Using Classic Literature in a Problem Solving, Project Based Unit on Linear Functions

Lani Napoli

California State University, Fullerton

M. S. Secondary Education

Foundation Level Mathematics

Spring 2014

The Curriclum Project of Lani Napoli is approved.

_____

Miguel Zavala, Committee Chair
Department of Secondary Education

_____

Chris Street
Department of Secondary Education

CALIFORNIA STATE UNIVERSITY, FULLERTON

2014

Table of Contents

Abstract

Mathematics is a required course in school that is seen as problematic for many. All students are capable of learning math but motivation and self-efficacy are hurdles that get in the way of success because of prior experience and preconceived notions about fixed mathematical abilities. Learning experiences need to shift from traditional direct instruction to real world collaborative mathematical problem solving situations.

The implementation of Common Core creates an opportunity to try new strategies and lessons in the classroom that will allow students to collaborate and communicate their critical thinking skills and use creativity to find solutions to given problems. Reading is especially important in all subjects because it provides an avenue for information input, but it is important to realize the unique literacy strategies in each discipline. Math requires deliberate reading with active engagement while using physical objects to see the relationships presented in words.

This curriculum project seeks to provide a bridge between mathematics and the real world by using classic literature to provide a project based, problem solving unit on linear functions. Students will be able to make connections with the characters in the novel, ***The Wonderful Wizard of Oz****, which will then provide motivation for solving the problems faced by Dorothy and her friends as they attempt to build the yellow brick road. This unit is designed for a middle school mathematics class and focusses on the relationships between function tables, graphs, equations and physical representations. The goal of the project is to provide necessary resources using functions to convince The Great Oz to hire a firm to build the yellow brick road. Group work will provide collaboration and an understanding of the importance of diversity while stressing the value of individual members and their strengths and weaknesses. Students will connect with the characters in the book as they seek to realize the knowledge that they*

already possessed. "You've always had the power, my dear; you just had to learn it for yourself". (Glinda, the Good Witch)

Introduction

A typical day in my middle school math teacher instructs 5 different groups of students each day. Some of the students come to class eager and ready to learn while others enter with the preconceived notion that their goal is to survive the next 45 minutes without having to participate in the dreaded subject of math for which they already believe they are failures. They are part of the group of people that will proclaim, without shame, that they are not "math brained" and will never really get it, but "it's okay", because they know many other people who proudly proclaim that they never used algebra in their lives so it is acceptable to not learn mathematics above the simple procedures of addition, subtraction, multiplication and division.

Unfortunately, many of these students are unable to realize that math is a beautiful area of study that is applicable and evident in every aspect of life. It is an exciting world of patterns, theories and relationships yet to be explored. The unfortunate circumstance is that many don't see or realize this beauty because they don't believe that they can ever understand math. The goal of this curriculum project is to create a mathematics unit with interesting and relevant problems that will motivate and instill confidence in students so that they will believe they can successfully "do math". The objective of this middle school function unit is to help all students realize their potential to learn, investigate, accept challenges and do mathematics. The introduction of Common Core State Standards for the 2014-2015 school year provides a component of "The Four C's" of the Common Core State Standards that promises to prepare students for 21st Century college and career skills. These "The Four C's of Common Core provide a mechanism of collaboration, communication, creativity and critical thinking that blends nicely with the idea of blending the fascination of math with the love of classic literature.

Because math is seen as "hard" for many and only easy for those with "math brains", students (and parents) accept that they may not be as successful as they could be if they only believed. Glinda says it perfectly in *The Wizard of Oz*, "You've always had the power, my dear, you just had to learn it for yourself" (Baum, 1900, Ch. 23). Today's students are very capable of learning the concepts and procedures of middle school math; they just need to realize their potential for learning. Motivation and self-efficacy are hurdles that students face when coming to math because of prior experiences in earlier math classes. Using classic literature in a project based unit will allow students to realize the impact that mathematics has in real life as viewed through the characters eyes. Classic literature can be an effective tool in opening doors to interdisciplinary studies that will allow students to make connections between core subjects (Beaton, 2006). Math is everywhere! Some students that feel inadequate in math may find that they can make connections with the characters in a given novel and find more enjoyment in the class as a result. Classwork and independent work will be centered on the novel, with real life problems written from the literature so that students can relate to the characters and their situations. Reading will become an important component of this unit as students learn about the situations of the characters and collaborate to strategize and solve the given problems.

Research will show that all students can learn to do math by changing their mindset to a growth mindset that will then increase their self-efficacy and motivation for learning more about math. Using the four C's of Common core (communication, collaboration, creativity and critical thinking), problem solving project based lessons will tap into the disciplinary literacy theories in math while exploring the relevancy of the Classic Book, *The Wonderful Wizard of Oz*, in the study of mathematical principals. Students will make connections with math as they participate

in a project based learning unit incorporating "real world" problems from *The Wonderful Wizard of Oz* in a thematic unit on functions for an 8th Grade Common Core math class.

Rationale and Problem Identification:

Mathematics will begin implementing the Common Core State Standards with the 2014-2015 school year. These standards provide a set of mathematical content standards that detail what a student should be capable of doing within each grade level. In addition to the content standards are set of 8 practice standards that focus on the "processes and proficiencies" that students should possess while practicing math (CCSS, 2010). While developing the Common Core State Standards, the NEA published a report that outlined the "Four C's" necessary in education to prepare students for College and Career readiness. These four C's: communication, collaboration, critical thinking and creativity provide a framework for how students should be prepared for the future (NEA, 2010). Tomorrow's jobs will require individuals to be able to read to learn and to use their knowledge to think critically, communicate, collaborate and be creative in coming up with solutions to real life problems. Reading is a necessary skill and should be used in all core classes to encourage academic growth.

Students need to be able to read literature in all subject areas. Disciplinary literacy is described as an educational approach to reading that provides guidelines for the way students read specifically in the different disciplines. Disciplinary literacy is different from content area reading. While content area reading provides generic strategies for students to comprehend and remember text across subject areas, disciplinary literacy focusses on the unique ways student should use literature and how they can read to learn appropriately within each academic discipline. Students should focus on the knowledge and abilities of the authors in literature and how they create and communicate their ideas (Shanahan and Shanahan 2012). The goal of

disciplinary literacy is to work towards programs that will enable students to understand the literacy needs within each academic discipline so that they can provide evidence of learning through communication, critical thinking, collaboration and creativity. Students need to be able to respond appropriately and communicate effectively using information that can be realistically cited using real life evidence.

Literacy in mathematics presents special challenges. While general reading strategies such as previewing, making predictions, re-reading and summarizing are used for remembering other types of text, they do not deepen the conceptual understanding required in a mathematics classroom. The function of reading for math involves using the sections of the text to gather information for understanding. Students must pay special attention to bold print, definitions, examples, graphs and diagrams. They should read slowly and use tools (calculators and pencil and paper) to practice concepts they learn about them (Carnegie, 2010).

Real life presents real problems. Today's students will not be required to do handouts with sets of mathematical exercises when they grow up. They will, however, enter jobs and participate in real life situations that lack clear direction and have more than one solution. It is accepted that students are challenged when reading and comprehending word problems in math. Many people feel that there are "math" people and "non-math people. Dweck refers to this condition as a fixed mindset in relation to mathematical abilities. These types of students believe that effort has no bearing on the ability to learn and perform (Dweck, 2006). Mathematics is a language and a form of communication. The use of fictional literature in elementary school will help students make connections between math and the real world (Carnegie, 2010). Many students enter middle school with the direct-translation strategy for solving word problems. They read certain words, assign numbers and operations to these words and then perform

procedures to solve the problem. They have no real context of what the problem entails and have trouble forming mental images of the problem at hand. Understanding of the problem is nonexistent which results in solutions that don't make sense. This can be the result of poor reading comprehension skills and poor technical reading skills which leads young students to feel inadequate in their mathematical abilities as they enter middle school. Anxiety then becomes an issue for many students as they progress to higher levels of math (Kyttala and Bjorn, 2012).

Anxiety in the middle school years leads to decreased motivation and confidence. Preconceived notions of fixed abilities to understand mathematics can get in the way of learning. Classes need to be structured in a way to instill confidence through strategy building lessons that are relevant and interesting to students. Lesson need to address procedures and strategies to change the mindset of students to that of a growth mindset that promotes effort as the predictor of success (Dweck, 2006). Technical reading skills in mathematics literature in needs to be emphasized but can be complemented with pleasure reading to increase interest and promote connections between mathematics and the real world. Using classic literature to provide problem solving situations in math can be an effective way to incorporate reading, Connections can be made between technical mathematics books and pleasure reading, after all, "Math is everywhere".

This curriculum project will provide an opportunity for students to study literature and math in a project based environment with real life (fictional) problems using the classic novel, *The Wonderful Wizard of Oz*. Students will become the guide of their own learning as they discover the use of functions in creating the yellow brick road that Dorothy and her friends must travel down as they progress towards the Land of Oz.

Literature Review

Self-Efficacy:

Middle school is a challenging time for many students. Their day now includes multiple classes, multiple teachers and multiple homework assignments. Students are placed in achievement oriented level math classes instead of by grade level. The result is that students in the more advanced math classes feel smart while students in the lower math classes feel dumb. Algebra is not recommended until students have a strong foundation in the basics of math. The Common Core Standards suggest Algebra in 9th grade. Eighth grade is one last chance for students to increase their knowledge and understanding of math before they move on to high school. Many of these students don't believe they will ever "get" math and give up before they even enter the class. How can we increase their self-belief? How can we encourage them to keep trying and to realize they do have untapped potential? How can we get them to see that, "they have always had the power, they just had to learn it for themselves". (Glinda, the good witch)

Confidence is one the behavioral characteristics of successful math students. Students that demonstrate confidence show increased motivation and behavior in math, while insecure math students give up and believer they will never succeed. Attitudes, behaviors, thoughts and emotions towards the subject of math are very different for confident or insecure students. Research shows that confident students place more interest in the tasks necessary for learning and thus spend more time (perseverance) towards mastery. Students with high self-esteem are generally better behaved, set goals, use strategies and create tasks in their daily academic workload. These beliefs provide control over individual emotions and behaviors students participate in learning and can be categorized as self-concept and self-efficacy. Self-concept refers to how an individual compares himself to others and can lead towards inhibitions while

attempting challenging work. Students may worry that they will not be successful and may not be perceived as smart if they fail. Self-efficacy is an individual's perception of their personal ability to organize thoughts and information which can result in a desired outcome. Failure is seen as an opportunity to learn and overcome challenges (Bong, 2012).

