person would have the knowledge of the content to help support the student. (Goos et al., 2002). Goos et al. (2002) described this process "as involving mutual adjustment and appropriation of ideas" (p. 195) instead of simply transferring knowledge from teacher to student during lectures.

Vygotsky first introduced the concept of the zone of proximal development. A student's zone of proximal development is the distance between the level of their actual development, determined with the help of a learning task performed independently, and the level the student could potentially reach with the support of a more knowledgeable person or teacher. This is

determined by specific learning standards and learning tasks that occur through instruction, (Vygotsky, 1978, p 42).

The ZPD model has four stages (Siyepu, 2013), the first dealing with the development of basic understanding. One of the most common ways to learn is by the observation of others. This is often referred to as modeling. Modeling can occur through the use of technological strategies as well. Technology can be used to enhance student learning and allow students to work towards independent work. Once a student can work independently on a concept, the level of understanding has been reached. The second stage of ZPD is where the student begins to work towards independent learning. Here, students access their prior knowledge in order to make connections to a new concept (Siyepu, 2013). “The ZPD occurs between the first and second stages. Learners practice alone, which implies that they perform certain activities without assistance. However, they are not at a stage of perfect proficiency and require some assistance sometimes” (Siyepu, 2013, p. 6). In stage three students are required to have mastered the concept through independent work. Finally, in stage four: “...are at the de-automatisation of performance that leads to the process of repeating a function, each time applying it to the results of the previous stage through the ZPD,” (Siyepu, 2013, p.6).

Goos et al. (2002) conducted an experiment through collaborative work looking at ZPD and metacognition. They state:

Previous research on metacognitive development has used the ZPD to explain how adults can scaffold learners' progress from assisted (other regulated) to independent (self-regulated) performance. The scaffolding process is best understood as involving mutual adjustment and appropriation of ideas rather than a simple transfer of information and skills from teacher to learner (p. 195).

Goos et al. (2002) showed that ZPD focuses primarily on student to student interaction in small group setting. However, they also placed great emphasis on teacher to student interaction. The teacher's role is also an important part to assess students' ZPD. Furthermore, they explained that often students thinking can get confused without the support from the teacher. The teacher does a good job at redirecting students thinking to enhance learning (p. 220).

One idea that makes connections between ZPD and metacognition was addressed in Schoenfeld's (1992) work. Schoenfeld's (1992) article discussed the importance of mathematical cognition. Schoenfeld (1992) stated: "Mathematicians have immediate access to large amounts of knowledge, but also employ a wide range of strategies when confronted with problems beyond the routine," (p. 51). This response shows that even though mathematicians have an abundance of knowledge, they still have strategies to pull from when they get stuck. The rationale involving problem solving suggests that there are better ways to learn mathematics outside of teacher based lectures. Allowing students to think cognitively also allows them to access their ZPD. This connects the two theories of ZPD and TPCK. Teachers can create activities involving technology to reach their levels of ZPD. The implementation of technology into the classroom should push students through their ZPD to close the gap.

Technology is a servant if it is used as a fast, reliable adjunct to pen and paper (e.g., as a tool for drawing graphs or performing numerical calculations), but does not change the nature of classroom activities. However, when teachers develop an affinity for technology as a partner, there is potential for students to achieve more power over their own learning by, for example, providing access to new kinds of tasks or new ways of approaching existing tasks (Goos, 2005, p 40).

Teachers' pedagogical and mathematical knowledge can be incorporated through the use of varied technological strategies. This goes beyond the teacher based lectures and allows students to gain conceptual understanding and shorten the gap of their ZPD.

Technological Pedagogical Content Knowledge

One model that has shown effective for all students is the Technological Pedagogical Content Knowledge (TPCK) model. Mishra & Koehler (2006) claim that: "the advent of digital technology has dramatically changed routines and practices in most arenas of human work" (p 1017). They later make connections with how teachers must use this change to their advantage (Mishra & Koehler, 2006, p 1017). Making this connection between technology and education can alter the framework between students reaching conceptual understanding. "Teaching is a highly complex activity that draws on many kinds of knowledge. There are clearly many knowledge systems that are fundamental to teaching, including knowledge of student thinking and learning, and knowledge of subject matter" (Mishra & Koehler, 2006, p. 1021). This framework is all about reaching the middle ground between the three components: content knowledge, pedagogy, and technology. Mishra & Koehler (2006) takes into account Shulman's (1987) research, introducing the idea that pedagogical content knowledge is vital to education. They further developed the idea that teaching requires an understanding of how technology relates to both the pedagogy and the content knowledge of a teacher. Mishra and Koehler (2006) provides their framework as:

Content knowledge (CK) is knowledge about the actual subject matter that is to be learned or taught...Pedagogical knowledge (PK) is deep knowledge about the processes and practices or methods of teaching and learning and how it encompasses, among other things, overall educational purposes, values, and aims...Technology knowledge (TK) is

knowledge about standard technologies, such as books, chalk and blackboard, and more advanced technologies, such as the Internet and digital video...Technological pedagogical content knowledge (TPCK) is an emergent form of knowledge that goes beyond all three components: content, pedagogy, and technology. (p. 1026-1028)

Teachers must develop their lessons and content that implements all three components: technology, pedagogy, and content.

TPCK is an approach that focuses on promoting a large variety of technological approaches to enhance learning. Marino et al (2009) state: “This integrated approach allows teachers to develop a strong understanding of how knowledge of technology, pedagogy, and content can be used to create flexible learning environments that benefit a wide range of learners. Including assistive technology in technology knowledge enhances the model by allowing teachers to gain enhanced understandings of the benefits of including technology in content specific instructional design”(p. 195). Technology ultimately provides opportunities for students to learn in an active, self-directed environment. With modern day technological practices more imminent in society, students will be connected with real world applications to apply to mathematics.

With inclusive of classrooms on the rise, it is important to provide teachers with the proper implementation of technology to accommodate for all students. School districts are focusing more on inclusion so it is important to differentiate instruction including technology use for all students. One way to differentiated instruction is with the effective use of technology. Teachers who feel ill-prepared to address the diverse needs of their students, for example, have ready access to more options, such as large variety of software and hardware tools to assist their

student's needs. This is the challenge that the TPCK theory faces, without proper preparation, teachers will not gain their TPCK.

Technology can guide teachers to address students' needs in various ways, through content strategies and learning activities. Also, students come to the learning environment with a tendency for using technology, so it is important to connect real world experiences to in school experiences. Inclusive pedagogy focuses on extending the needs of students. It requires the learning community to expand their available resources in the classroom so all students gain more knowledge. Therefore, TPCK is a process that is teaching educators how to implement technology to improve the learning of new content. TPCK supports the learning of students with disabilities just as much as the general education learners.

With current teachers struggling to integrate technology into the classroom, how did the learning-technology-by-design approach lead to the development of TPCK? The proposed solution is described as putting a large emphasis on learning by doing. The learning-technology-by-design approach strays away from lectures and traditional teaching (Mishra & Koehler, 2006, p 1035). In mathematics, it is important to understand the difficulty students have with understanding the abstract concepts. Technology is a strategy that can make abstract concepts concrete. Once a student has understood the concept, technology can help students achieve fluency in mathematical facts. "In an early study by Hasselbring, Goin, and Sherwood (1986), it was found that computerized drill and practice was ineffective in developing declarative fact knowledge in students with math difficulty," (Hasselbring, 2008, p 6-7). Due to this research, Hasselbring and Goin (2005) developed a program called FASTT (Fluency and Automaticity through Systematic Teaching with Technology) which was created for students to improve their math fluency. FASTT is an interactive technological program that can be used for students are

already excelling on mathematical concepts, or students who need to catch up on their mathematics facts.

The connection between technology and achievement implies that educators should adapt instruction to incorporate computer-based, electronic technologies within the context of the academic subject areas. Niess (2005) discussed the importance of teaching mathematics and science and noted that regardless of how teachers first learned the specific content, they can teach the content in a different way than how it was learned. Furthermore, learning content through the use of technology is different from learning to teach that content with the use of technology (Niess, 2005, p 509). Thus, all teachers should incorporate technology based strategies in their lessons to support the enhancement of student learning.

Chapter 3: Curriculum

This chapter focuses in detail on eight different technological strategies that could be used in an Algebra classroom. Teachers are experts in designing lesson plans well. The pace of changes to modern technology leave teachers struggling to implement technology. The following strategies presented would most likely not be used in one learning segment since most teachers would not include technological strategies in 10 straight lessons.

This chapter provides specific details on how to implement technological strategies using TPACK:

1. **Graphing Calculators:** the TI graphing calculators and the TI Nspire are relatively new technologies that many teachers are currently using. These methods are being implemented throughout the Algebra curriculum. In order to access conceptual understanding and procedural fluency, an educator should give students multiple ways to solve a problem. The use of a graphing calculator will do just that.

2. QR Codes (also known as Quick Response Codes): Can be scanned with a smartphone, tablet, or laptops, and link directly to e-mails, videos, or documents. Using a QR Code in the classroom environment will allow the student to be responsible for their own learning in and outside of the classroom. If a student is absent from class, they can take their notes and scan the QR code with a QR Code Reader and be able to watch a video tutorial on the content from that lesson. Students will then be able to complete any missing assignments without falling behind.
3. Plickers: These are known as paper clickers. Each student will receive their own paper clicker and the teacher uses the technology in the front of the room to assess their students quickly. This is a great resource for warm-up or exit-ticket activities.
4. Poll Everywhere: Another way to get all students involved. This can only be done when all students have access to a texting device. This can be done easily to measure if your students are understanding the material or if they need more support for learning.
5. GeoGebra: This is an interactive resource to get students using modern technology to learn mathematics. This app can be used in both Algebra and Geometry classrooms.
6. Socrative: This is a resource that teachers can use to create formative and informative assessments. Along with making assessments, students can use the QR code resource to input their answers to the socrative app.
7. Kahoot!: For this technology to work, every student will need access to the internet. To ensure that all students have access to the internet, a teacher could rent out school laptops or tablets. Then, students will need to log into the Kahoot! app (on a web browser it is www.kahoot.it). Kahoot! could be used during review sessions and goes beyond the

“Jeopardy” review because students are able to use their technological device right in class to answer the questions.

8. Edmodo: This is an education app that looks very similar to Facebook. Teachers will be able to post homework assignments and post a “status” on homework, exams, or even notices. Students can log into their Edmodo app if they were absent to find any missing assignments so they do not get behind.

Below lists the following CCSS in Algebra I that involve teaching with technology.

Some standards specifically state that students should be using technology to graph. Other standards may say to graph functions and it would be up to the teacher’s discretion to implement technology to enhance conceptual understanding. When making lesson plans involving technology, teachers must take into account the following CCSS below:

CCSS with Technology	
A-REI-9	(+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3×3 or greater).
A-REI-11	Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.
F-IF-7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
F-BF-3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them
S-ID	Compute (using technology) and interpret the correlation coefficient of a linear fit.

Other Algebra CCSS may be assessed through the use of technology. Both the NCTM standards and the CCSS had technology embedded in their curriculum; moreover the

encouragement of technology needs to be more imminent in the CCSS. With searching through the CCSS, only five standards were found that involve technology. However, this does not mean to only use technology when assessing these following standards. As teachers are continuing to adapt to the CCSS in their lesson plans, they should be addressing mathematical practices on the best ways to implement TPCK to enhance student learning.

This chapter will go into greater detail on implementing modern technology to get the students engaged and interested in the learning of Algebra. Ultimately, the focus is on technology and its implementation. Thus, problem sets will be provided to show how the technology is used in a particular lesson plan. However, TPCK can be used throughout the Algebra curriculum.

Lesson 1: Graphing Calculator

Lesson Overview	
Central Focus	Students will gain a conceptual understanding of the Absolute Value Function by relating the symbolic expression of an equation to a graph of the function. (Translation and Shift). Students will do this with the use of a graphing calculator.
CCSS	<p>F.BF.B.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.</p> <p>F-IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.</p> <p>F-IF.9: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).</p>

Name: _____

Date: _____

Lesson 1: Function Translation and Shift

1. Let $f(x) = |x|$ $g(x) = f(x) - 3$ $h(x) = f(x) + 2$ for any real number x .

a) Write an explicit formula for $g(x)$ and $h(x)$ in terms of $|x|$ (i.e., without using $f(x)$ notation):

$f(x) = |x|$ $g(x) = \underline{\hspace{2cm}}$ $h(x) = \underline{\hspace{2cm}}$

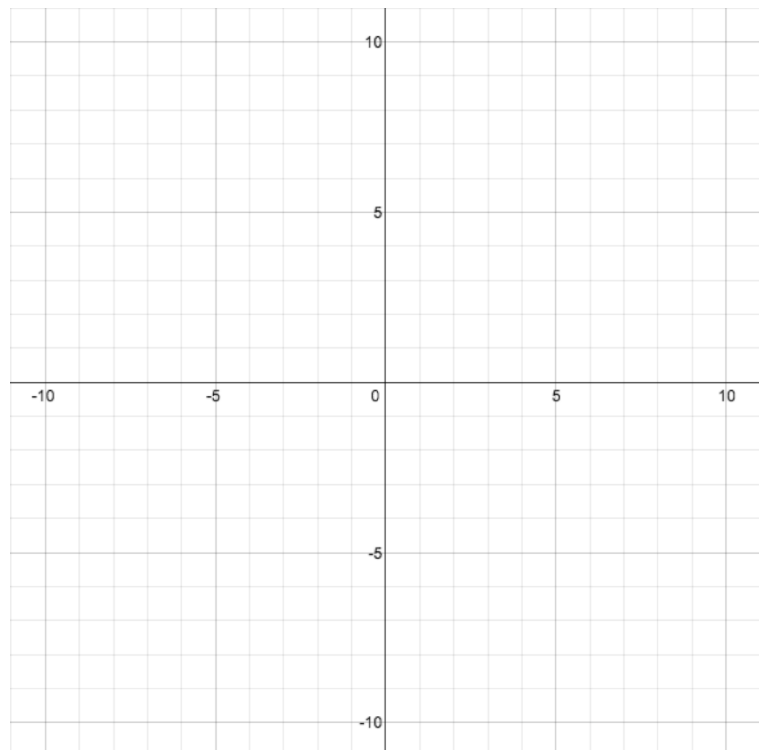
b) Complete the table of values for these functions using your graphing calculator.

x	$f(x) = x $	$g(x) = f(x) - 3$	$h(x) = f(x) + 2$
-3			
-2			
-1			
0			
1			
2			
3			

c) Graph all three functions.

d) What is the relationship between the graph of $y = f(x)$ and the graph of $y = f(x) + k$?

e) How do the values of g and \square relate to the values of f ?