Believe and you can achieve. We've all heard quotes and inspirational speeches regarding putting your mind to work for you. This idea is commonly referred to as a mindset. Mindset is generally seen as set of assumptions, beliefs, ideas and processes that provide incentive for individuals or groups of people to continue their behaviors, strategies and choices. Some would call it a philosophy (Wikipedia, 2014). Carol Dweck has studied the idea of mindset over the years and its effect on academic achievement and success. She developed the idea of two mindsets. A fixed mindset says that you have a fixed intelligence. In the math world, we call these "math people" or "non-math" people. People are born with a set ability to do math or they are not. Abilities will not change no matter what one does. This mindset is problematic because people have a predisposition to want to maintain their "smartness" and will avoid situations that might cause them to fail for fear of not looking smart to others. This is similar to the self-concept theory. The growth mindset is a belief that you are born with a set of abilities that can be improved and change with effort. Challenge is an opportunity to learn and these individuals are intrinsically motivated to persevere through problem situations. This parallels the idea of self-efficacy (Dweck, 2006).

Mindset is seen in all levels of academia. As students begin to choose their academic paths through high school and into college, they tend to avoid courses that prove to be especially challenging. They focus on their strengths, accept their weaknesses and often give up on their first choice of study because of their fixed mindset beliefs. They fail to realize that perseverance

is necessary to succeed in challenging situations and worry about failing instead. Many of these ideas are supported by college professors. The fixed mindset mentality takes over (Rattan, 2012). It is necessary to encourage students to believe that they can change their mindset. Resilience is an idea that promotes change in the mindsets of students in school settings. Resilience can be defined as "any behavioral, attributional, or emotional response to an academic or social challenge" that promotes positive learning experiences (Yeager and Dweck, 2012, p. 303-304). Increasing effort, seeking new strategies, changing attitudes and beliefs about effort, and conflict solving behaviors are taught to students to help them realize the ability to change their mindset and thus increase their achievement in school settings. This changed mindset (resilience) provides students an ability to "stretch" their brains and realize that intellectual ability can increase over time with effort, strategies and help from others (Yeager and Dweck, 2012).

Motivation

Teaching students in middle school is challenging. Research demonstrates that student attitudes about math frequently decrease during the middle school years. As a result, math achievement suffers and students begin to doubt their math ability. While prior academic achievement is expected to provide higher self-efficacy beliefs, these beliefs will not provide enough motivational strength for students during middle school if the focus is not on the value students place on their engagement in mathematics. We need to ensure that students continue to believe that math is important, interesting and enjoyable. Curriculum and programs should be created that provide quality engagement, motivation, interest and perseverance (Pajares and Graham, 1999).

Motivation can be described as the "intensity, direction and duration" of behavior (Ames, 1990, p. 211). A motivated student in math wants to work hard, has a positive attitude and is willing to spend time working through math skills and concepts. They are initiators, committed and persistent throughout the learning process. Orientation towards learning is important. Mastery orientation refers to students who are interested in learning new things and developing skills and abilities. Performance orientation is the ability to complete necessary goals correctly on assessments (Ames, 1990). While the outcome is generally considered to be the most important aspect of learning, what is defined as an outcome is confusing. Is the outcome achievement, or is the outcome learning? What is success? Why is the student motivated?

Students need to be provided clear guidance in the learning process in order to ensure continued motivation through the secondary level of education. Pre-determined mindsets or orientations may hinder the learning process and decrease self-efficacy. It is important to stress the ability to succeed with individual hard work and goal setting strategies directed towards learning instead of performance. Outcome should be a result of student work and effort (Ames, 1990). As students orient their goals towards learning, the focus will change towards understanding schoolwork, improving competence and striving for individual betterment (intrinsic motivation) rather than social comparison. Collaboration is valuable in classrooms where students are motivated to learn regardless of prior ability. Low achieving students improve their learning capacity and begin to create goals towards a better understanding of curriculum when paired with higher achieving students. They begin to "own" the process of learning (Gabriele, 2007).

Motivation is a determining factor in academic success. Strategies need to be taught to all students to so that they can set goals, increase time spent on understanding, work collaboratively

with others and demonstrate perseverance in challenging situations. Positive learning environments and real world problem solving strategies need to be modeled so that students will find math interesting, important and enjoyable.

Doing Math

In traditional math classrooms, students are expected to sit quietly while the teacher gives instruction on the correct skills and procedures for completing a given lesson. After a few practice problems, with guidance from the teacher, they are expected to follow these procedures and steps while they perform their newfound math ability independently. Research shows that students need to be engaged throughout the entire lesson and need to actively participate in order to really understand the concepts of math. Instead of rote memorization and procedure mimicking, they need to have time to discuss ideas, investigate concepts and learn from failed attempts in real problem solving experiences. In order to become mathematicians, students need to be able to "play math" by actually "doing math". Students need to participate in discourse about their understanding of investigations and discoveries of mathematical patterns and properties in a project oriented approach as they are presented in the classroom. This project oriented approach needs to include time to plan, choose strategies, explore ideas, "debug" these ideas, discuss and creatively approach individual ideas about the properties and concepts of math (Papert, 1972).

Active engagement in cooperative learning activities that are interspersed with lectures provide increased focus and interest for students of all ages. Using the idea that active learning would benefit from authentic and real life knowledge, a group of students were given an opportunity to participate in a classroom environment that blended traditional lecture time with active engagement and discourse. Students in this study found that they were able to stay more

focused and interested with the blend of lecture and active engagement. They expressed satisfaction with this style of learning and felt that they were more motivated to prepare for class. It was important for them to remain focused and attentive so that they could participate in the activities and reflective thinking components of the lecture (Cavanaugh, 2011).

Disciplinary Literacy

Instructional strategies are taught to new teachers and reinforced to experienced teachers through professional development programs. Content area literacy emphasizes teaching general reading strategies to help students develop study skills across all content areas to use within each subject matter. Students are given instruction in pre-reading activities to help them activate prior knowledge and induce questions about what they are about to read. They are encouraged to continue a questioning attitude throughout the reading activity. Post reading activities such as classifying, categorizing, comparing and contrasting information helps students reinforce knowledge gathered from the readings. While all of these strategies are excellent in helping students realize what they have read and how to remember important concepts, this type of literacy does not address the importance of reading within the different disciplines.

Because it is important to realize that reading within different disciplines requires different skills, the concept of disciplinary literacy is an area of research worth discussing in the creation of this curriculum project. While content area literacy focusses on general strategies to remember and comprehend text better, disciplinary literacy focuses on the idea that each academic discipline requires certain background knowledge about how to read text within the discipline in order to read like an expert in the field (Carnegie, 2010). In order to help our students become better at acquiring knowledge within each discipline, it is important to study how the experts in the field read and write about the information presented (Shanahan and

Shanahan, 2012). Each academic disciplinary subject requires different strategies and knowledge. It is important to acknowledge the necessities of each area while planning for instruction.

Mathematics requires a very different way of reading. Each word in mathematics is deliberately written with specific meaning. Symbolic notation is provided to express quantities, functions and operations. Students need to read slowly in order to understand the ideas expressed within each sentence before they move on to the next sentence. While reading mathematics texts, students should be aware of the definitions of each word they read and how these words relate to the concept being presented. Understanding and verifying theorems and proofs within examples provided is an important element in the knowledge acquisition for math. While reading, it is highly recommended that students have a paper and pencil readily available so that they may test and apply their knowledge to that which they are learning about (Carnegie, 2010). In his literature review on disciplinary literature, Hillman summarized this by saying, "Reading in mathematics has fewer words but each word is extremely important" (Hillman, 2014, p. 401).

As a teacher, our role is to help students realize their potential in reading math and to help them change the way they read while studying mathematical concepts. We need to understand the way that students gain mastery of the literacy component of learning. Collins describes a Cognitive Apprenticeship model which implies that mastery of literacy is like the journey from being a novice to an expert. This model emphasizes situated learning, modeling, coaching, reflection, articulation and exploration as the student begins with very little knowledge and eventually acquires expert knowledge within the field (Collins, 1989).

Collins Model of Cognitive Apprenticeship	
Type	Benefits
Situated Learning: Learning knowledge and skills in contexts that reflect the way the knowledge will be useful in real life.	a. Students learn conditions for applying knowledge. b. Students foster invention. c. Students see the implications of the knowledge. d. Context structures knowledge appropriate to its uses.
Modeling and Explaining: 1. Modelling of processes in the world. 2. Modelling of expert performance	a. Seeing expert solutions to problems set by the student. b. Integrating what happens and why it happens. c. Making visible parts of a process not normally seen.
Coaching: Patiently observe students as they try to carry out tasks, providing hints or assistance as needed.	a. Provides help directed at real difficulties b. Provides help at critical times c. Provides as much help as is needed to accomplish tasks. d. Provides new eyeglasses for the student.
Reflection on Performance: Looking back over what they did an analyzing their performance.	a. What the student did becomes an object of study b. Students can compare their performance to others'. c. Abstractions about the process can be used for characterizing strategies. d. Spatial reification permits comparison of multiple performances to form abstractions.
Articulation: Methods for forcing students to explain and think about what they are doing.	a. Making tacit knowledge explicit b. Making knowledge more available to be recruited in other tasks. c. Comparing strategies across contexts. d. Articulation for other students promotes insight into alternative perspectives.
Exploration: Pushing students to try out different hypotheses, methods and strategies to see their effects.	a. Learning how to set achievable goals. b. Learning how to form and test hypotheses. c. Students will make discoveries on their own.

In discussing literacy, Kaiser and Willander (2005) explained that literacy is composed of the following five levels: illiteracy, nominal literacy, functional literacy, conceptual and procedural literacy and finally, multidimensional literacy.

Levels of literacy: Kaiser and Willander	
Level	Description
Illiteracy	Inability to cope with information regarded as culturally relevant. An ignorance of basic mathematical concepts and methods.
Nominal literacy	A minimal understanding of terms, questions or topics as part of mathematics for the individuals age and stage.
Functional literacy	Mathematical standard methods can be applied for solving simple problems. Individuals can use scientific and technologic vocabulary but it is often confined to a particular activity or need.
Conceptual or procedural literacy	An understanding of the use of central mathematical concepts and methods in the context of mathematical investigations. Involves some understanding of the structure and function of central mathematical ideas and patterns.
Multidimensional literacy	A contextual understanding of mathematics as it incorporates philosophical, historical and social dimensions. The learner makes connections within mathematics and between mathematics and larger social problems as aspirations.

In comparing the Cognitive Apprenticeship Model and the Levels of Literacy, one can see that that both of these models seek to provide guidance towards mastery of literacy for students. Mathematically, we seek to work as a coach for our students as we guide them through the levels of learning, understanding, knowing and eventually being able to have intelligent discourse about mathematics. Students need to be able to learn through investigation, trials, discovery, mistakes and corrections while communicating ideas, reasoning, and thought processes as they move towards a correct solution to their mathematical problems. Discourse is probably one of the most important components of true learning throughout these processes. Evidence of discourse can be obtained through verbal conversations, writings, pictures and models created by students as they seek to process newfound knowledge an explain it to others (Hillman, 2014).

Mathematic is more than just numbers and procedures. It is everywhere. The NCTM standards recommend the use of fictional literature to help students make connections between

math and the real world. If students can connect pleasurable reading with mathematical ideas, they will begin to think and see math in everyday life. Studies show that literacy in math is important. Students that understand and can have discourse about math in higher level math classes have higher SAT and ACT scores. These students then form lifelong reading habits. They become accustomed to reading newspapers and magazines with mathematical evidence which in turn helps them to become educated and informed citizens as they enter adulthood and enter their careers (Carnegie, 2010).

Literature and Thematic Teaching

Some students love to read but are afraid of math while others love math but don't enjoy reading. Perhaps there is a way to incorporate a love of reading with the investigation of mathematical patterns and concepts that will blend classic literature and mathematics. Math is everywhere; however, most people don't see the mathematical properties and patterns that exist in everyday activities. Students need to have opportunities to formulate connections in their life with mathematics in order to become aware of its presence and beauty.

Using the novel, *Chasing Vermeer*, students in an urban district middle school learned about pentaminoes and the geometry behind them. Six teachers worked together to create an interdisciplinary unit that required students to read the novel and then participate in dramatizations and mathematics lesson based on the novel. Throughout this unit, students became more engaged and made connections between literature and mathematics, which provided an enriched learning experience (Willburn and Napoli, 2007). Teachers that participated in this unit found the students enjoyed learning about math in different ways and were more focused and engaged.

Elementary school classrooms, often provide thematic units across the curriculum within a single class, however, this is infrequent in middle school settings. Thematic teaching can be used for all students. The reading behind literature leads to writing and helps stimulate student ideas, helps them make connections and results in more engaged students (Gaughan, 2003). As students become more engaged, they find personal meaning in what they are learning. Using a thematic unit allows students to make connections from what they already know to what they are learning. They can use this newfound knowledge to then reinforce prior knowledge through observations, investigations and discoveries while communicating their ideas and knowledge of mathematics through both verbal and written discourse (Tucker, 1997).

Using the contemporary novel, *Harry Potter*, one school provided an interdisciplinary unit for science, math and literature. Problem based learning activities were designed where student had to identify problems, generate facts and ideas and analyze alternative methods for solutions. These types of problems required critical thinking and forced students to make informed decisions based on information gathered from the novel. As a result of this unit, students experienced higher level thinking, participated in listening activities and "did the math" while incorporating science concepts across the discipline. Students actively participated in problem solving exercises, showed increased motivation and developed more positive attitudes about mathematics in general (Beaton, 2006).

Common Core

The 2014-2015 school year presents an exciting, yet scary time for educators begin to implement the Common Core State Standards in mathematics. The impetus behind the development and creation of the Common Core State Standards resulted from a required National Assessment of Educational Process (NAEP) assessment given to schoolchildren

nationwide. The results of this test provided evidence of a large achievement discrepancy between states even though individual states reported successful results from state mandated exams. Educational leaders formed an organization that would come to be known as the Common Core State Standards Initiative. This organization developed a clear set of grade-by-grade standards for English Language Arts and Mathematics for all states that promised to provide resources and educational practices to create "college and career ready" graduates (Rothman, 2012). This document provides content standards patterned after the previous state standards which describe what the student should know for each grade level and Practice Standards which describe how the student should be able to perform these skills.

Within the Common Core State Standards are specific skills that are deemed necessary for success in college and the real 21st Century world. Critical thinking, communication, collaboration and creativity (The Four C's) provide an emphasis on the ways students need to work towards achieving career and college readiness. All of these skills are equally important and can be combined or focused on individually. Collaboration is necessary for all students to learn to work peacefully towards the successful completion of group projects. Diversity is important and needs to be accepted while students create group projects with an understanding that each member brings individual goals and knowledge that are important. Communication requires students to be able to express individual thoughts, ideas and beliefs using verbal, written and digital formats. It is necessary to share ideas with others locally as well as globally using technology which requires collaboration, creativity and critical thinking. Creativity is an idea that has been sidelined recently with standardized testing mandates, but is being considered necessary for our future leaders. It demands that students be able to think creatively while developing, promoting and communicating ideas. Howard Gardner explained the advantages of

creativity when he coined the idea, “the creating mind” as the mind of tomorrow’s society. Creativity needs to be cultivated and students need to have opportunities to explore, discover and make mistakes towards the goals of learning (NEA, 2010, p. 24).

Common core introduces a new aspect towards the pedagogy of teachers. While the ideas are really not new, the opportunities provide an excuse to explore and develop student thinking to a new level. With the goals of creating situations for students to be creative, communicative, collaborative and critical thinkers, educators can use these new strategies to energize their classrooms. Learning situations need to be designed to engage students and provide opportunities for them to try, fail, reflect and then retry until they realize success and can communicate and prove their ideas.

One area that has been recently discussed with the introduction of Common Core is the use of problem solving and project based learning in classrooms in order to increase motivation, encouragement and excitement towards the learning process.

Problem Solving and Project Based Learning

Most students love a challenge if they feel they can successfully understand and master it. Working together with friends to find solutions to tricky problems is enjoyable to children. Mathematics classes can use this idea to present curriculum in a way that engages students and allows them to communicate their ideas as they make sense of problems and begin to strategize towards developing solutions. Discourse is necessary in creating connections between mathematical concepts and real life. Mathematical problems can be provided using multiple representations so that connections to other subjects are more readily recognized (Berry and Ellis, 2013).

Problem solving is seen as a challenge for many teachers. In a survey of math teachers, 83% of the teachers identified problem solving as a difficult concept because of the perceived inability of students' understanding of conceptual ideas presented in word problems. Most of these ideas center on the inability of students to understand multiple representations and their relationship to mathematical ideas. Physical representations of abstract concepts will allow students to physically manipulate and diagram mathematical problems as they work toward a solution. Students need to be given opportunities and time to make the connections between abstract mathematical ideas and their relationship to mathematical symbols and operations. Once the conceptual structure of the problem is identified and understood, the problem solving becomes procedural and easily accomplished (Danesi, 2007).

Problem solving is an important element in real life. Real world problems are situations that require thinking, strategies, logic and trial and error towards an acceptable solution. In the process of problem solving, Polya describes four phases that students participate in: 1) understand the problem; 2) use prior knowledge to create a plan; 3) carry out the plan; 4) reflect on the solution to ensure it is logical and that it addressed the real question for the problem. Students should be presented problems that are interesting and relevant to their lives. Time should be provided for students to discuss and work through the all phases of problem solving effectively. The teacher should devise appropriate questions that lead the students towards a solution while eliciting a desire to truly accomplish the goal of solving the problem (Polya, 1945). True problem solving requires all four components of "The Four C's" in Common Core: communication, collaboration, critical thinking and creativity. Interpretation of the problem is a challenge in problem solving. It is important that the student use their own interpretation, make their own goals and proceed towards a solution at a pace that is good for them. They need to

"own" the process towards finding a solution that they can understand. This is a skill that they can improve upon for future problem solving situations (Lesh, 1985).

Narrative

In reviewing the literature on motivation, self-efficacy, Common Core, mathematics and disciplinary literacy, it has increasingly important to create a curriculum unit using classical literature with a problem solving approach to a project based unit. Current textbooks (prior to the introduction of Common Core) contain units that are broken down by skills within each concept but connections are rarely investigated between the skills. For instance, in a unit on linear functions, students are taught how to create a T-chart to graph points on a coordinate plane and then introduced to the concept of slopes, slope intercept form and graphing using these short cuts to graph. Solving equations is rarely connected to graphing when in reality, solving equations provides an algebraic method to what the graphs look like mathematically. Quadratic functions are introduced on a new level with graphing, solving and factoring, but the relationships between linear and quadratic functions are rarely discussed. Students get opportunities to visit each concept quickly and separately with procedures and short cuts. Independent work is frequently assigned that provides opportunities for student to practices steps to solving given problems in redundant and procedural ways. Few word problems are presented and those that are assigned are frequently avoided due to the difficulty in understanding what the problem is. Students need to have time to understand and apply mathematical concepts in different problem situations using their reading ability (Meaney and Flett, 2006).

The traditional approach of teaching a lesson, providing guided practice, independent practice and then assessment reinforces the notion of self-concept as students compare their achievement to others (Bong, 2012). This unit seeks to provide opportunities for collaboration

and communication as students creatively seek solutions to real world problems presented from reading classic literature. The classic novel, *The Wonderful Wizard of Oz*, provides a link between reading, writing and math that will help students connect math in real world concepts (Kaiser and Willander, 2005). Themes allow children to understand and relate to topics more thoroughly (Gaughan, 2003).

While individual and group work will be assessed throughout the unit, opportunities and suggestions will be provided to improve student solutions as they work towards a final presentation to showcase their knowledge and ideas. Students will work in collaborative groups to identify and solve situations as they arise in the project. In an effort to ensure equal participation, group members will determine individual roles using the characters from the novel and will have specific jobs that will provide completion of the project. The use of classic literature is expected to gather the interest of students who may fear math but love reading and provide a way to make connections to math with characters from the book. Group work will encourage diverse personalities to discover why different talents are necessary to produce evidence of learning in group projects. Whole class discussions will help student to resolve problems and issues towards a concrete understanding of functions. Lessons are designed to visit the concept of functions in different ways so that students will build confidence in their abilities in a non-threatening environment within their groups. While it is expected that the students have read the novel in their English courses (as part of an interdisciplinary unit) this project will focus on the building of the yellow brick road from *The Wonderful Wizard of Oz,* and the necessary use of functions to solve the problematic situations from the novel. Students will use functions several times in different modes as an attempt to reinforce and strengthen

connections between the written word, equations, tables, and graphs and the interpretation of necessary commodities needed for each problem.

This 19 day unit will be composed of three parts. Students will have an understanding of proportions, graphs, and unit conversions from previous units. As an introduction for this unit, students will work collaboratively to create their version of a yellow brick road with the limitation of using only two different types of tiles. They will be allowed to creatively choose a pattern but must communicate and collaborate in their groups to design a complete section. Critical thinking will be necessary to determine how tiles should be arranged and how many tiles need to be used. Classroom instruction will be provided to guide students to make connections with the use of tiles and their relationship to functions. Function tables, graphs and equations will be discussed and practiced in class to reinforce knowledge of each component of a function and how they can be used to illustrate the creation of a pattern such as the yellow brick road in *The Wonderful Wizard of Oz*. An essential question will guide students towards the focus for each lesson using ideas and characters from the novel. In the beginning, students will be guided carefully with structured questions towards the understanding of the elements necessary to create tables, graphs and equations for the functions they have created with their section of brick road; however as the lesson progress less guidance will be provided so that students may depend more on group members.