2. Let $f(x) = |x|$ $g(x) = f(x - 3)$ $h(x) = f(x + 2)$ where x can be any real number.

a. Write the formula for $g(x)$ and $h(x)$ in terms of $|x|$ (i.e., without using $f(x)$ notation):

$f(x) = |x|$ $g(x) = \underline{\hspace{2cm}}$ $h(x) = \underline{\hspace{2cm}}$

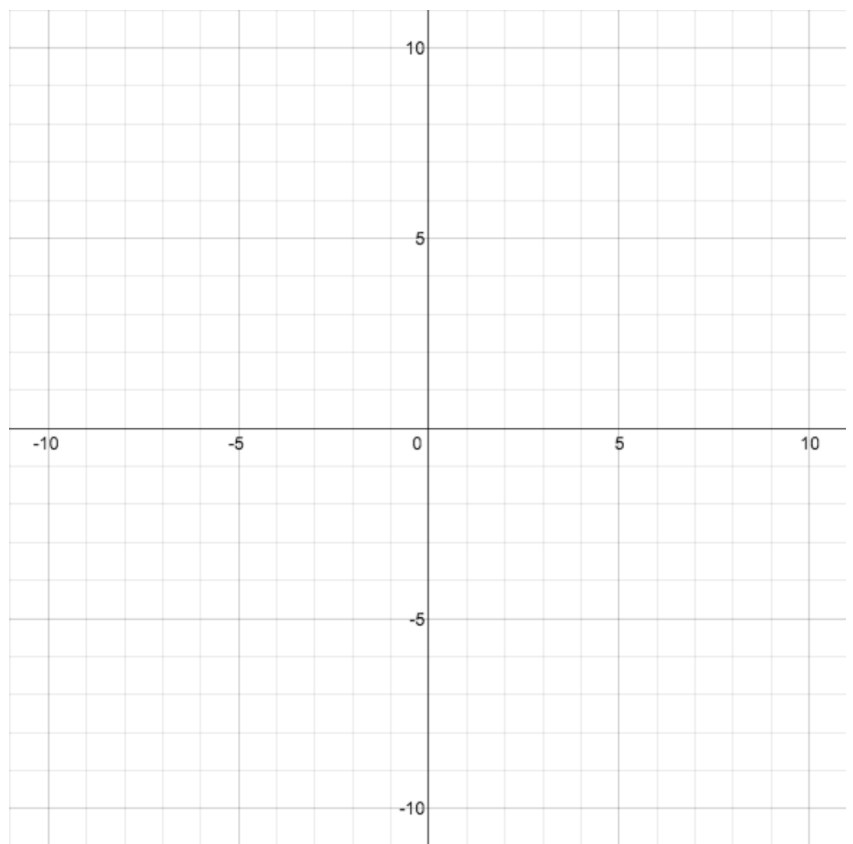
b. Complete the table of values for these functions.

x	$f(x)$ $= x $	$g(x) =$	$h(x) =$
-3			
-2			
-1			
0			
1			
2			
3			

c. Graph all three functions using the graphing calculator.

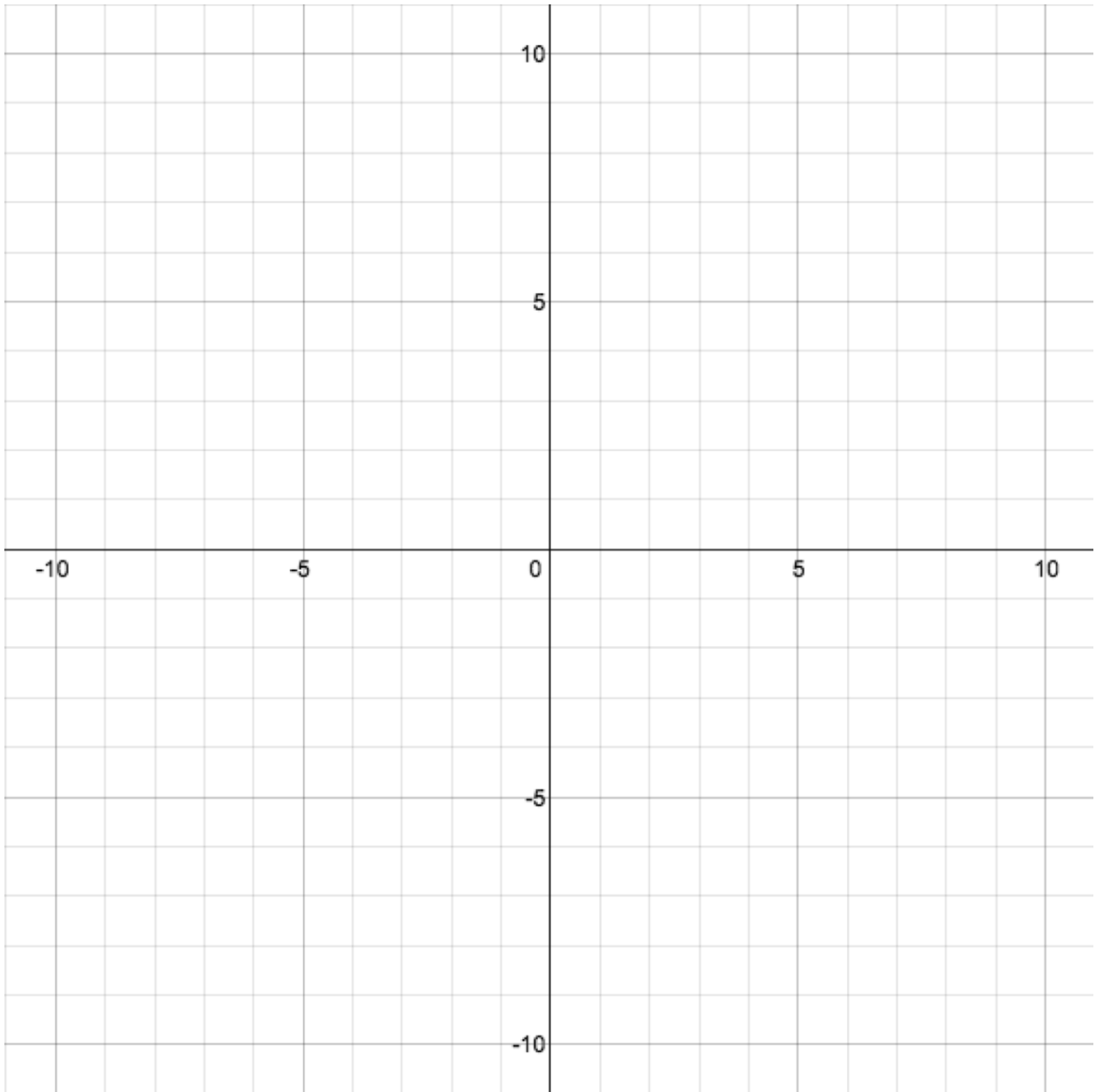
d. How does the graph of $y = f(x)$ relate to the graph of $y = f(x - 3)$?

e. How does the graph of $y = f(x)$ relate to the graph of $y = f(x + 2)$?



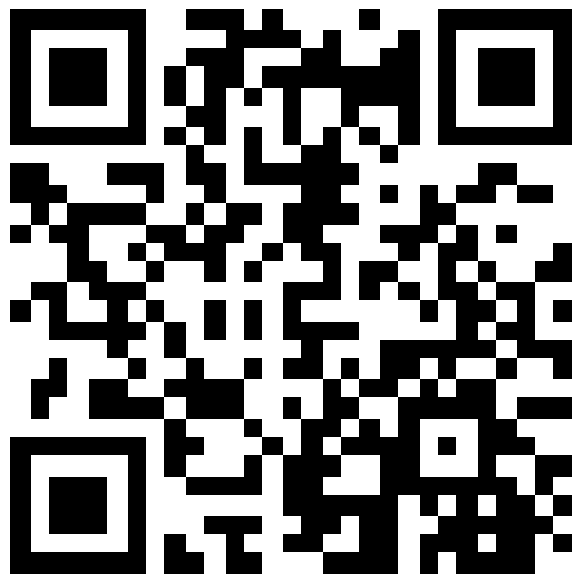
f. How does the graph of $y = |x| - 3$ and the graph of $y = |x - 3|$ relate differently to the graph of $y = |x|$?

2. Rachel and Steve are disagreeing over which way the graph of the function $g(x) = |x + 3|$ is translated relative to the graph of $f(x) = |x|$. Rachel believes the graph of g is “to the right” of the graph of f , Steve believes the graph is “to the left.” Who is correct? Graph the following functions using your graphing calculator to show the correct shift.



Lesson 2: QR Codes

Lesson Overview	
The following lessons are currently used in an upstate NY school district and through the emathinstruction curriculum: http://emathinstruction.com/	
Central Focus	The following two lessons are from Unit 3: Functions in eMathInstruction. The central focus of the lesson does <i>not</i> involve technology. The important part about the following two lesson plans is the QR code located at the top right of each lesson. The students must download the QR code app. Once the lesson is taught, the students will then go home and if they are struggling on their homework they can scan the QR code and it will bring them to videos and examples to guide them through their homework. This eliminates the issues with parents not understanding the common core state standards. It also allows students to be proactive and independent. Students will be able to take ownership of their own learning.



LESSON #5
EXPLORING FUNCTIONS USING THE GRAPHING CALCULATOR
COMMON CORE ALGEBRA I



GRAPHING CALCULATOR ESSENTIALS

1. A TABLE APP
AND
2. A GRAPHING APP

We can use our calculator to help us produce tables that are very useful in plotting graphs and exploring functions.

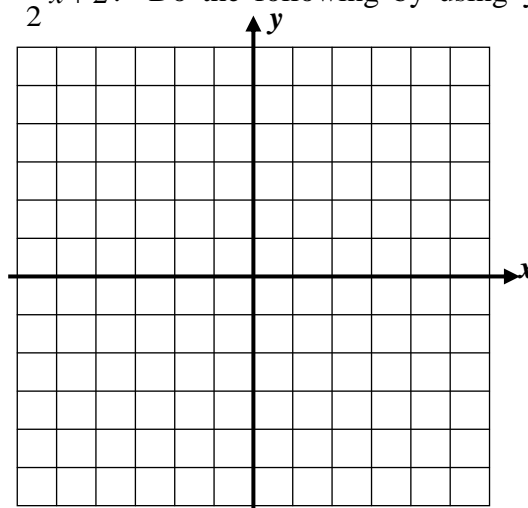
Exercise #1: Consider the linear function $f(x) = \frac{1}{2}x + 2$. Do the following by using your graphing calculator's table function.

(a) Evaluate $f(-6)$, $f(0)$ and $f(8)$.

(b) Explore the table to determine the value of x for which $f(x) = 11$.

(c) Use the table to fill out the following table and graph the function on the grid for the interval $-6 \leq x \leq 6$.

x	y	(x, y)
-6		
-4		
-2		
0		
2		
4		
6		



(d) Graph the linear function $g(x) = 5 - x$ on the same set of axes and find where the two lines intersect.

(e) Show that the point that you found in (d) is a solution to both equations:

$$y = \frac{1}{2}x + 2 \text{ and } y = 5 - x$$

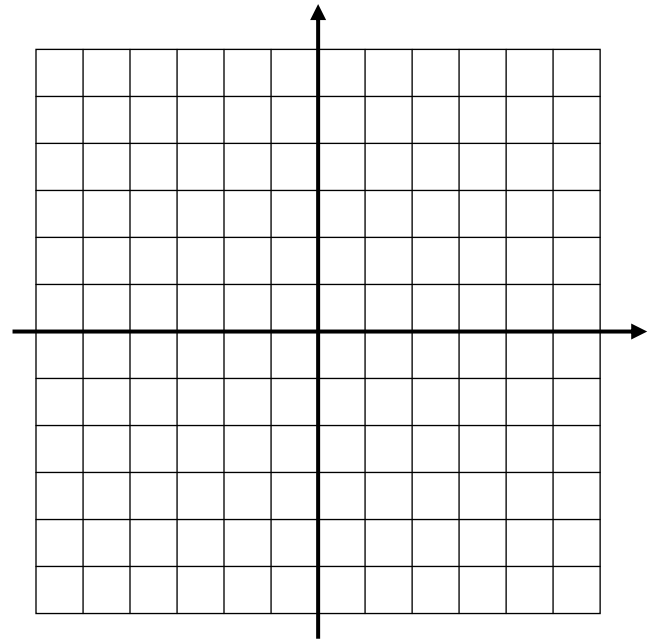
Exercise #2: Consider the function $y = (x-1)^2 - 4$ over the interval $-1 \leq x \leq 4$.

- (a) Create a table of values for this function over the specified interval. (b) Create a sketch of this function over this interval. Verify by examining the graph that your calculator produces.

(c) What are the function's minimum and maximum values on this interval?

(d) Over what interval is the function negative?

(e) For your graph, state the interval over which the function is increasing.



(f) How can this graph help to solve the equation $(x-1)^2 - 4 = -3$? Can you solve this by looking at your table?

Exercise #3: Which of the following is a point where $y = \frac{3}{2}x + 7$ and $y = -5x - 6$ intersect?