The second section of this unit will introduce the idea of the financial costs of each section of brick road. Once again, functional knowledge will be revisited to make the connections between the cost of each brick and the cost of labor using tables, equations and graphs. While it may seem that students are doing the same activities from the introductory unit using tiles, it is necessary to allow students time to practice their knowledge and skills with

different types of ideas. The essential question will be, "How much does it cost to build each section of the brick road"? This question presents multiple parts as students must then discuss the purchase price of bricks, installation time as well as labor costs. Student groups will be presented with opening problems involving characters from the story to solve. These problems will be written in story form but will require the use of mathematical knowledge to discover a solution. While content area reading strategies will help students understand what they are reading, they will need to use disciplinary literacy skills in English as well as Math to realize what the problem is and how to solve it. They will need to think critically about what is being asked and communicate ways to show the relationships and strategies for finding the solution. It is hoped that by using situations and characters from the book students will be inspired to want to find solutions. Groups will need to collaborate and communicate their ideas and strategies independently at first. Whole class discussion will help to guide groups towards specific questions and strategies. This holistic theory of learning allows students to grapple with the big idea before they discover and discuss specific elements necessary for successful completion of learning activities (Berry and Ellis, 2013). Once again, groups will create a collaborative presentation to summarize their information gathered.

The final section of this project will focus on the complete cost of building the road and the questions that need to be addressed in order to calculate this price. This will bring into focus more than just the creation of tables, graphs and equations. Students will need to discover how long the road is and make connections with brick costs, labor costs, unit conversions and time constraints. As a culminating project, students will design a presentation to win the bid to build the yellow brick road that will provide evidence of understanding of the use of tables, graphs, and equations in functions. This information should provide visual information clearly in order

to illustrate why their road is the best. Groups will need to work collaboratively and creatively while communicating their individual ideas towards completion of this final project. Polya (1945) described a four step problem solving plan that students go through towards successful work. This four step plan involves 1) Understanding the problem, 2) making a plan, 3) completing the plan and then 4) reflecting on the realities of the solution (Polya, 1945). They will be allowed to choose the type of presentation but will need to use critical thinking to meet the guidelines and limits presented.

Each section of this project will be assessed according to a given rubric that encourages completion in a timely manner, neatness, consistency and accuracy. Evaluations will provide guidance towards the completion of the entire project and students will be allowed to resubmit revised work throughout the unit. It is hoped that students will reflect on their work and be encouraged to discuss and revise their work towards a complete understanding of the use of functions in the real world as a resource for visual presentations.

Reflections and Analysis

Mathematics classes in middle school serve a group of students transitioning from elementary school to secondary education. Elementary school classes use interdisciplinary units to teach concepts to relate the core subjects on a regular basis. Once students enter middle school, they have multiple classes, teachers and curriculum that are different. Students are placed in achievement based math classes and develop a mentality about their math abilities based on these placements. Studies show that students frequently lose confidence in their math abilities in middle school (Pajares and Miller, 1997). This unit seeks to provide continuity with elementary teaching styles in a thematic based mathematics unit in order to maintain interest,

motivation and confidence while providing real world concepts in an interesting way using fictional literature.

The novel, *The Wonderful Wizard of Oz*, will allow students to make connections to characters as they face real world problems that require mathematical problem solving skills and knowledge of functional concepts. This unit has been created in an attempt to blend the love of reading with the fascination of mathematical patterns and relationships. Students who love literature but fear math may feel a comfort level while working through problems and seeing math in their literature books. The use of collaborative groups working towards solving problems in a project based unit allows students to communicate ideas, practice skills and resolve confusions in small groups. Lessons are created to scaffold the level of difficulty in order to provide guidance with opportunities to demonstrate creativity while groups develop evidence of understanding that connects the knowledge of tables, graphs and equations and their relationship.

On a theoretical level interdisciplinary teaching can be used to inspire students in all core subjects to use their imagination towards a deeper level of learning by connecting ideas between the disciplines (Beaton, 2006). The use of thematic based projects increase student interest and allows connections to be made to the real world while increasing reading skills (Gaughan, 2003). Reading within disciplines is important in order for students to understand written expectations from textbooks. While content area literacy promotes strategies to remember what is read, disciplinary literacy emphasizes reading to gain and apply necessary knowledge and abilities within a subject (Shanahan and Shanahan, 2012). With the implementation of Common Core State Standards for the 2014-2015 school year, it is necessary to focus on reading and writing in mathematics so that students can communicate and apply knowledge. With this in mind, it is

important to create reading opportunities where students read for interest as well as for understanding on a mathematical level. Reading in mathematics requires technical reading skills and reading comprehension. Studies indicate that literacy skills are the powerful predictors of word problem performance. If we can increase a student's literacy skills, we can improve their ability to master word problems (Kyttala and

Bjorn, 2012). While many students have a fixed mindset about their abilities in math, it is imperative that we provide learning experiences that will develop resilience. Students need to realize that they can develop into better math students if taught skills and strategies to improve their abilities. Students with this growth mindset believe they can learn from challenging school situations and persevere through higher levels of mathematics (Yeager and Dweck, 2012). Our goal as educators is to develop students that believe they can succeed even in challenging situations. They need to know that hard work pays off and realize they have what it takes to be successful.

In the planning stages, the use of a thematic based problem solving unit is beneficial on a practical level. The use of interdisciplinary lessons help students connect core subjects and maintain academic interest and provide a continuity of this practice from elementary school. Because of the numbers of students, organization of class schedules and various teaching styles, complications arise in attempting to create interdisciplinary units.

An elementary school teacher generally only has 30-35 students on a daily basis and can control the content within each discipline. This allows the teacher to develop lessons that are connected and organized in a daily or weekly unit. The difference with middle school that teacher is responsible for larger number of students on a daily basis. Teachers generally teach six different classes with over 30 students in each class. Each core subject has six different

teachers and each student has seven classes arranged in different ways. This means that each student has a different group of core teachers. Interestingly enough this is a math problem in the works. How many teachers would need to collaborate on a regular basis to plan and construct coordinated lessons for these students. Time alone is a problem for this type of collaboration. Each teacher has different preparatory periods which make it difficult to meet during the regular school day. Professional development during non-teaching hours is required to allow groups of teachers to have ample time to creatively collaborate and communicate ideas and goals but this is difficult to establish within a normal workday. Some schools do create a "village system" where groups of students have the same group of teachers. This is an ideal situation to promote interdisciplinary teaching. Unfortunately my school does not do this.

Teacher experience and styles can hinder the development of interdisciplinary lessons because of prior experience with established lesson plans. Many teachers have taught the same courses over the years and use units and projects from year to year. It is difficult to change old habits with established teachers. The belief that, "if it isn't broken, why fix it", is strong within the teaching profession. With the introduction of Common Core State Standards and "The Four C's", change may be inevitable. This is a good time to try new things and to use the standards as an excuse to promote collaboration, communication, creativity and critical thinking on a deeper level.

Professional development conferences are important in educating teachers about the changes with Common Core, but time needs to be given for these opportunities. Just as we expect our students to use the "four C's", teachers need to learn to use them as they develop new classroom environments. Teachers need time to collaborate with other professionals and communicate needs and concerns. Opportunities need to be provided for educators to creatively

seek learning opportunities for themselves and develop curriculum for their students. Just as we expect our students to use critical thinking in their learning experiences, teachers need to think critically about the curriculum they are creating and presenting to our student to prepare them for the 21st Century.

References

Ames, C. A. (1990). Motivation: What teachers need to know. *Teachers College Record*, 91(3), 409-421

BBN Laboratories. (1988). *Cognitive apprenticeship and instructional technology*. (BBN Report No. 474). Cambridge, MA: Colins A.

Baum, L. F. (1900). *The Wonderful Wizard of Oz*. New York, NY: Bedford Park Books

Beaton, T., & Perry, T. (2006). Harry Potter as a context for interdisciplinary studies. *English Journal*, 95(3), 100-103

Berry, R. Q., & Ellis, M. W. (2013). Multi dimensional teaching. *Mathematics Teaching In The Middle School*, 19(3), 172-178

Bong, M., Cho, C., Ahn, H., & Kim, H. (2012). Comparison of self-beliefs for predicting student motivation and achievement. *Journal Of Educational Research*, 105(5), 336-352.

Carnegie Corporation. (2010). *Reading in the disciplines: The challenges of adolescent literacy*. New York, NY: Lee, C. & Spratley, A.

Cavanagh, M. (2011). Students' experiences of active engagement through cooperative learning activities in lectures. *Active Learning In Higher Education*, 12(1), 23-33.

Danesi, M. (2007). A conceptual metaphor framework for the teaching of mathematics. *Studies In Philosophy & Education*, 26(3), 225-236.

Dweck, C. (2006). *Mindset: The new psychology of success*. New York, NY: Random House Publishing

Gabriele, A. J. (2007). The influence of achievement goals on the constructive activity of low achievers during collaborative problem solving. *British Journal Of Educational Psychology*, 77(1), 121-141.

Gaughan, J. (2003). A Dose of Thematic Teaching. *English Journal*, 92(5), 18.

Hillman, A. (2014). A literature review on disciplinary literacy. *Journal Of Adolescent & Adult Literacy*, 57(5), 397-406.

Kyttälä, M., & Björn, P. M. (2014). The role of literacy skills in adolescents' mathematics word problem performance: Controlling for visuo-spatial ability and mathematics anxiety. *Learning & Individual Differences*, (29) 59-66.

Lesh, R. A., & Doerr, H. M. (2003). *Beyond constructivism: Models and modeling perspectives on mathematics problem solving, learning, and teaching*. (pp.317-336). Mahwah, N.J.: Lawrence Erlbaum Associates.

Meaney, T. & Flett, K. (2006). Learning to read in mathematics classrooms. *Australian Mathematics Teacher*, 62(2), 10-16

National Educational Association. (2010). *An educators guide to the four C's.* (NEA Publication) Retrieved from http://www. http://www.nea.org/tools/52217.htm

Pajares, F., & Miller, M. (1997). Mathematics self-efficacy and mathematical problem solving: Implications of using different forms.. *Journal Of Experimental Education*, 65(3), 213

Pajares, F., & Graham, L. (1999). Self-efficacy, motivation constructs, and mathematics performance of entering middle school students. *Contemporary Educational Psychology*, 24(2), 124-139

Papert, S. (1972). Teaching children to be mathematicians versus teaching about mathematics. *Journal of Mathematics and Science Technology,* 249-262

Polya, G. (1945). *How to solve it: A new aspect of mathematical method*. (pp. 1-36). Princeton, N. J.: Princeton university press.

Rattan, A., Good, C., & Dweck, C. S. (2012). "It's ok — not everyone can be good at math": Instructors with an entity theory comfort (and demotivate) students. *Journal Of Experimental Social Psychology*, 48(3), 731-737.

Rothman, R. (2012). A Common Core of Readiness. *Educational Leadership*, 69(7), 10-15

Shanahan, T., & Shanahan, C. (2012). What is disciplinary literacy and why does it matter?. *Topics In Language Disorders*, 32(1), 7-18.

Tucker, B., & Hafenstein, N. (1997). An integrated-thematic curriculum for gifted learners. *Roeper Review*, 19(4), 196

Wilburne, J., & Napoli, M. (2007). Integrating literature & mathematics: A mysterious connection. *Mathematics Teaching In The Middle School*, 13(3), 134-139

Yeager, D., & Dweck, C. S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist*, 47(4), 302-314.

Curriculum

A Problem Solving, Project Based Unit

on Linear Functions using Classical Literature

Common Core State Standards

8. F. 1: Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is a set of ordered pairs consisting of an input and the corresponding output.

8. F.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

8. F.3: Interpret the equation $y = mx + b$ as defining a liner function, whose graph is a straight line: give examples of functions that are not linear.

7. RP. 1: Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measures in like or different units.

7. RP. 3: Use proportional relationships to solve multistep ratio problems.

Essential Questions

1. How many bricks will be needed to build the yellow brick road in the Wizard of Oz using two different types of bricks and how can I use tables and graphs to show my work?
2. How much will it cost to create each section of the road?
3. How long is the yellow brick road? How much will it cost to build?
4. How can I convince the Great Oz to let my firm build the yellow brick road?

Section 1: Scope and Sequence

Day: 1-3 Topic: Introduction of a Function		
Standard	8. F. 1: Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is a set of ordered pairs consisting of an input and the corresponding output.	
Essential Question	How can you use a mapping diagram to show the relationship between two data sets? **In the world of Oz:** How many bricks will be needed to build the brick road? If I use two different types of bricks, how many will I need of each brick for one section? How many will I need for each additional section of the road? How can use equations, tables, graphs, pictures and models to show my work?	
Activity	Students will work in groups of four to design a section of the brick road. They will have 5 different types of tiles to choose from but may only use 2 different types for their section. Questions: 1. Which tiles will you choose and why? 2. What patterns did you create and why? 3. How many of each tile did you use 4. How many of each tiles will be needed to build 2 sections? 5. Three Sections? 6. Four sections? 7. N sections? 8. How can we write a formula to represent the needed bricks? 9. How can we represent our choices with tables? 10. How can we represent our choices with graphs?	
Class Instruction	What is a function? 1. Define function: Use resources: books, internet. How many ways can we find the word "function" in different contexts besides math? 2. Students will work in their groups to draw two different input/output tables for their bricks. a. Discuss the relationship between the x and y value in each table. b. What kinds of things are noticed? (a rule is applied to x to produce each y for each of the lines). c. How can we combine this information onto one table? d. Can we identify how many bricks are needed for 1 section? 3 sections? 5 sections? N sections?	

	e. When is this function? When is it not a function? 3. Creating a graph: a. What should the horizontal line represent? What should the vertical line represent? Do we need to include the negative parts of the coordinate plane? Why or why not? b. Should each line represent one unit or more units? Why or why not? c. From this graph can we answer the following questions? i. How many bricks were needed for one section of the brick road? Two sections? Three sections? N sections? d. Identifying functions from graph i. How will the graph appear if it is a function? ii. How will it appear if it is not a function? iii. How can we describe the function rule using a graph? 4. Are the following diagrams functions? a. Give students a set of equations, tables and graphs. Have them work in pairs: then go over answers and solutions. 5. Students will work in groups to complete the evidence for their first assignment.	
Evidence	1. A creation of one section of the proposed brick road 2. Worksheets 3. One page presentation showing an equation, table and graph with a summary paragraph.	
Rubric	1. Yellow Brick Road Section: (5 Points) Point values are as follows: a. Completed on time (2 Points) b. Section is completely filled in with no blank spaces (1 Point) c. Use of exactly two different types of tiles (2 points) 2. Worksheets (10 Points) a. On time (5 Points) b. All questions answered in complete sentences. (1 Point) c. Answers are relevant to questions and easily understood. (1 Point) d. All graphs and tables completed (1 Point) e. All graphs, tables and equations provide consistent and accurate answers. (1 Point) f. Work is neat. (1 Point)	

	3. Presentation Sheet (20 Points) a. On Time (3 points) b. Name and period written clearly (1 Point) c. Equation, table and graph are consistent and accurate. (1 Point) d. Table has five different values and all calculations are correct (5 Points) e. Graph has an x and y axis with values clearly labeled. (2 Points) f. Graph has all five values from the table clearly identified and labeled. (5 Points) g. Summary Paragraph: Complete sentences that are relevant to the questions and easy to read and understand. (5 Points)	

Assignment #1:

CCSS: 8F1: Relations and Functions: *Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.*

Essential Question: How can you use equations, tables, pictures and graphs to show the relationship between the required number of bricks and the number of sections of yellow brick road being created?

In the world of Oz: How many bricks will be needed to build the brick road? If I use two different types of bricks, how many will I need of each brick for one section? How many will I need for each additional section of the road? How can use equations, tables, graphs, pictures and models to show my work?

You will design your section of the yellow brick road. Each section is actually 8 feet x 8 feet, however this template is 8 inches by 8 inches. Each inch will represent 1 foot. You must use **two** different styles of bricks and you must completely fill the section. Use the template provided in this packet. Cut out desired shapes and glue your tiles onto the section of the yellow brick road.

Which bricks did you decide to use?

What kinds of patterns did you create? Why?

How many of each did you use for this section?

How many total bricks are needed for one section?

Two sections?

Three sections?

n sections?

Can you write a formula for the total number of bricks needed for *n* sections of the brick road?

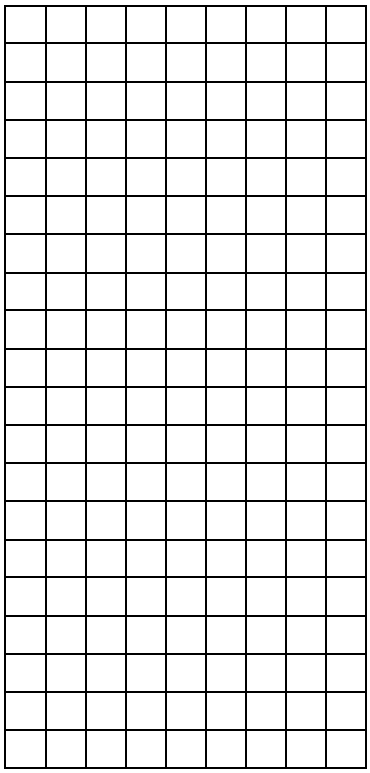
How can we represent our choices with tables?

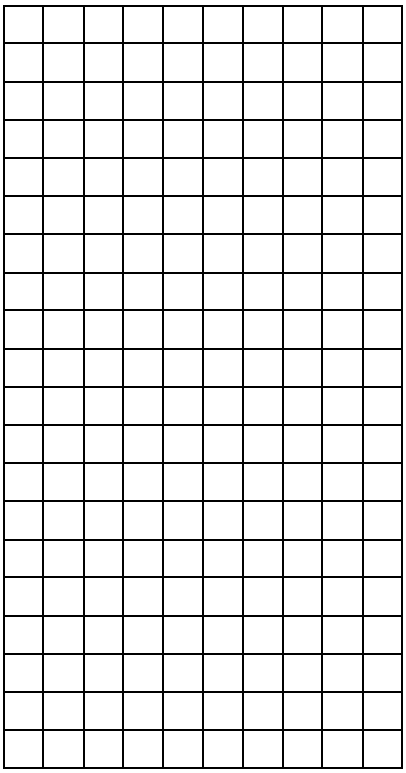
Sections	Brick 1

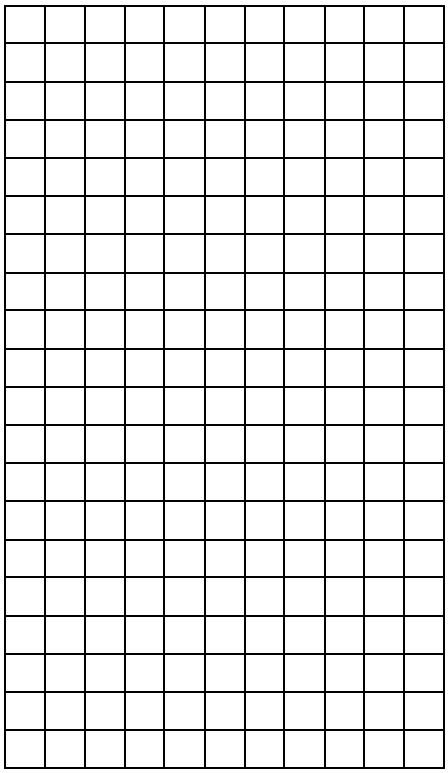
Sections	Brick 2

Sections	Total Bricks

How can we represent our choices with a graph? Use two different colors for each type of brick. This will help you identify how the lines represent a function for each brick.







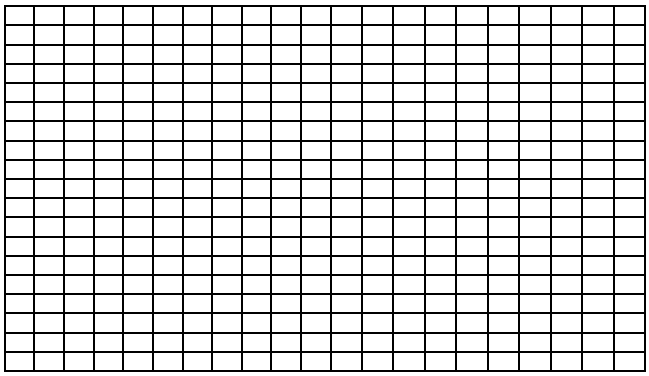
Create a one page presentation to represent your brick road using an equation, table and graph using both bricks. Write a one paragraph summary of your work. Include why your chose your bricks? What kinds of patterns you used and what you think is good about your creation? What do you notice about your equation, table and graph?