- (1) $(0, 7)$ (3) $(-2, 4)$
 (2) $(-1, -1)$ (4) $(2, 10)$

**EXPLORING FUNCTIONS USING THE GRAPHING CALCULATOR
COMMON CORE ALGEBRA I HOMEWORK**

FLUENCY

1. Consider the function $g(x) = 3x^2 + 2x - 4$. Evaluate the following using your graphing calculator.

(a) $g(-2) =$

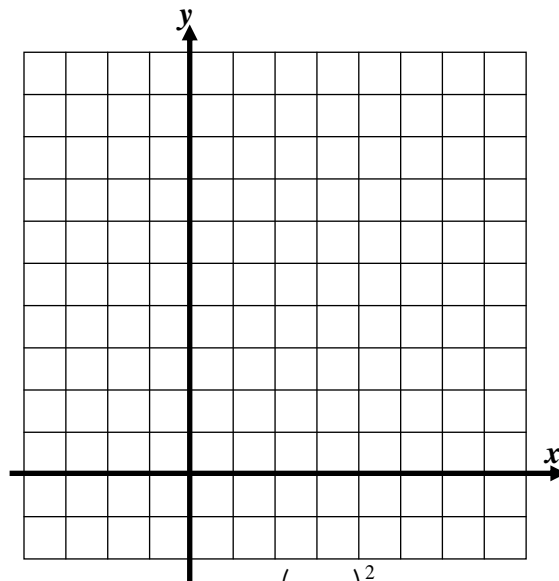
(b) $g(0) =$

(c) $g(4) =$

(d) $g(15) =$

2. Given the function $f(x) = x^2 - 2x + 1$, fill in the missing values in the table then using the table graph the function on the grid for the interval. Use your calculator.

x	Y	(x, y)
-2		
		$(-1, 4)$
0		
	0	
2		
3		
	9	



3. Which of the following values of x will make the equation $3(x - 2)^2 - 4 = 23$ true? Show the table on your calculator that justifies your choice.

(1) $x = 1$

(3) $x = 5$

(2) $x = 4$

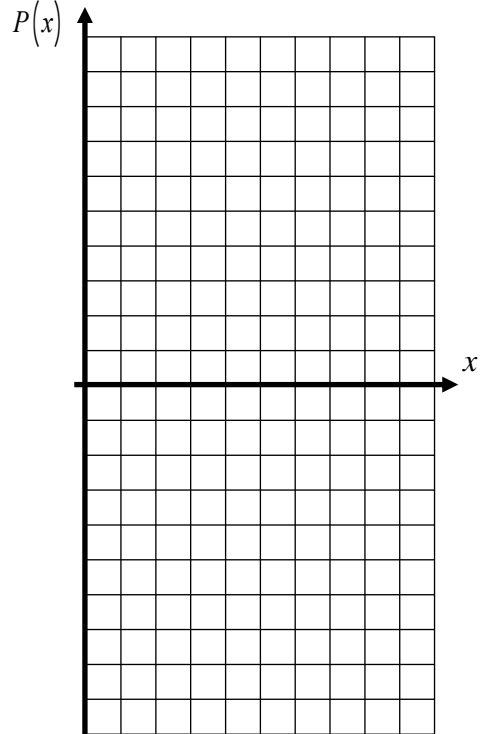
(4) $x = 0$

APPLICATIONS

4. Profits for the upcoming year for a shipping company have been quantified and put into the equation $P(x) = \frac{1}{2}(x - 2)^2 - 8$ where x is the number of packages shipped in thousands and $P(x)$ is the corresponding profit in millions of dollars.

(a) Use your calculator to fill out the following table and graph the function on the grid for the interval $0 \leq x \leq 10$.

x	$P(x)$	(x, y)
0		
2		
4		
6		
8		
10		



b) Over what interval is $P(x) < 0$? What does this interval represent

(c) Evaluate $P(0)$. What might this stand for?

(d) Explore the table to determine the Value of x for which $P(x) = 0$.

REASONING

5. After placing an equation into his calculator Rob got the following table. He then determines that $x = 6$ when $f(x) = -4$. Is he correct? Explain.

x	$f(x)$
-4	6
-2	3
0	-1
2	-4

Lesson 3: Plickers

Lesson Overview	
Central Focus	Below will describe the steps on how to use plickers. Plickers are paper clickers and is a free app that can be used in the classroom. The implementation of this technology will be described. Teachers can use this form many different forms of assessment. There is not a lesson provided showing how to implement this technology. Plickers can be used anywhere in the algebra curriculum.

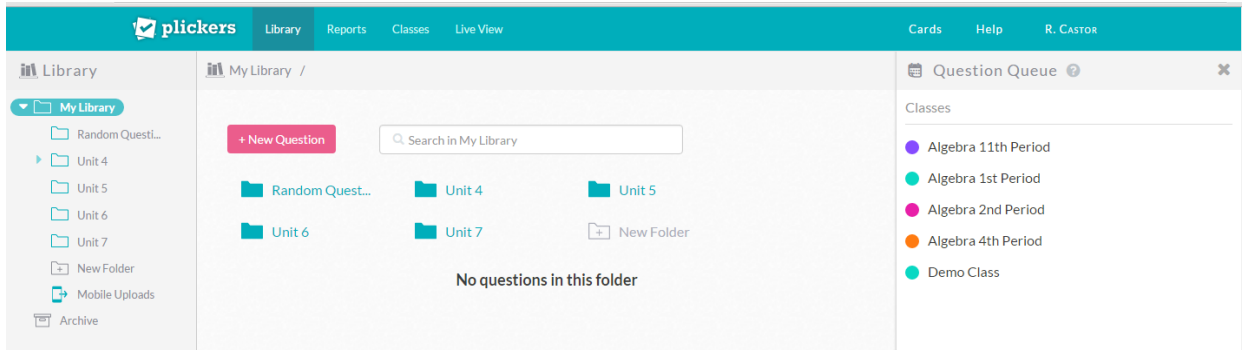
Plickers are simply just paper clickers. This is a free app that allows you to get feedback from all your students very quickly. Through the app you will have to print off a piece of paper that is tied to each of your students. On the top of each card, there is a small letter: A, B, C, or D. Plickers could be used for many different purposes to formally assess your students. Such as for warm up or exit tickets. The teacher will ask the students a multiple choice question. Then, the students will choose their answer, A, B, C, or D, and hold the card toward the teacher with the letter they chose on top. The teacher, with their phone, or iPad/tablet, will scan the student's responses through the plickers app. When finished, the teacher can instantly see the results of the classroom. One way to use plickers in a mathematics classroom is to tape the plickers cards on the back of the calculator and assign the students to a particular calculator for the year. Plickers forces *every* student to participate. You can also quickly look at your mobile device as you are scanning to see who has not answered. In addition, this app is entirely free to use. Here are the steps to follow:

1. Download the Plickers app on your mobile device/tablet

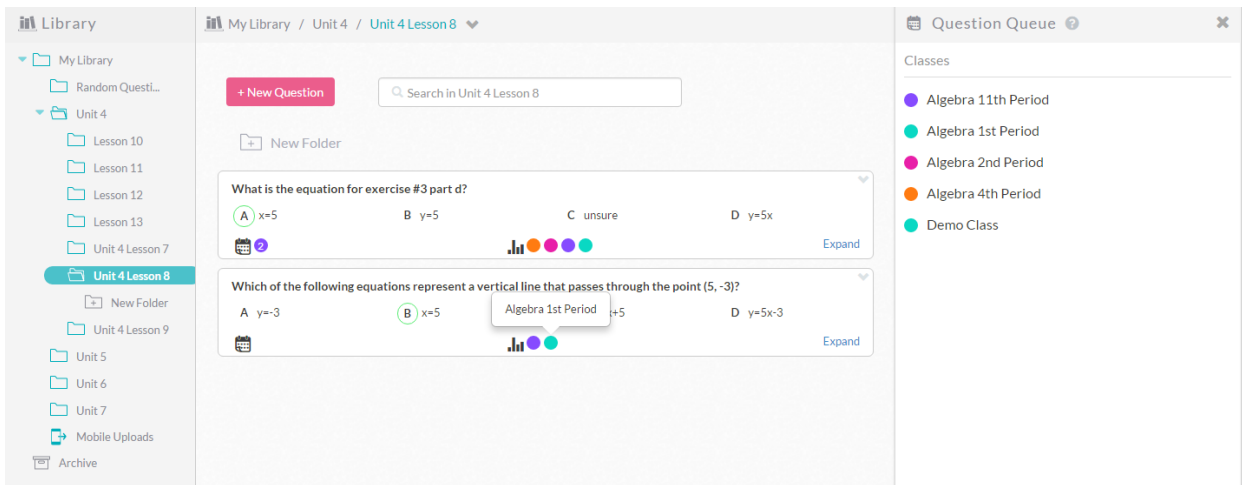
2. Go to www.plickers.com to set up a free account
3. Click “cards” at the top and print a set of cards
4. Create a class by clicking “classes”, then “add new class.”
5. Create the numbers of your class in a way that makes sense. Like stated before, in a mathematics class, the calculators will be numbered and the students will be assigned a particular calculator. Therefore, make sure the plickers card is the same number of the calculator.
6. Click on “library”, to create a set of questions.
7. Once you have created the poll, the teacher will take out the iPad (or other mobile device) and open the Plickers app. Then, select the class you wish to poll.
8. Click on the camera icon at the bottom of the screen to begin scanning. As you scan, your students' names should appear, along with their answer choice. You can easily scroll through all of your students' names at the top to see whose name is in white (has still not answered), red (wrong), or green (correct).

When you log in, you will have four different options:

1. Library: add or edit any questions
2. Reports: look or export reports
3. Classes: add or edit classes
4. Live View: when a teacher is ready to assess their students, they will go to this tab



The teacher can assign certain questions to specific class periods or all class periods.



Under reports, the teacher can see the percentage of the class and also how each individual student performed on the questions.

The screenshot shows the Plickers Live View interface. At the top, there is a navigation bar with 'plickers', 'Library', 'Reports', 'Classes', 'Live View', 'Cards', 'Help', and 'R. CASTOR'. A search bar is on the left. Below it, a 'Filter by class:' section lists 'Algebra 11th Period', 'Algebra 1st Period' (checked), 'Algebra 2nd Period', 'Algebra 4th Period', and 'Demo Class'. There is also an 'Archived Reports' checkbox. The main area displays three exercises:

- Exercise #2 d:** "What is the 21st term in the sequence?" Correct: 83%. Options: A 21, B 42, C 43, D 20. Bar chart: A=1, B=1, C=10, D=0.
- Exercise #1 f:** "Solve for n: a(n)=128" Correct: 82%. Options: A 5, B 6, C 7, D not sure. Bar chart: A=0, B=9, C=1, D=1.
- Exercise #1 e:** "a(5) - a(4) is equal to" Correct: 83%. Options: A 1, B 32, C 64, D 16. Bar chart: A=1, B=10, C=1, D=0.

A 'Help' button is located in the bottom right corner.

Once you are ready to assess your students, go to the “live view” tab. Teachers will show this screen on their smart board to their students. Once the teacher makes the question live on his or her tablet/smartphone, then the question will appear on screen to the students.

The screenshot shows the 'Live View Ready!' screen. At the top, the navigation bar is the same as in the previous screenshot. The main content area has a large heading 'Live View Ready!' and the text 'Select a question in your Plickers iOS/Android app to project to your class.' Below this are three numbered instructions:

1. Open the Plickers iOS/Android app and select your class.
2. From the app, select the question you want from your Queue.
3. Live View will automatically update with your question!

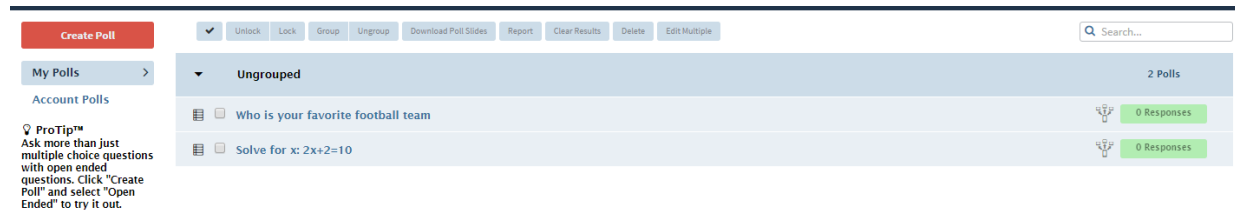
At the bottom, there is a section titled 'Still not seeing your question?' with the text 'Try refreshing below or check out our troubleshooting page.' and a 'Refresh' button.

Lesson 4: Poll Everywhere

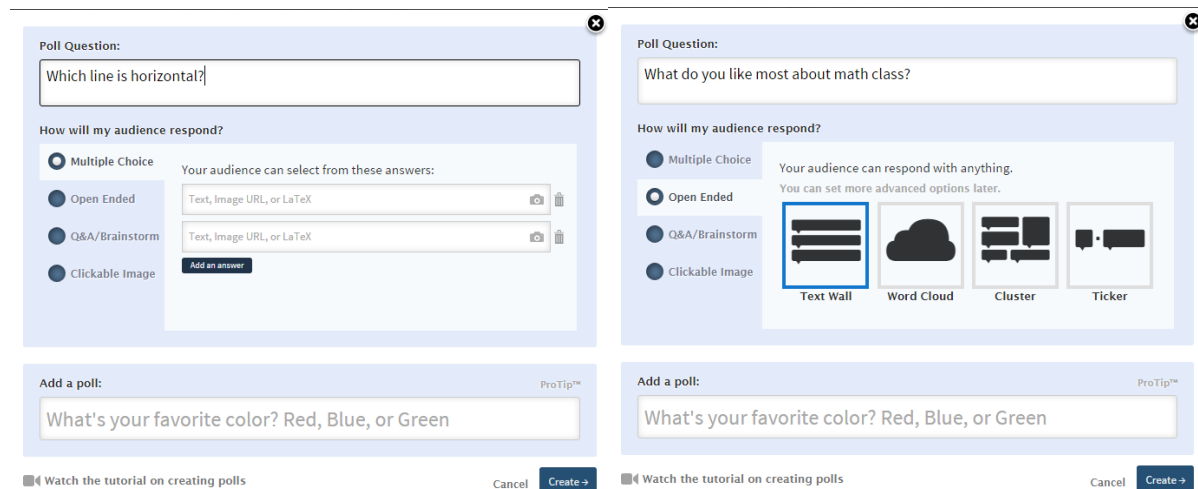
Lesson Overview	
Central Focus	<p>Poll everywhere is a device that can be used if all students have a texting device.</p> <p>Teachers will create an account and create a poll. Once the poll is created they will activate their poll and the students will have to text their response to a certain number. Below describes the implementation of poll everywhere and how teachers can use it to engage their students in meaningful learning. There is not a lesson provided showing how to implement this technology. Poll Everywhere can be used anywhere in the algebra curriculum.</p>

Create a Poll:

In the top left corner, select “create poll”



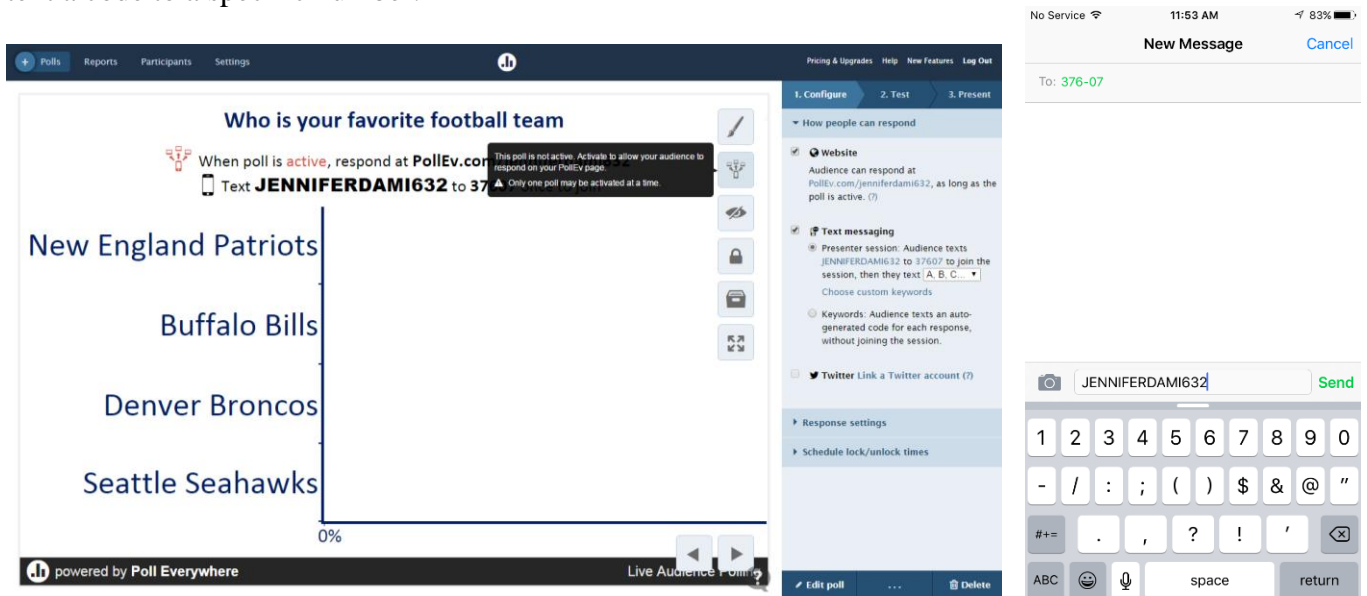
You will then be prompted to create a question and select between the four options below:



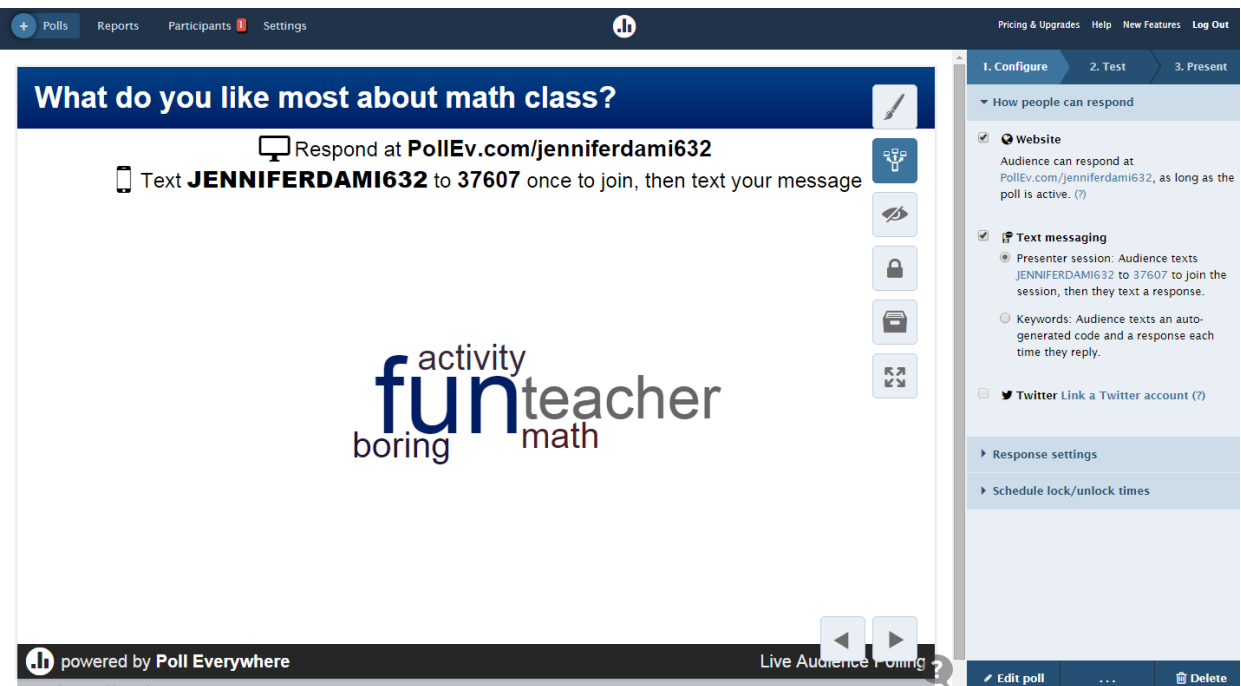
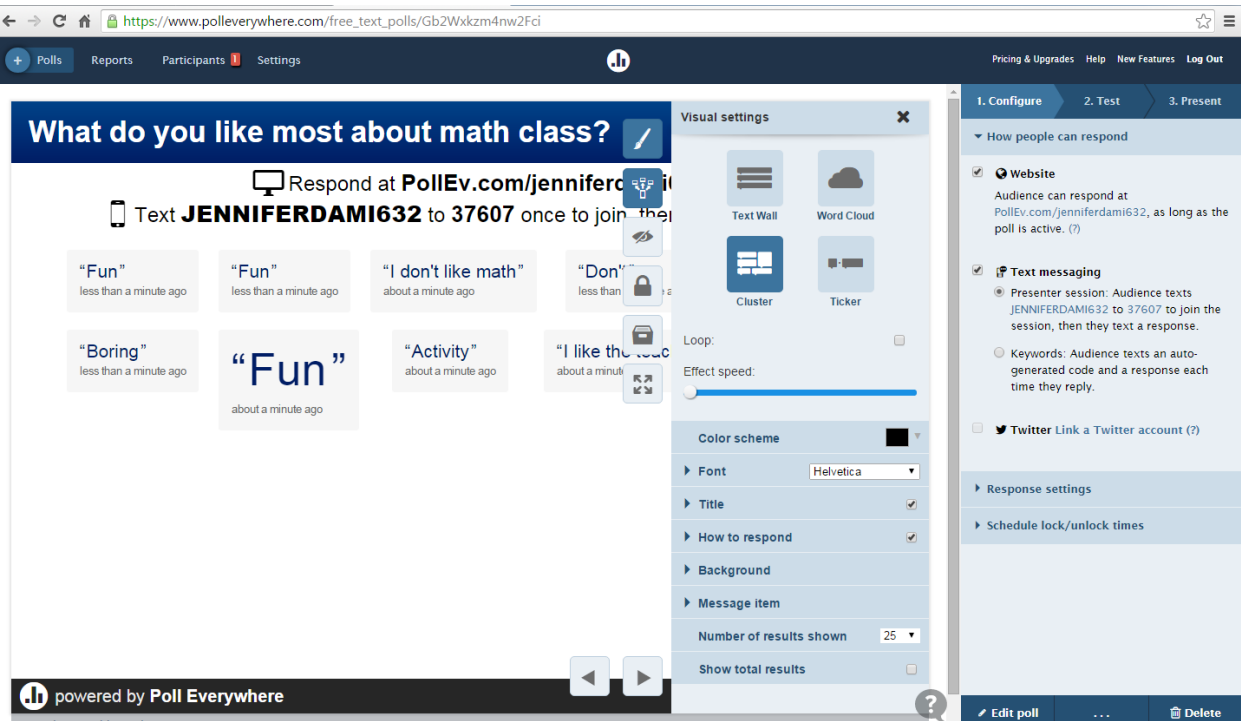
Poll Everywhere offers four different types of questions:

1. Multiple-choice polls
2. Open-ended polls
3. Clickable image polls
4. Q&A / Brainstorm polls

Click on the poll you wish to use with the students, then activate poll (second tab down on the right hand side). Once the poll is active, students must follow the instructions on the screen to text a code to a specific number.




Below lists examples of how to show the results of the polls. Under the first tab (paint brush), you can change the visual settings to make a text, word cloud, cluster, or ticker. Below are examples of cluster and word cloud poll results.






Lesson 6: GeoGebra


Lesson Overview	
Central Focus	<p>GeoGebra is an interactive app that can be downloaded on many devices, as shown below.</p> <p>Go to www.GeoGebra.org</p> <p>Click download at the top</p> <p>You can then choose to simply download using google chrome or put it directly on the computer. In order for students to be able to save their work, saving it to either Windows or Mac would work best. The next step is to explore the many different resources this site has to offer. There are many tutorials as to how to navigate through the app. Below are simple things that I particularly explored. GeoGebra could be very useful to geometry students to get them to explore concepts to gain a deeper understanding.</p> <p>There is not a lesson provided showing how to implement this technology. GeoGebra can be used anywhere in the algebra curriculum. If you are elaborating on any mathematical concept, you can take your students to the computer lab or rent out tablets/laptops to have students do a group project using GeoGebra.</p>

GeoGebra is available on tablets, desktops, and phones. GeoGebra is also available for free downloading.

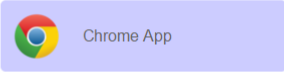





GeoGebra for Tablets








GeoGebra for Desktops

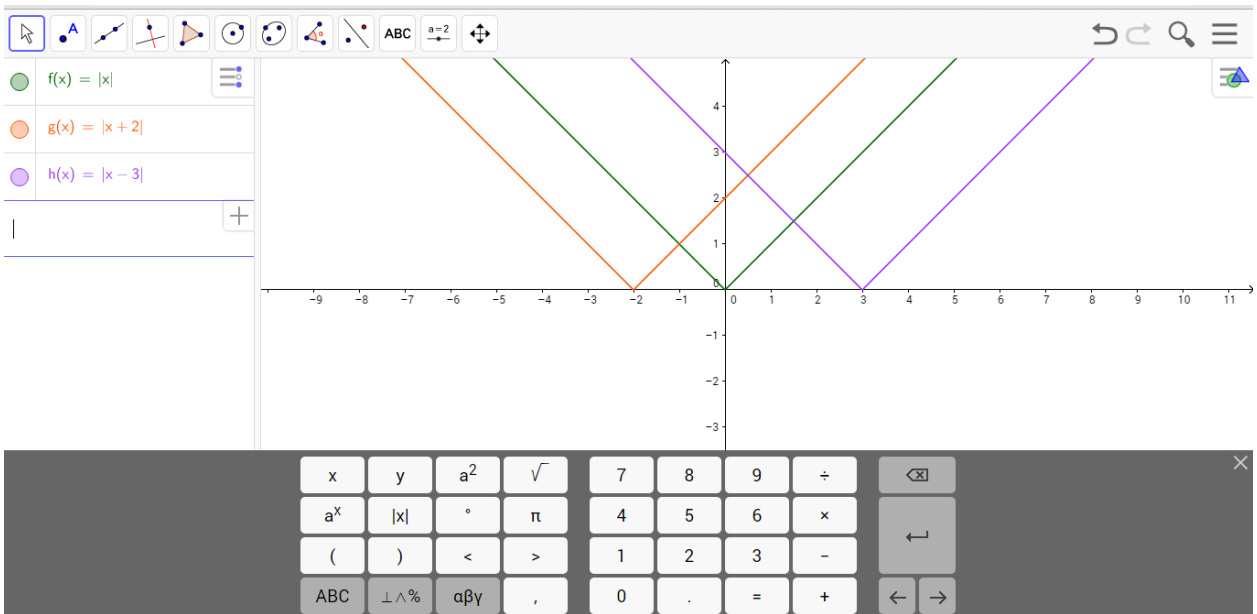
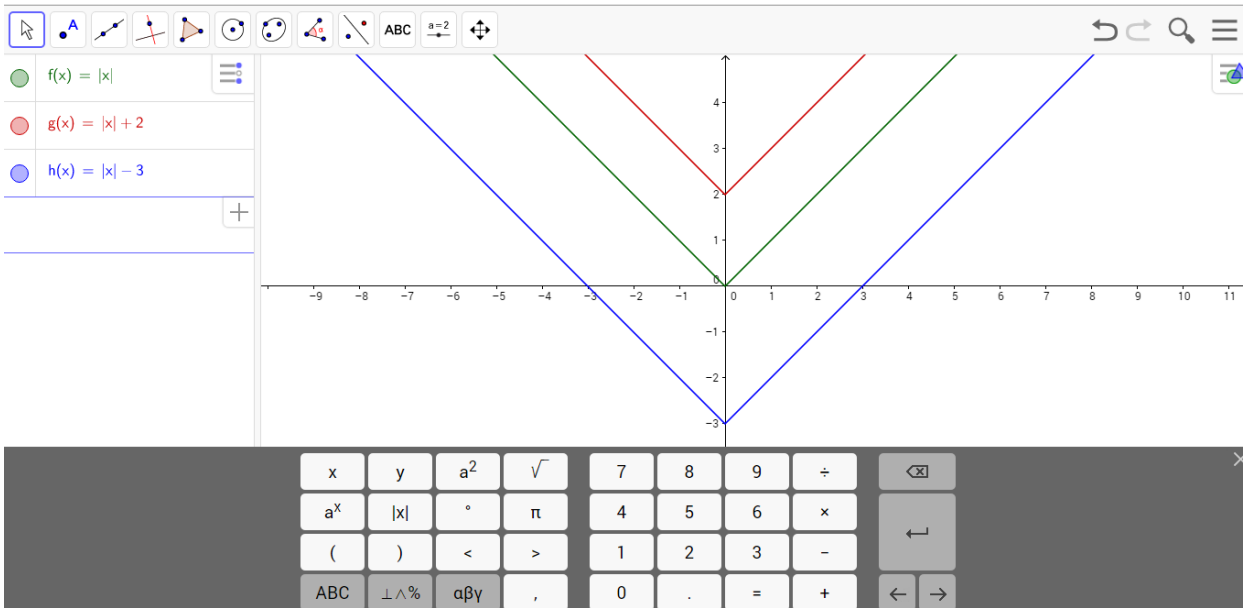
[More GeoGebra downloads](#)
[Partner Portal](#)