Name:	Period:
Equation:	

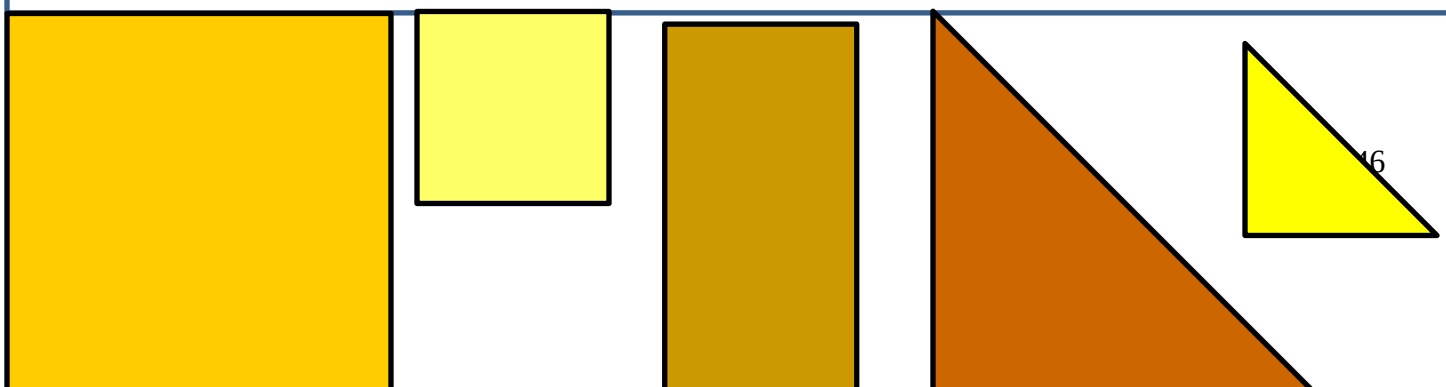
Table

Sections	Brick 1	Brick 2	Total Bricks

Graph

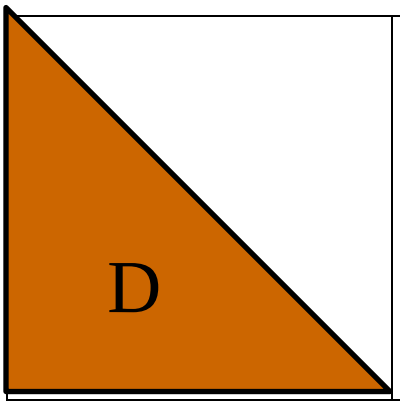


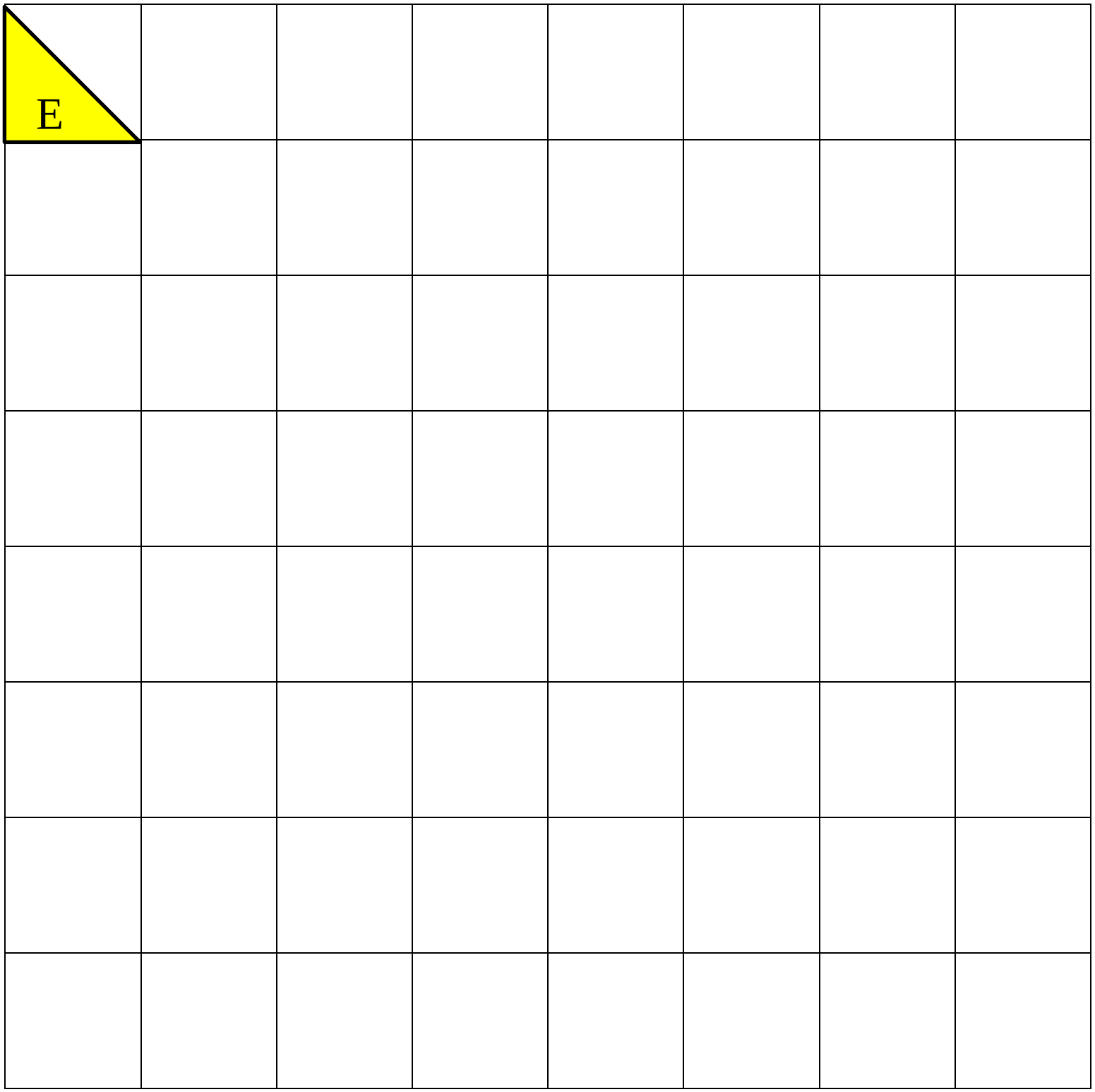
Summary Paragraph



A			

B							

 D			


E

C							

Day: 4-9 Topic: Financial Obligations: Tiles, Installation time and hourly wages

8. F. 1: Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is a set of ordered pairs consisting of an input and the corresponding output.
8. F.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
8. F.3: Interpret the equation $y = mx + b$ as defining a liner function, whose graph is a straight line: give examples of functions that are not linear.

How much will it cost to create each section of the road?

In the world of Oz: How much does each tile cost? How long does each tile take to install? How much time will it take to create your section? How much will we pay a worker to install these bricks for this section? How much will it cost to create two sections? Three sections? N sections?

Students will work in their groups to determine the purchase price of the tiles for one section of the brick road they have designed. They will also determine how long it will take to create their given section of road and then will determine how much money they must pay a worker to build that section. They will finally determine the financial costs to build one section of the road.

Questions:

11. What was the purchase price of each brick?
12. How many bricks did you need for each section?
13. How much will you pay to buy the materials for each section?
14. How much time does it take to install each of your bricks?
15. How much time will it take to install all of the bricks in one section?
16. If a worker is paid $15.00 per hour, how much will you pay him to install all of the bricks in one section?
17. How much will it cost to have the worker install the bricks in one section and to pay for the bricks for one section?
18. What is the financial cost to build one section?
19. How can we represent our choices with tables?
20. How can we represent our choices with graphs?
21. How can we represent this with an equation?

Students will work in their groups to investigate the solutions to the questions presented.

Day Four: How much will it cost to purchase the materials for each section of the brick road?

1. Determine the purchase price for each brick used.
2. Determine how many of each bricks will be used in a section.
3. Determine the cost for each type of bricks.
4. Determine the cost for all bricks in one section.
5. Create a table, graph and equations to illustrate the tile cost for each section of the brick road.

Day Five: How much time is required to install each section of the brick road?

1. Determine the required time to install one of each type of tile used in your section.
2. Determine the time needed to install each type of tile separately for one section.
3. Determine the total time to install tiles for one section of your road.
4. Create an equation, table and graph to illustrate the time needed to install each section of your brick road.

Day Six: How much will I need to pay a worker to install the bricks for each section of the brick road?

1. A worker will be paid $15.00 to install the tiles on your brick road.
2. Determine the cost for the installation one section of your brick road.
3. Determine the cost to install two sections, three sections and n sections of your brick road.
4. Create an equation, table and graph to illustrate the cost to pay a worker to build your brick road.

Day Seven: How can I use the information gathered to create a chart for the final cost on creating a yellow brick road? How are all the tables, graphs and charts related?

1. Compare the equations, tables and graphs of the last three days.
2. How are they the same?
3. How are they different?
4. What is the rate of change for each situation?
5. How is rate of change described in an equation, table and graph?

Day Eight: Wrap up and review to create a one page presentation for the total cost of each section of the brick road?

1. How do we consider the purchase price of the tiles with the installation price of the road?
2. How much did it cost to purchase the tiles necessary for one section of your road?
3. How much did it cost to pay a worker to install one section of your road?
4. How can we illustrate this with a table and a graph?
5. How can we create an equation to illustrate this situation?
6. What is the total cost per section for your road?

Day Nine:

1. Create a one page presentation to show the total cost per section of your brick road using equations, tables, graphs and a written summary of your observations of the rates of change with each of these situations.

Day Ten:

1. Presentations
2.

Evidence:

1. Tables, graphs and equations for each part of the problem.
2. A presentation to show the final costs of the brick road per section using and equation, table and graph.

Rubric:

1. Worksheet for each day (20 Points)
    a. On time (5 Points)
    b. Introduction problem: (5 Points) All work shown with attempts and explanations for solution. Corrections clearly made.
    c. Individual work: All questions answered in complete sentences and address the question clearly. (5 Points)
    d. All tables, graphs, equations or forms completed neatly. Solutions are accurate and consistent.
2. Final Presentation (25 Points)
    a. On time (5 points)
    b. Poster: Correct size, neat, presents work clearly and accurately. (5 Points)
    c. Proof of collaboration of all members (5 Points)
    d. Presentation: All members participate in the given time frame. Clear speaking provides proof of understanding of functions) (5 Points)

Financial Obligations for the Brick Road

Day Four:

Dorothy and the Scarecrow are preparing a budget to begin construction of the Yellow Brick Road that they designed. Now we all know the scarecrow doesn't have a brain, so he needs our help. If one section of the brick road contained 20 large bricks at $0.90 each and 10 smaller triangular bricks at $0.25 each, how much will one section of the brick road cost? If they want to plan ahead and purchase the required bricks for 3 sections, how many bricks will they need of each and how much will it cost? What if they want to purchase enough to build 10 sections? What if they were to want to purchase for 25 sections? What is the most efficient way to determine costs if the number of sections varies?

Brick Cost: Independent work: Using your design, complete the following information.

Using tables: Use one table for the cost of your first brick for each section. Use one table for the cost of the second brick for each section. Use last table for the cost of both bricks in each section.

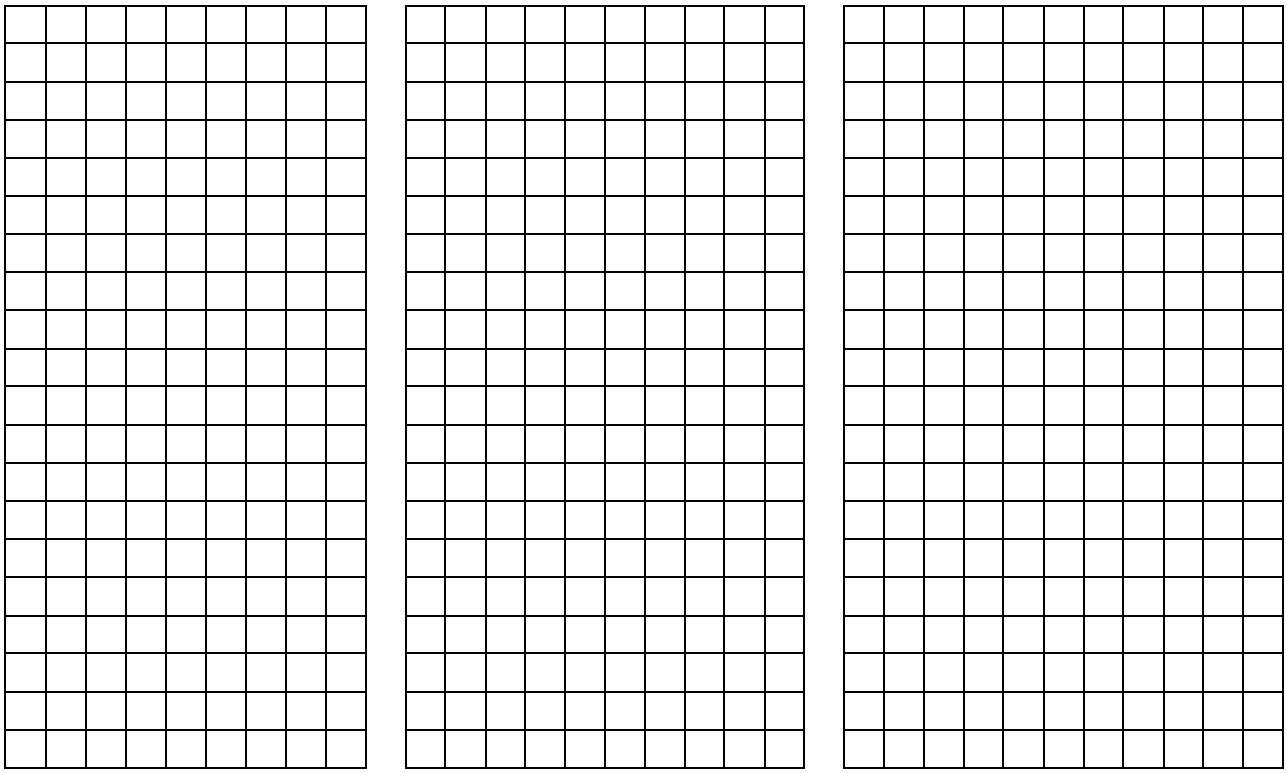
Sections	Brick 1

Sections	Brick 2

Sections	Brick 1 and 2

What would an equation look like for each of these tables?

Create a graph to illustrate the cost for each brick separately and together.



Day Five:

Dorothy and the Scarecrow prepared the tables and charts for the purchase price of the bricks for the brick road and they were excited to begin the project. They were strolling home from the hardware store when they met the Tin Man. He was excited to hear about their project, however, he brought up the fact that they would need to hire workers to install this brick road because they did not have the required experience. If each of the large bricks takes 20 minutes to install and each of the smaller triangular bricks takes 5 minutes, how long will it take the workers to install one section of the brick road? How long for 2 sections? How long for 5 sections? How long for n sections?

Installation Time: Independent work: Using your design, complete the following information.

Using tables: Use one table for the installation time for each of your bricks and the last table for the cost of both bricks in each section.

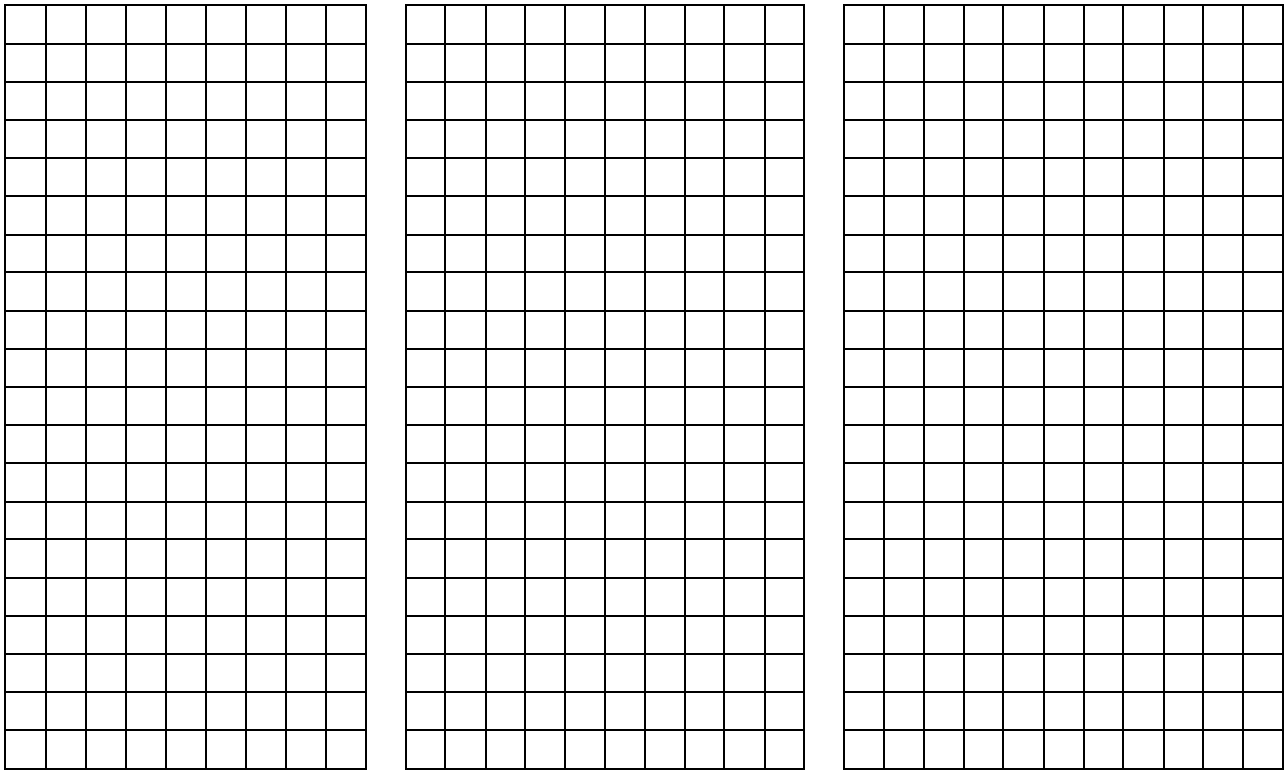
# Brick 1	Time needed
1	
2	
3	
N	
Each Section	

# Brick 2	Time needed
1	
2	
3	
N	
Each Section	

Sections	Brick 1 and 2
1	
2	
3	
10	
N	

What would an equation look like for each of these tables?

Create a graph to illustrate the cost for each brick separately and together.



Day Six:

Dorothy, Scarecrow and Lion were walking along discussing their brick road and how well prepared they were to begin construction. They knew the cost of the bricks and how much time it would take to build so they were ready to begin. They scarecrow had no fears because he didn't have a brain to tell him to be afraid and the Tin Man didn't have a heart so he couldn't really feel the need to tell his group that there was one more thing to consider before they could start. Lucky for them, the Lion had courage and he decided to approach the group to help them with one final aspect to consider in the financial costs to build the brick road. He explained to them that the workers would need to be paid for their time. If each of the workers needs to be paid $15.00 per hour, how much money will it cost to pay them for their work on each section of the brick road? Be sure to show how much for one section, two sections, three sections or *n* sections.

Paying the Workers: Independent group work: Using your design, complete the following information.

Using tables: Use one table for the installation time for each of your bricks, one table for the cost of the second brick for each section and the last table for the cost of both bricks in each section.

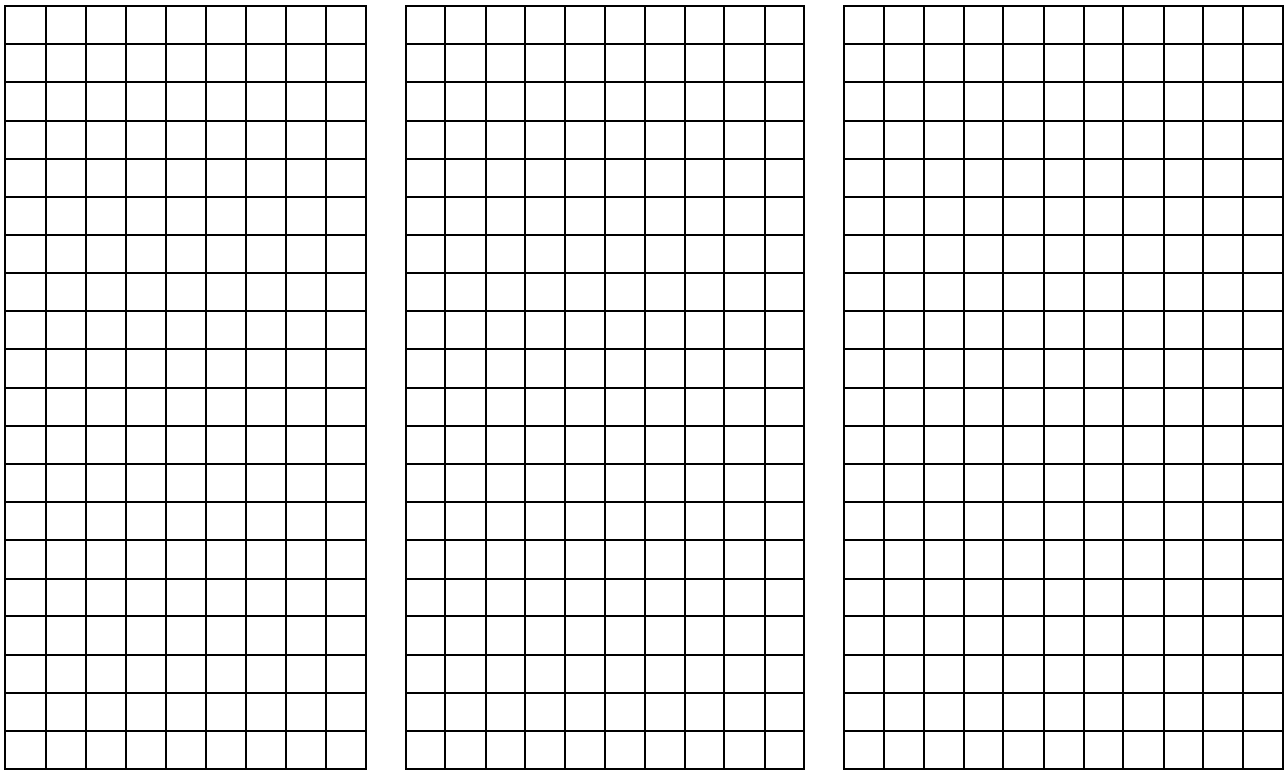
# Brick 1	Installation Cost
1	
2	
3	
N	
Each Section	

# Brick 2	Installation Cost
1	
2	
3	
N	
Each Section	

Sections	Installation Cost for Brick 1 and 2
1	
2	
3	
10	
N	

What would an equation look like for each of these tables?