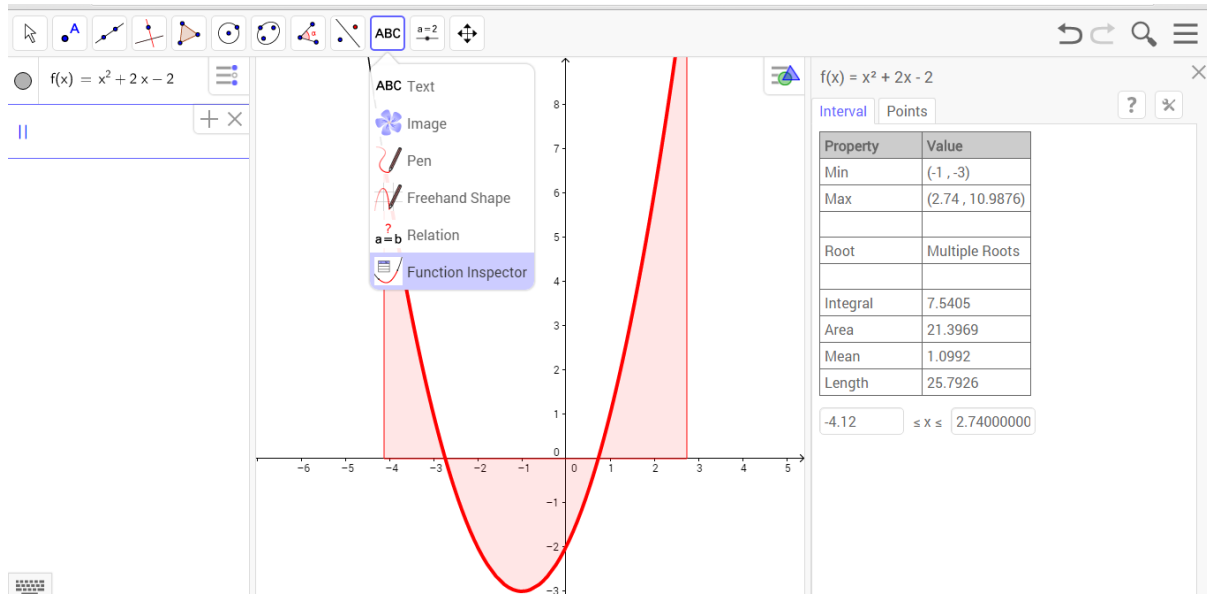
GeoGebra for Phones

[GeoGebra Graphing Calculator for Android Phones Beta](#)

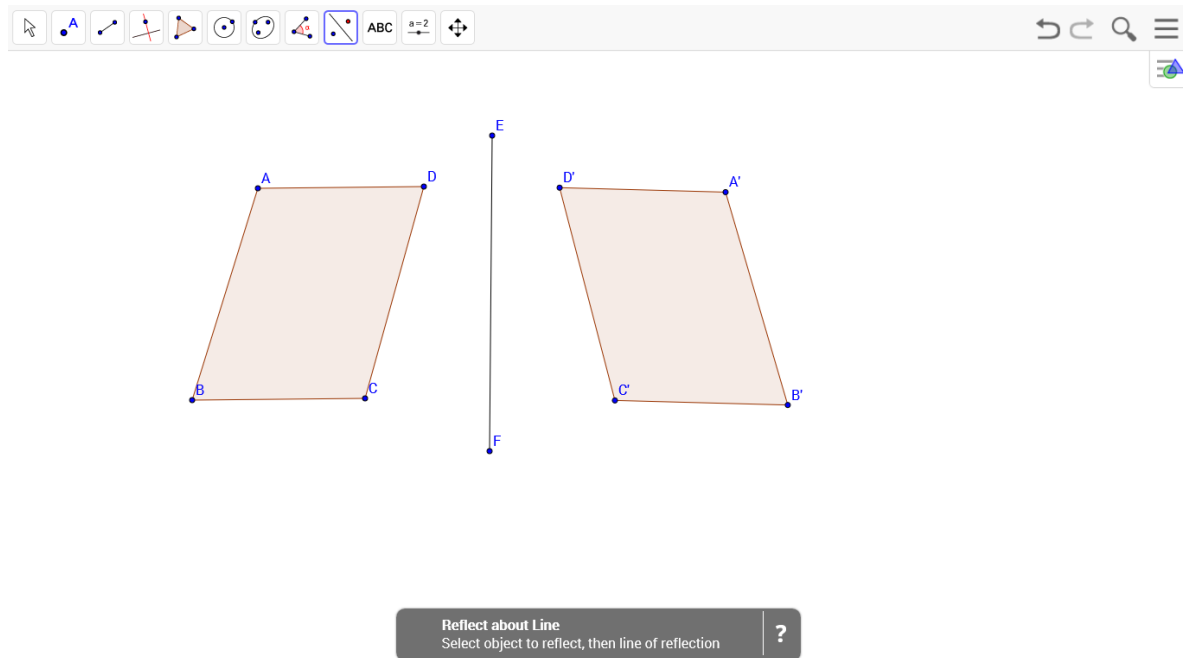
Once you download GeoGebra you can work in an Algebra tab or a Geometry tab. Below shows how this can be used in a lesson involving absolute value functions.



Another property in the algebra tab in GeoGebra is examining the different features of a function.



Finally, this can be used often in the Geometry tab. Below shows how you can reflect an object about a line.



There are many different features to GeoGebra, the more practice a student and teacher has with the features, the better they will understand the software.

Lesson 7: Socrative

Lesson Overview	
Central Focus	<p>Socrative is an app that teachers can use to create assessments online. It also generates nice results for the teachers to export immediately.</p> <p>Furthermore, Socrative implements the use of QR codes. If you print out an assessment for students, they can complete the assessment on paper, scan the QR Code and take them to the Socrative site, they will input their answers and the results and scores get sent directly to the teacher. There is not a lesson provided showing how to implement this technology.</p> <p>Socrative can be used anywhere in the algebra curriculum.</p>

Part 1: Create a Socrative Quiz. Follow the steps below to create a socrative quiz.

Part 2 (if you want to use multiple technologies): Create a QR code and link to quiz created in Socrative. This following website will create a QR Code:

[QR Stuff website](#)



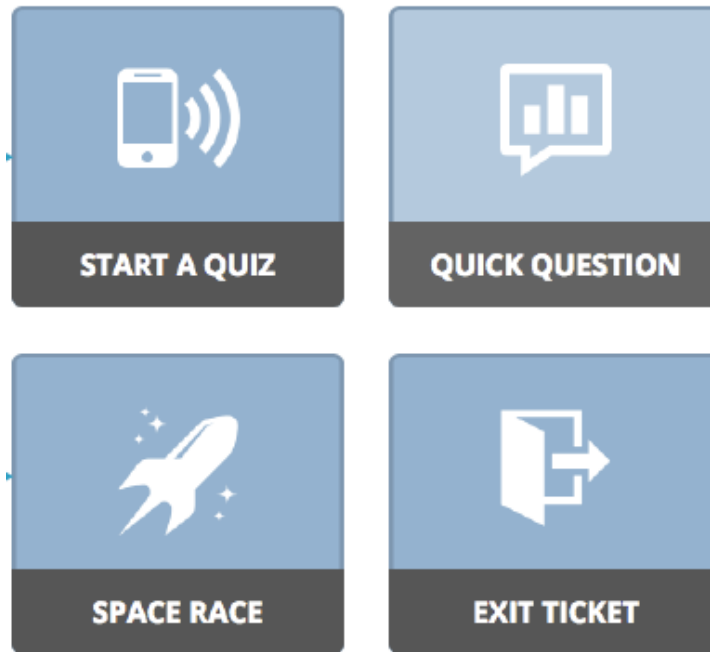
Below lists the differences between the teacher log in and the student log in.

Visit [socrative.com](https://www.socrative.com) or open your Socrative app:

Teachers

Students

Once you are logged in as the teacher on the socrative website, you can generate a quiz, question, space race or exit ticket. Below lists the steps on creating a quiz.



Creating a Quiz

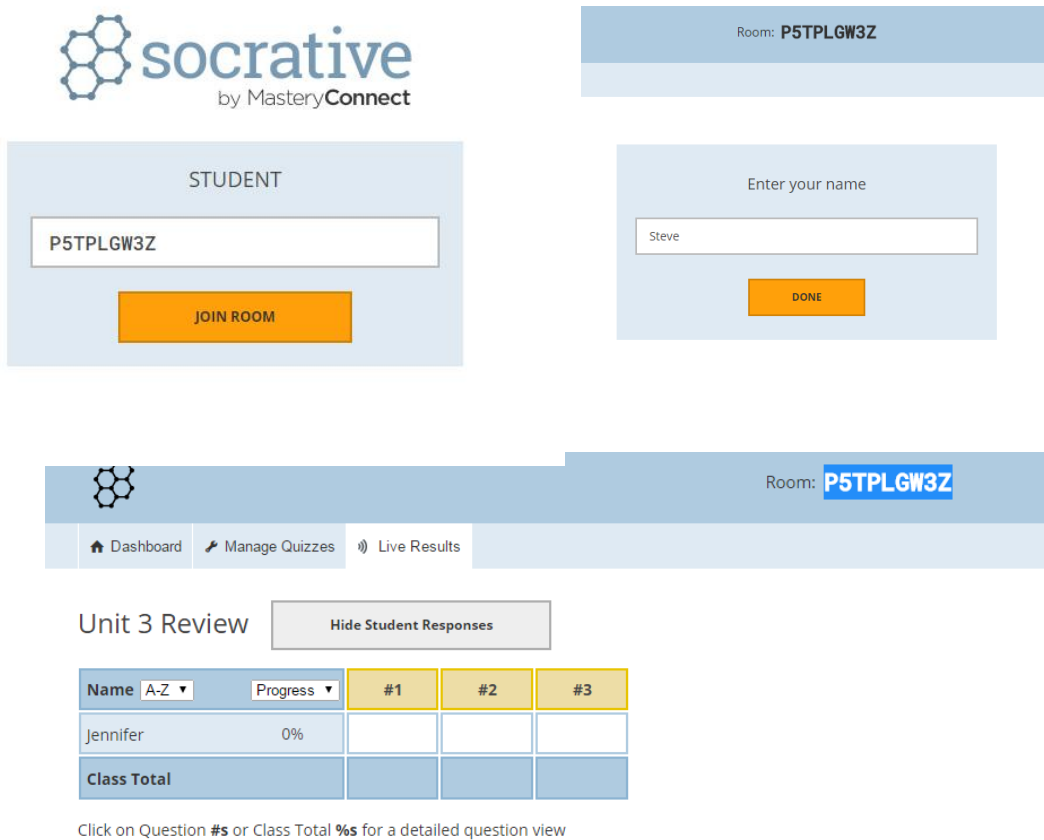
1. Sign up for a teacher account at www.socrative.com
2. Click “Start a Quiz”
3. You will be prompted to choose a question type
4. Fill in your question and answers.
5. Scroll down to add another question
6. Save your quiz

Running a Quiz

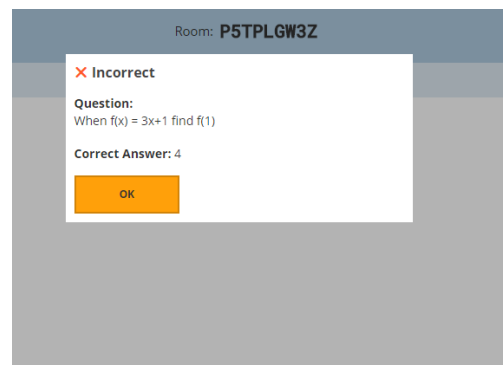
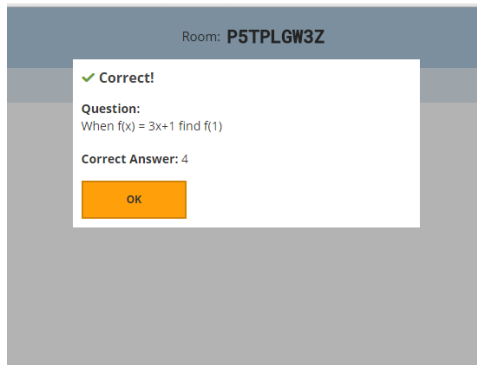
1. Go to t.socrative.com or download the Socrative Teacher App on your tablet/phone
2. From the Control Center, click “Start Quiz”
3. You will be prompted to select “Student paced” or “teacher paced” quiz.
4. When ready, click “send next question to students”

5. Continue previous step until the end of the quiz or until ready to end
6. When quiz is finished, click “end quiz”
7. Download reports from quiz to save into your data records.

The image below is the screen accessible to the teacher. The room number is given at the top of the screen, if you choose not to use QR Codes, students can enter the quiz by entering the given room number into their mobile device or tablet/laptop. The teacher will be able to see who has entered the room and once they respond, teachers will be able to see the response the student has given. The following image below is what the student sees on his or her screen to enter the room, once they enter they will be prompted to enter their name:



Students now can begin the assessment. Below are images of what pops up if a question is correct or incorrect.



As the teacher, when the assessment is done, you can look at the results directly on the screen. You can also export the results into an excel sheet to save for later use (which I have also included below).

Room: **P5TPLGW3Z**

Dashboard Manage Quizzes Live Results

Unit 3 Review Hide Student Responses

Name	Progress	#1	#2	#3
Jennifer	100%	E	C	A
Steve	100%	D, E, A,	C	B
Class Total		50%	100%	50%

Click on Question #s or Class Total %s for a detailed question view

Room: **P5TPLGW3Z**

Dashboard Manage Quizzes Live Results

Unit 3 Review Hide Student Responses

Name	Progress	#1	#2
Jennifer	100%	E	C
Steve	100%	D, E, A,	C
Class Total		50%	100%

Click on Question #s or Class Total %s for a detailed question view

Select an option below to end the activity and save the reports.

- Get Reports
- View Chart
- To Dashboard

Below lists the results from the Unit 3 Review:

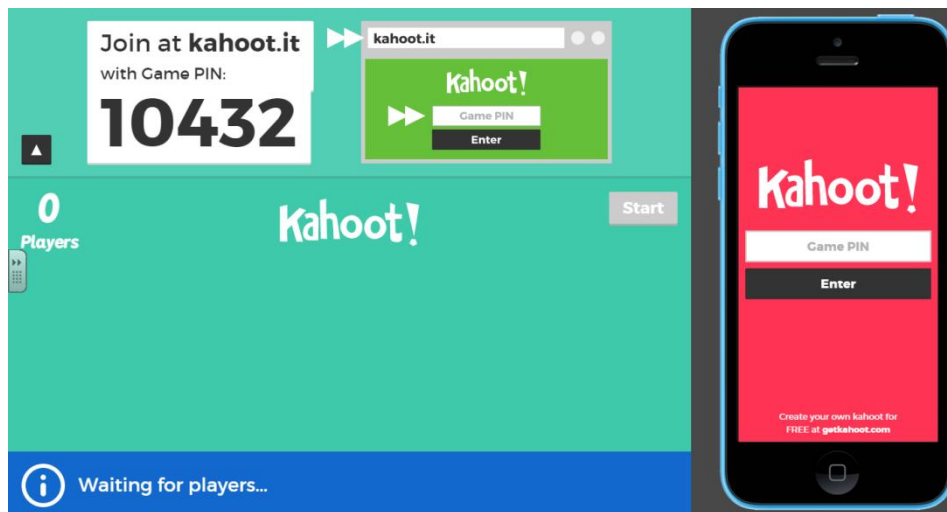
**Unit 3
Review
Common Core
Tags:**

Student Names	Total Score (0 - 100)	Number of correct answers	Favorite Football Team?	What is the absolute value of - 3	When $f(x) = 3x+1$ find $f(1)$
Steve	100	3	I do not watch football, Denver Broncos, Buffalo Bills, New England Patriots, None of the above	3	4
Jennifer	33	1	New England Patriots	3	3
Class Scoring	66.7%	2.00	50.0%	100.0%	50.0%

Lesson 8: Kahoot!

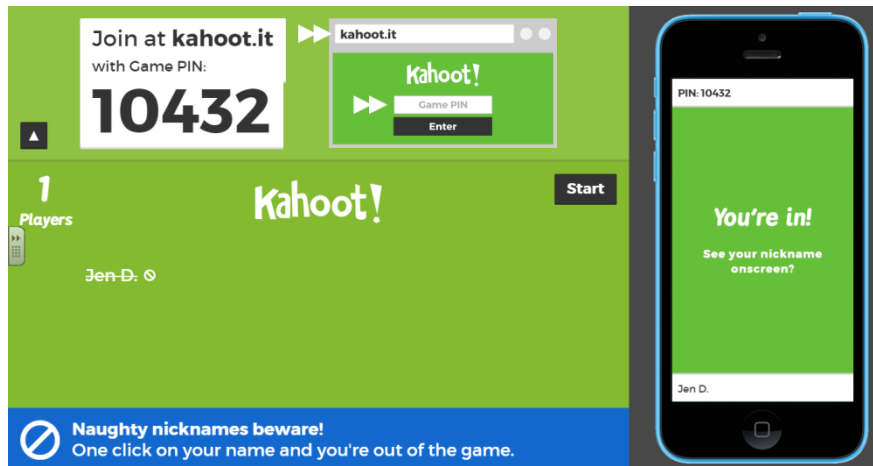
Lesson Overview	
Central Focus	<p>The following tutorial given below was directly from a ninth grade algebra class in the author’s district. The teachers went through this Kahoot! lesson a day before the Unit 3 Exam.</p> <p>As the teacher you will have to make the quiz, survey, or discussion before launching the quiz to the class. You can add one image per question. Once the quiz/survey/discussion is ready to launch follow the steps below.</p>

1. Have students log onto Kahoot.it on their smartphone device, tablet, or laptop. Since not all students have access to a smart phone, renting out the schools laptops for the day will help avoid lack of participation.
2. They will enter the game code given at the top of the page.

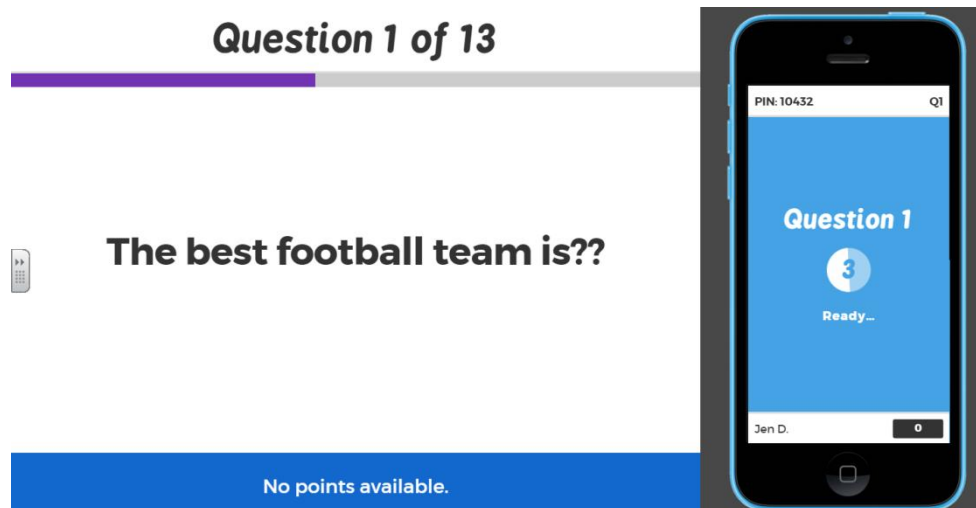


5. Once they enter the game code, they will enter their name. Once they enter, their names will appear on the board. Remind your students to only enter appropriate names, this app will allow the teacher to remove any player if they enter an inappropriate name. Just put your cursor over the name and click, then the student will

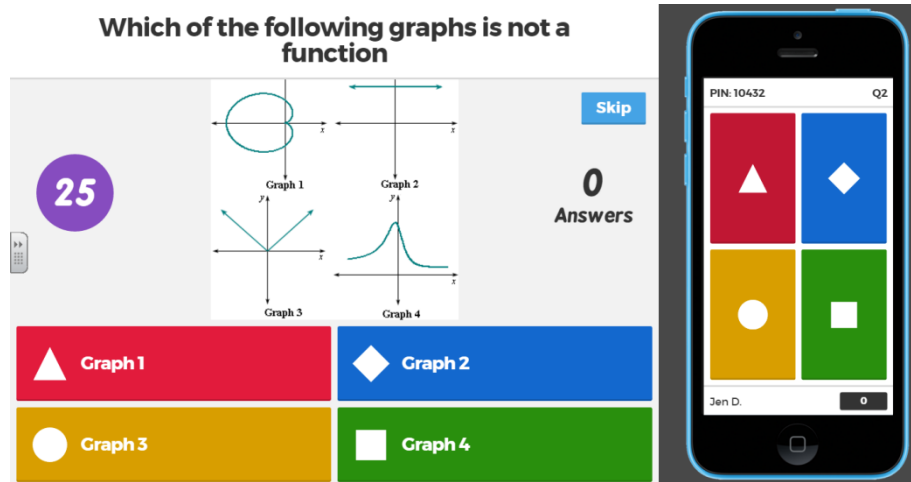
have to go over the process again until they properly follow directions and enter an appropriate name.



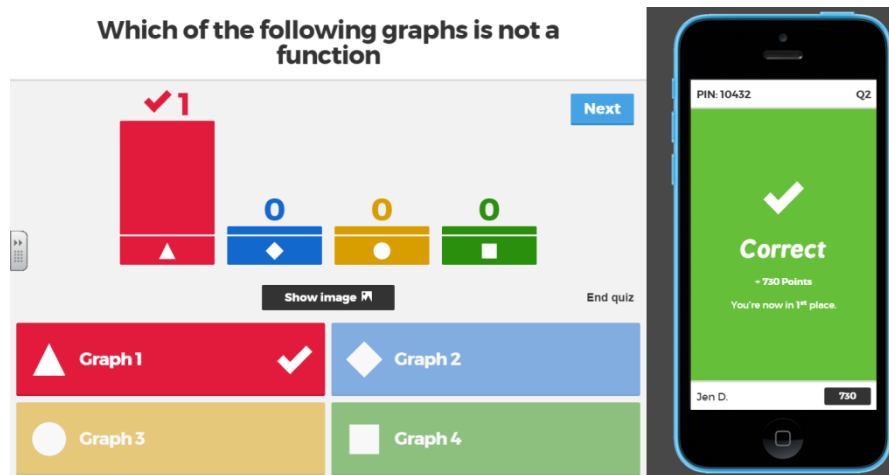
- Below lists some sample questions, they will be prompted the question first before they see the multiple choices answers.



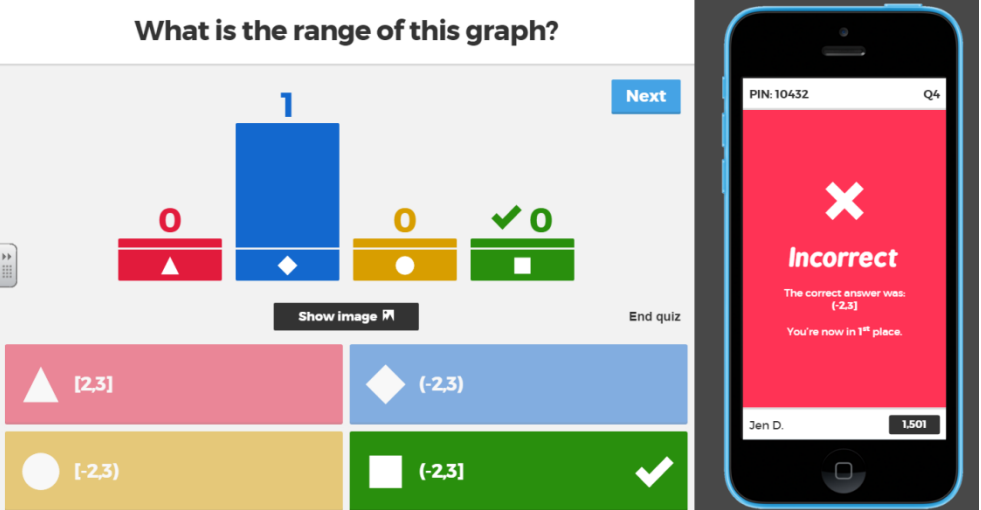
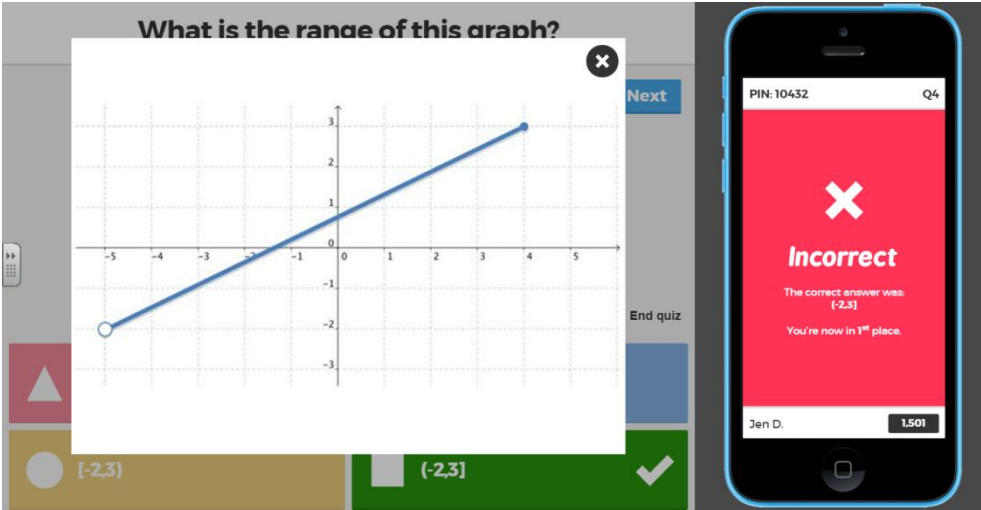
- If there is a graphic, the student will see the graphic after they see the question.
- On the student's mobile device, or laptop, they will only see the four shapes, as shown below. They will not see the question, or the choices. The students will have to choose the multiple choice option based on the front board.



9. If the student is correct, they will see a green screen on their device and also let them know what place they are in.
10. This next part is helpful for the teacher, you can see how many students got the answer correct and how many students got the answer incorrect.



11. If many of your students got the answer incorrect, you can click “show image” and go over the question with them.



Once your assessment is complete you will be able to save the results, this can show you exactly what each student chose as their answer. Below lists results of random names of students. When the Kahoot! lesson is done, you can export into an excel file, as shown below.

Period 2:

STUDENT	C ANS	INC ANS	SCORE	football	not a function	is a function?	range
Katie	8	5	5881	None of the above	Graph 1	{(0,1), (0,2)}	(-2,3]
King.Adian	7	5	5131	None of the above	Graph 1	{(1,1), (1,1)}	[-2,3)
Tyler	7	6	5019	None of the above	Graph 1	{(2,0), (2,6)}	[-2,3)
Lauren	6	6	3863	None of the above	Graph 1		(-2,3]
Gabe.King	6	7	3860	New England Patriots	Graph 1	{(2,0), (2,6)}	(-2,3]
Jada	6	6	3307	New England Patriots	Graph 1	{(1,1), (1,1)}	(-2,3)
Connor	5	8	3246	None of the above	Graph 1	{(2,0), (2,6)}	[2,3]
TJ	5	8	3223	Buffalo Bills	Graph 2	{(1,1), (1,1)}	(-2,3]
ravenwolf	5	8	2620	New England Patriots	Graph 2	{(1,1), (1,1)}	[2,3]
Meghan	4	9	2261	None of the above	Graph 1	{(0,1), (0,2)}	[-2,3)

STUDENT	C ANS	INC ANS	SCORE	football	not a function	is a function?	range
Madison	13	0	9749	None of the above	Graph 1	{(0,1), (1,1)}	(-2,3]
Lauren	11	2	8379	None of the above	Graph 1	{(0,1), (1,1)}	[-2,3)
Collin	11	2	8108	None of the above	Graph 3	{(1,1), (1,1)}	(-2,3]
kayleigh	10	3	7072	None of the above	Graph 1	{(0,1), (1,1)}	(-2,3]
Morgan	8	5	6233	None of the above	Graph 1	{(0,1), (1,1)}	[2,3]
Dylan	8	5	5993	New England Patriots	Graph 1	{(0,1), (0,2)}	(-2,3)

Kobs	8	5	5399	New England Patriots	Graph 1	$\{(0,1), (1,1)\}$	$[-2,3)$
Kyle lanasia	7	6	4996	None of the above	Graph 1	$\{(0,1), (0,2)\}$	$[-2,3)$
Kailyn Koebi	5	8	2428	Buffalo Bills	Graph 1	$\{(0,1), (0,2)\}$	$(-2,3)$
Stephom	4	3	2529	None of the above	Graph 1	$\{(1,1), (1,1)\}$	$(-2,3)$
Katie	4	4	2427	None of the above	Graph 1	$\{(0,1), (1,1)\}$	$(-2,3)$
Cordelia	4	8	2092	None of the above		$\{(0,1), (1,1)\}$	$[2,3]$
Avery	3	9	2098		Graph 4	$\{(1,1), (1,1)\}$	$[-2,3)$
colter	3	10	1551	None of the above	Graph 2	$\{(0,1), (0,2)\}$	$[2,3]$
Lexi	2	11	689	New England Patriots	Graph 3	$\{(2,0), (2,6)\}$	$[-2,3)$
Mel	1	5	705				
Kt	1	2	672				
Melaney	1	4	665			$\{(0,1), (1,1)\}$	$[2,3]$

This is a fun, engaging activity that allows your students to be accessed on material through the use of technology.

Lesson 9: Edmodo/Edmodo Snapshot

Lesson Overview	
Central Focus	This app is a very similar set up as Facebook. As a teacher you can post notes, assignments, reminders to your students, they can see it on their “Wall”. This app is a good way to connect with students and parents. Edmodo Snapshot -This part of the app will tests students’ knowledge of all ELA/Math CCSS.

Getting Started for the Teacher

Go to Edmodo.com and create a teacher account

Once logged in, create a group

For secondary this can be by period

For elementary, this can be by subject

Each group will require the following information

Group name

Grade level

Subject area (ex: Math)

Specific area (ex: Algebra)

When a group is created, a group code will be assigned to it, this code will be used to assign students to that specific group

The code will lock in 14 days, for safety reasons. Once locked, it can be unlocked or reset.

Select code is upper right and using the dropdown select reset code or unlock group

Creating a Snapshot

You can create a snapshot from the main screen, but more features are available if you select the last item with a checkmark on the toolbar on the far right of the screen

1. Select snapshot from toolbar on right
2. Select create new snapshot
3. Select student group (more than one can be selected at a time)

Select subject (Math or ELA)

Select grade level

Select standards—for every standard, 4 questions will be generated

4. Name snapshot, enter a due date, time frame and optional note

When finished, you can preview the snapshot, assign or plan for later. Each student will receive a unique set of questions, similar to the preview. To see list of all assigned or planned assignments, go to schedule in upper right. Select any planned or assigned snapshots and you can assign, edit or delete assignment

To see Results

Select Reports in upper right

You can view 3 areas:

Focus: shows the number of students assessed, along with the number of students who are meeting, borderline or behind

Students: breaks down performance of individual students by each standard and displays their questions and answers

Standards: visualizes how everyone performed on each standard with graphs to illustrate where each student fails

Student Login

Edmodo for Students

Join your classroom in less than 2 minutes

Last Name

Group Code

Username

Email (Optional)

Password

Sign Up For Free

Group code will be the number that is assigned to your group. If the student needs to join more than one group, it will be done once logged in. There may be conflicts of user names so you may want to come up with something unique. You may also want to use the same password for all students, especially elementary

Once account is created, student may join another class

Login

Select Join a Group on left side of home screen

Enter code from teacher

Managing Students

Return to the Edmodo main screen

Select Manage Group

Select specific Group

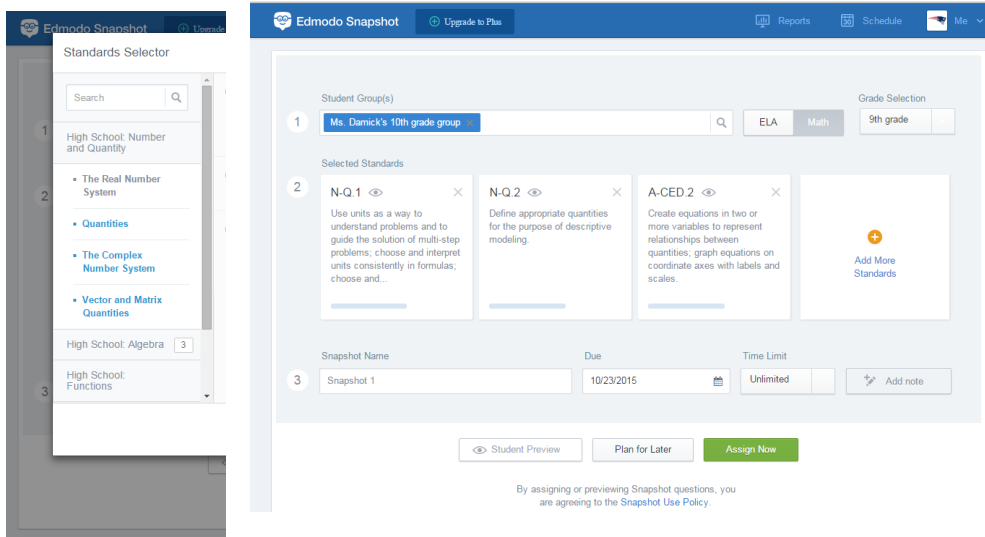
Select Members

Underneath name on left will be the student's user name

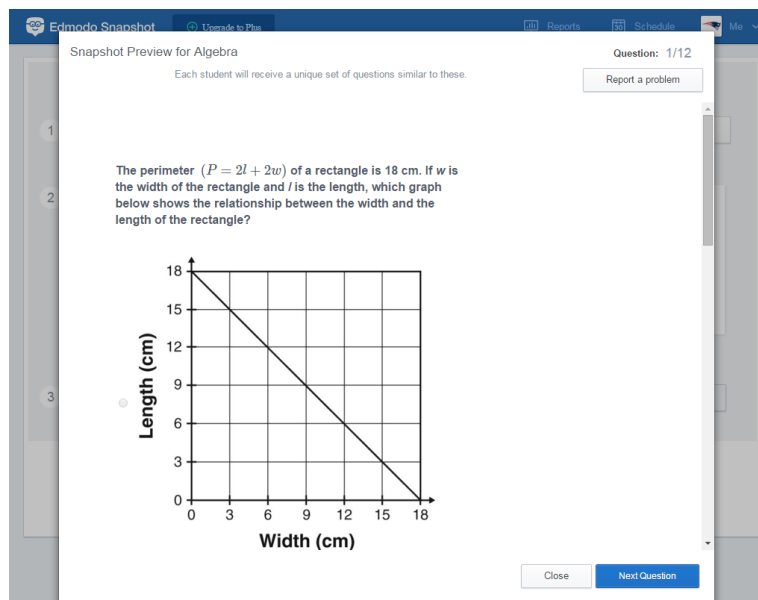
More to the right of name will allow you to change password

Create an Edmodo Snapshot

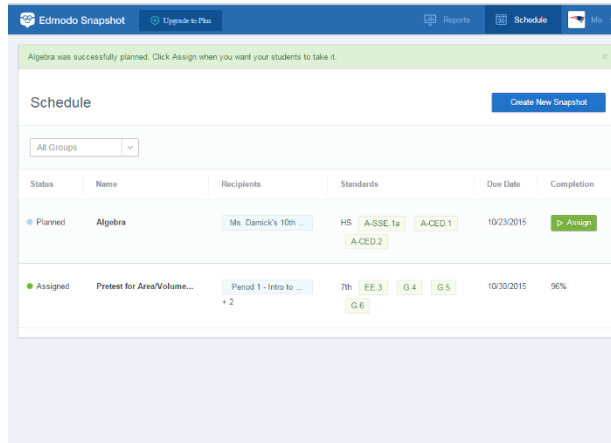
Below shows the screen view of how to make an Edmodo Snapshot. You can assess students based on CCSS. Edmodo will generate four questions based on one standard. Unfortunately, there is no way to delete a question if you do not like it.



Once you are done choosing the standards you want to assess, you can preview the questions (as shown below).

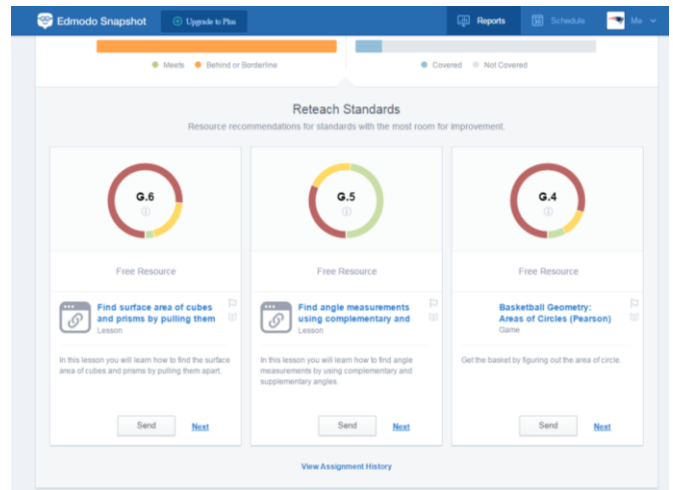
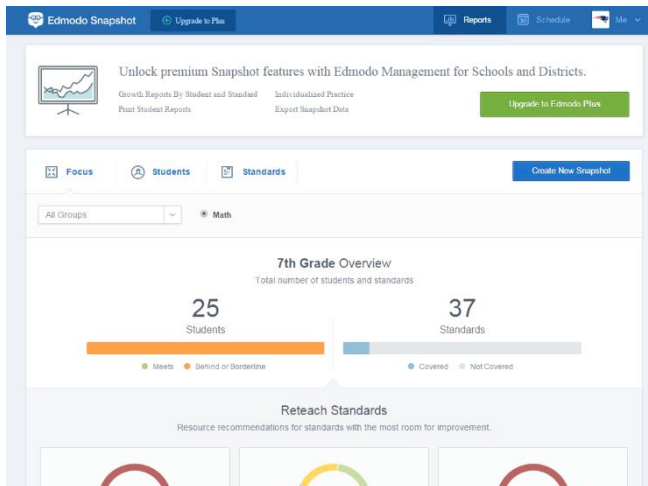


Once you have selected the standards, you can either assign the quiz, then students can view the quiz the next time they are on Edmodo. Another way is to have it planned, so you can assess the students' right in class.



Results from an Intro to Geometry Class:

On the screen “reports,” you can view several different tabs. The tab below shows that we are assessing 7th grade standards. This was a pre-assessment to see what the students remembered from the topic before moving forward on the units. It showed 25 students were assessed and all were behind or borderline. You could also see results based on individual standards. The students did better with G.5 than G.4 and G.6.



The next tab, “Students,” you can see what each individual student selected as an answer. It will also show you by color if they met the standard or are borderline/below the standard.

Answer report for Terry EE.3 Report a problem

An observer reported the probability of an experiment as 0.45. Which fraction is equivalent to this probability?

- $\frac{20}{9}$
- $\frac{9}{20}$ This answer is correct.
- $\frac{9}{200}$
- $\frac{1}{45}$

✓ This answer is correct. Question 1 of 4 Next Question

The radius of the circular placemat below is 8 inches.

Which measurement is closest to the area of the placemat?

- 25 square inches
- 50 square inches
- 201 square inches This answer is correct.
- 804 square inches

✓ This answer is correct. Question 1 of 4 Next Question

Answer report for Terry G.5 Report a problem

When two lines intersect, they form two pairs of vertical angles. If the measure of $\angle 1$ is 53° , what is the measure of $\angle 2$?

- 43°
- 53° This answer is correct.
- 37°
- 127°

✓ This answer is correct. Question 1 of 4 Next Question

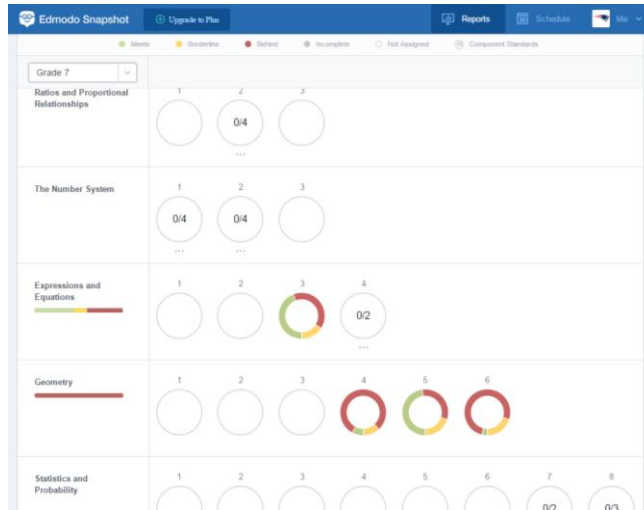
What is the total surface area of the figure in square centimeters?

- 20 This answer was selected.
- 22
- 88 This answer is correct.
- 120

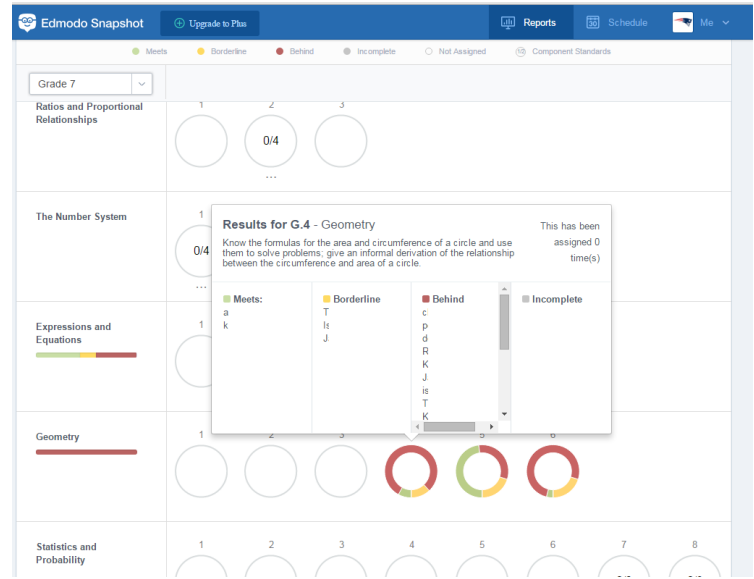
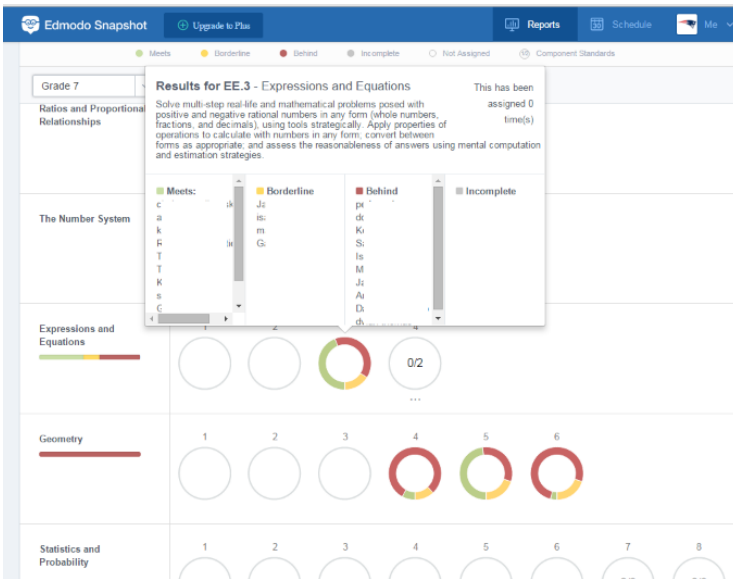
✗ This answer is incorrect. Question 1 of 4 Next Question

Finally, in the “Standards,” tab you can see all the results based on each individual standard.

This is also color coded. Red means below, yellow is borderline, and green is met.



If you put your cursor directly over the standard that is being assessed you can see which students met, are borderline, or are behind. There is also an incomplete column if your students did not answer any of the four questions from the standards.



This is a great resource to pre-assess and post assess on common core state standards in mathematics.

Chapter 4: Validity of Curriculum Project

This curriculum project was submitted for feedback to two different veteran teachers at a rural school district located in upstate New York. The author knows the first teacher from being a teacher assistant in his Algebra I classroom, and is confident in the teacher's abilities; specifically because he (the teacher) currently teaches Algebra I and has implemented several of the following technologies in his classroom. He also wrote a similar thesis involving technology in a geometry classroom. The second teacher is known by the author from being a teacher assistant in his geometry classroom. The author is confident in the teacher's abilities; specifically because he (the teacher) currently implements several technologies into his classroom on a daily basis. The knowledge and experience of both teachers is what validates the author's curriculum.

Teacher #1 Response – Algebra

In my Algebra Common Core class, consisting of ninth graders, we used Kahoot to review for our Unit #3 Test, which covered topics dealing with functions. It was the first time our class was given an opportunity to work with the laptops and use Kahoot to review. The students took a little longer than I had hoped to get their electronic devices signed onto the Kahoot App, but every student was able to navigate the sign in process independently.

During the lesson, students were engaged in the review and they were excited to be playing a math game. The review game brought out the competitive side of the students. Students were using their knowledge of functions and troubleshooting the multiple choice problems to find the best answer. Because the score totals were shown after each round, students put forth their best effort, demonstrating how Kahoot is a great tool to evaluate the students' knowledge. After every student answered the question, Kahoot clearly displayed the

statistics of the students' choices. Displaying this information allows the teacher to review the question and any misconceptions.

One downfall of Kahoot is that it only allows for multiple choice questions to be asked instead of free response questions. I also noticed students trying to answer the questions as quick as possible, because of the point value attached when answering the problems correctly and first. This led to students guessing and made it more of a game and less of a learning experience.

Another piece technology I find useful in an Algebra class is the graphing calculator. Once a student understands how to graph equations without a graphing calculator by creating a table or understanding how to find the slope and y-intercept, I believe a graphing calculator is useful. I think it is extremely important for a student to be able to graph without a graphing calculator first, because it gives the student a deeper understanding of how an equation is graphed. The graphing calculator then becomes a useful tool for solving systems of equations, graphing equations, and determining the solutions for many different types of problems through the use of the table. The graphing calculator makes it easier to graph equations and leaves more time to develop a deeper understanding of the material.

Remind 101 is a useful App to help remind students and parents of the homework assignments and upcoming tests and quizzes. Because many students and parents have a cellphone and check it regularly, Remind 101 allows me to easily able to communicate the homework assignments on a regular basis. This App involves parents in the class and encourages them to support their children with homework completion. Parents can check every night for assignments rather than rely on their children to communicate accurate information.

Technology is a large part of our society today and will continue to play an even more significant role. We, as teachers, have to implement technology into the classroom to prepare our students for the future. The frequent use of technology will provide students with the comfort level, experience, and knowledge that is required of a 21st century learner in the workforce. Technology allows teachers to be more effective and engaging as well as connected with home.

Teacher #2 Response – Geometry

1. **Graphing Calculators:** I have always believed that the use of graphing calculators is extremely important for students to learn and apply mathematical concepts. I believe it's important for students to understand where the numbers and answer come from when they use their calculator. I always teach them by hand or another way in the calculator how or why and answer is derived. Then I give them multiple ways in the calculator or other technologies to get to the answer. Our students will always have many different tools and pieces of technology in the real world so it's very important that our students know how to use them. In addition to Texas Instruments graphing calculators the use of Desmos (www.desmos.com) is a great tool as well. In a way, it's an extension of the standard graphing calculator, with great options that truly illustrate changes in equations and their graphs. These technologies are even easier to access with apps such as Wabbitemu (may not be legal because of copy right infringements but it's still great) and the Desmos app.
2. **QR Codes:** I haven't any experience using QR codes but I have seen the app, Aurasma used in a technology conference. It seemed like a great idea, but all students would need a

device to scan the QR code and not all students have a device or are willing to use them in the classroom.

3. **Plickers:** Plickers is an amazing app and website combination. I use Plickers to assess students prior knowledge, review content, and show Regents questions to prepare throughout the year. Plickers also allows me to collect everyone's answers, show the responses, and then show the correct answer. Each step of the collection and analysis process is different on many different levels. Students can first see how everyone answered without seeing the correct answer. This allows students to question their answer and see why other answers may be correct or incorrect. One aspect of this app/website combination is that it does not allow the teacher to collect data throughout the year for each individual student to track their progress. (Plickers is in its early stages and I believe this will be offered in later versions, possibly in a paid version.)
4. **Poll Everywhere:** I had one experience using Poll Everyone on the first day of school and it was not successful. The reason it wasn't successful was because not all students had a device and some had one but refused to use it. I don't really understand why students would refuse to use their phone in the classroom other than the fact they don't want to participate. The best way to implement this app is to ensure that all students have a device to participate with.
5. **GeoGebra:** This website is amazing! I have used it a lot to create examples and quickly show transformations in my Geometry class. Because I used this in my Geometry class, a Regents class, I was not allotted the time by the state to integrate this into the curriculum. However, I did show my classes how to use it and offer extra credit for different transformations. I am teaching a class called Intro to Geo that does not end in a Regents and

I will have my students use GeoGebra in class on laptops. This will start next week.

Students will create geometric figures and transform them in many different ways. At first directions will be given to them and then students will be asked to recall the directions and create their own transformation designs.

6. **Edmodo:** I have used Edmodo to post daily notes, completed notes, and homework. I also post any reminders for the class. I have also used the Snapshot feature which a teacher picks a standard or standard(s) and students answer four questions from each standard. At the end of the questions I can see how each student and class did for the chosen standards. I did this before a unit where I taught area, volume, and perimeter. I then plan on assigning the same standards and compare the results.

Chapter 5: Discussion, Summary, Reflection

During the implementation of the following technology strategies, the author learned that some technological methods are more useful in student learning than others. The ideas of the veteran teachers helped the author understand that some of these strategies can only be implemented at the beginning or end of the unit plan. With that information, it may not be as beneficial to student learning as the typical lesson plans without the use of technology. For example: The veteran algebra teacher stated: “, I believe a graphing calculator is useful. I think it is extremely important for a student to be able to graph without a graphing calculator first, because it gives the student a deeper understanding of how an equation is graphed.” This is an example that the technology should only be used to deepen conceptual understanding. It should not be used to introduce a concept. The algebra teacher has firsthand experience with implementing Kahoot! for the first time, and he stated that due to it being the first time it took

up time for the students to get acclimated to the technology. The students had a great experience with this app as it was a great review tool to get the students engaged. Once students work with this technology, the time management will work itself out.

The veteran geometry teacher gave the author insight on one of the strategies that may not be useful in a mathematics classroom such as Poll Everywhere. He stated: “I had one experience using Poll Everyone on the first day of school and it was not successful. The reason it wasn't successful was because not all students had a device and some had one but refused to use it... the best way to implement this app is to ensure that all students have a device to participate with.” In secondary mathematics, not every child will have access to an electronic device to utilize the technological strategy of poll everywhere, therefore changes should be made on how to implement this technological method in the classroom. If available, teachers should access the districts tablets or laptops to implement this technology to assure all students can participate.

What all educators should learn from the use of technology is to not get tied down to the software mechanisms moreover, to use technology as a tool to become a better educator. With the changes in society and the amount of technology assessable to students, teachers must be able to adapt to change with their teaching. With doing so, it will improve the teaching of mathematics by allowing students to become more engaged through strategies that interest the adolescent youth.

Implementing technology allows students to learn on their own and to deepen their understanding of content. Students will become more engaged in their learning and achievement will improve. In order for technology to deepen student learning, teachers need to learn how to use the technological strategies. Doing so will allow teachers to effectively

implement technology into their lesson plans. The connection between technology and achievement implies that educators should adapt instruction to incorporate computer-based, electronic technologies within the context of the academic subject areas. Niess (2005) discussed the importance of teaching mathematics and science and noted that regardless of how teachers first learned the specific content, they can teach the content in a different way than how it was learned. Furthermore, learning content through the use of technology is different from learning to teach that content with the use of technology (Niess, 2005, p 509). When the implementation is done correctly, students will find the software helpful and easy to use. Technology can help educators become more effective teachers and also allow students to modernized their learning experience.

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Appendix

Other Resources:

Remind101	Remind101 is a texting service that teachers can use to reach their students and parents. Teachers can use remind101 to send reminders of homework and exams to students. Parents can also sign up to receive the text messages.
Wabbitemu	This is a calculator resource for students who have an android phone. Students can download this free app and the TI-84 calculator will be directly on their phone, with all the features in its entirety. This app can also be found on a windows computer in case a student does not have a graphing calculator at home but has a windows computer.
GrafNCalc83	This is a calculator resource for iPhone users. Though this app costs \$5.99 currently, the TI-83 calculator will be directly on your iPhone.
Quick Key	Teacher scans students' custom scantron with device. The Data is exported to website. Initially you receive four different quizzes scanned is free, \$2.50 monthly for a whole year plan.
Class Dojo	This is a Classroom management app. Students are assigned a character on the board where they are awarded positive/negative points depending on behavior (or other criteria set by teacher).
Knowmia	Technology application for teacher improvement: Records lessons with device and also shows videos created by other teachers. The Pro version \$9.99, can export videos to YouTube to be viewed by students.