Create a graph to illustrate the cost for each brick separately and together.



Day Seven:

Dorothy, Scarecrow, Tin Man and Lion seem to be a working well together on their Brick Road project. They have considered tile cost, time constraints and how much they need to pay the workers to build the brick road and have created tables, equations and graphs for each part of the building project. Now they are confused about how all these tables, graphs and equations are related. Compare the tables, graphs and equations, make notes about the similarities and differences and be prepared to discuss your findings.

	Characteristics	Similarities	Differences
Tables			
Equations			
Graphs			
Rates of Change			

Putting it all together: Independent work: Work in your group to decide who will be the expert in each area. The scarecrow will be the expert in the cost factors of the tiles and how to use tables to inform. The Tin Man will be the expert in the time constraints of construction and how to use equations to inform. The Lion will be the expert in the wages of the workers and how to use graphs to inform. Dorothy is the project manager and will oversee everyone to ensure they are all doing their part and can explain their expertise area. She will also be responsible for communication between the teacher and the group. All members will be responsible for the final presentation. Begin planning how to present the information gathered so far in a one page documents that illustrates the cost, time and wages required for one, two, three and n sections of the brick road.

Dorothy: (Project manager and communication coordinator)

Scarecrow: (Expert in cost factors of the tiles and tables)

Tin Man: (Expert in time constraints of construction and equations)

Lion: (Expert in worker wages and graphs)

Day Eight: Creating Tables, Equations and Charts:

Complete this page to use in the creation of a one page presentation for the class. Represent your brick road using an equation, table and graph using both bricks. Write a one paragraph summary of your work. Include why your chose your bricks? What kinds of patterns you used and what you think is good about your creation?

Name:

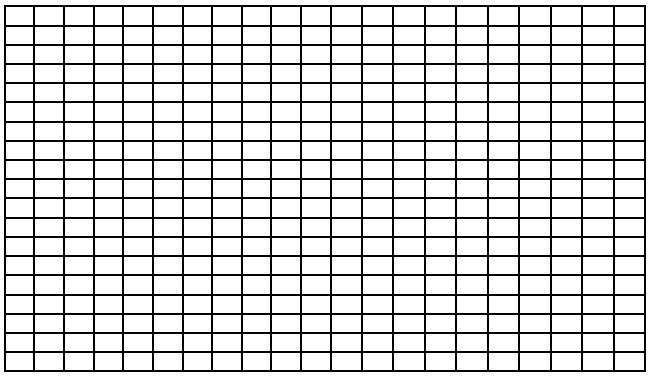
Period:

Equation:

Tables: Purchase price for tiles

Sections	Cost of Brick 1	Cost of Brick 2	Total Cost

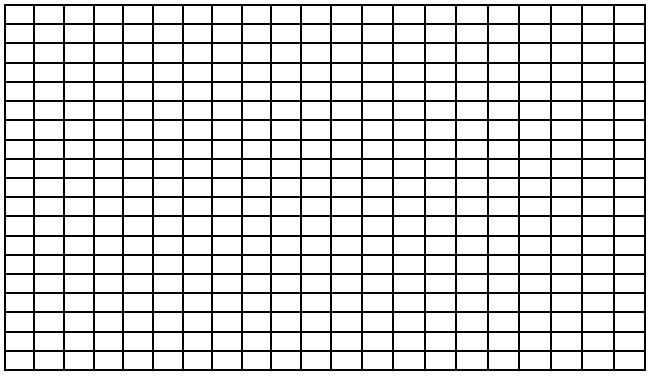
Graph: Purchase price for tiles



Tables: Installation time

Sections	Time for Brick 1	Time for Brick 2	Total Time

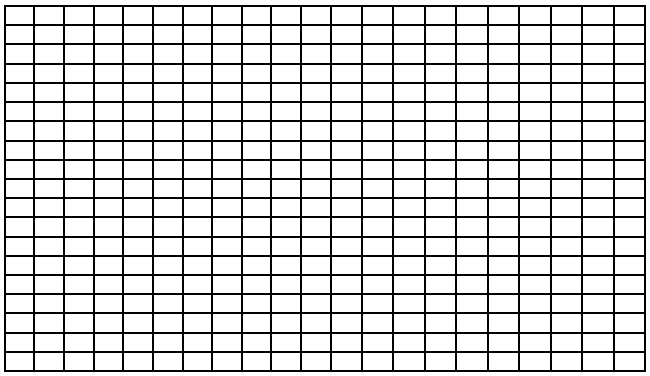
Graph: Installation time



Tables: Cost per hour

Time	Cost/hour	Total Fees

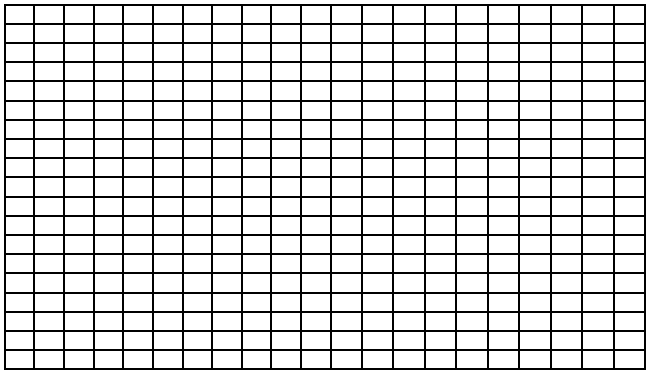
Graph: Cost per hour



Tables: Purchase price

Sections	Total fees	Purchase price of bricks	Total Cost

Graph: Purchase price

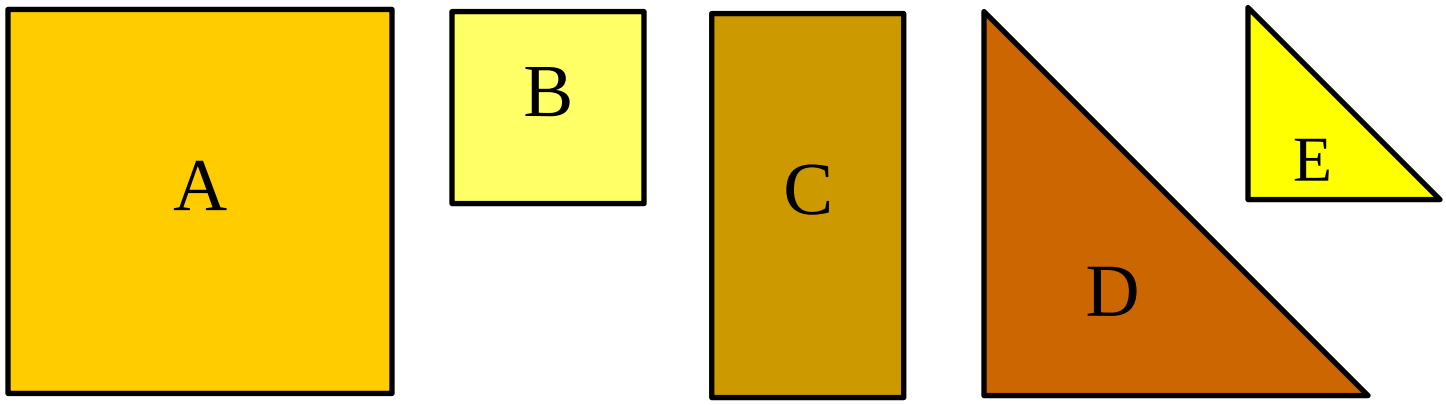


Summary

Day Nine: Work with your group to prepare a 3 minute presentation of your findings so far. You must include a visual that can be no more than 20 inches by 24 inches. All members must participate in the audio portion of the presentation. The presentation may be in person or pre-recorded using digital media. If you choose to use visual media, you must use a program that is easily accessible and emailed such as YouTube. Remember to use your experts for each area and to make the presentation clear and easily understood. If you do not pre-record, we will record the presentation in class as a document of evidence.

Brick	Purchase price	Installation time
A	$6.00 per brick	30 minutes
B	$2.00 per brick	5 minutes
C	$3.00 per brick	15 minutes
D	$3.00 per brick	15 minutes
E	$1.00 per brick	2 minutes

Workers will be paid $15.00 per hour to work.



Section 3: Scope and Sequnce

Day: 11-19 Topic: Final Length and Total Cost		
Standard	8. F. 1: Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is a set of ordered pairs consisting of an input and the corresponding output. 8. F.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). 8. F.3: Interpret the equation y = mx + b as defining a liner function, whose graph is a straight line: give examples of functions that are not linear. 7. RP. 1: Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measures in like or different units. 7. RP. 3: Use proportional relationships to solve multistep ratio problems.	
Essential Question	How long is the yellow brick road? How much will it cost to build? **In the world of Oz:** Given that some interpretations say that the Yellow Brick Road is 33 miles, how long will it take to build and what will be the final cost. How long will it take one worker, two workers, three workers or n workers? What will each worker earn each day and what will be the final cost including supplies and employee costs?	
Activity	Students will work in groups of four to determine the how many sections are in each mile of the yellow brick road and how many sections are in the 33 miles of the yellow brick road. Using this information, student groups will determine the final cost of the construction of their yellow brick road including supplies and employment costs. Questions: 22. How many feet are in a mile? 23. How many sections will it take to complete one mile of the brick road? 24. How much will it cost for supplies for one mile of the brick road? 25. How much time will it take one worker to build one mile of the road?	

	26. What is the total cost for the construction of one mile of the road? 27. What is the total cost for 2 miles, 3 miles, n miles? 28. Given that the brick road is 33 miles, what is the final cost for building the entire road including supplies and employment costs? 29. How long will it take one worker to build the road, 2 workers, 3 workers, n workers? 30. How can we represent our choices with tables? 31. How can we represent our choices with graphs? 32. How can we represent this with an equation? 33. If we need to road to be completed in 90 days, how many workers should we employ? 34. How can you create a presentation to deliver all of this information to a prospective buyer to encourage them to hire your firm to build the brick road?	
Class Instruction	Students will work in groups of four to investigate the solutions to the questions presented. **Day 11: How long is the Yellow Brick Road and how much will it cost to build?** 6. Determine the ratio of feet to miles. 7. Determine the number of 8 feet sections in one mile. 8. Determine the cost of supplies for one mile. 9. Determine the time it takes for one worker to construct one mile. 10. Determine the cost for one worker to construct one mile of the road. 11. Determine the financial cost of one mile of your brick road. 12. Create a visual element to illustrate the costs of one mile of the brick road that clearly demonstrates your understanding of proportional relationships between units. **Day 12: What is the total time and cost for 1 mile, 2 miles, 3 miles, n miles of the road?** 5. Create a set of equations, tables and graphs to illustrate the time and cost of construction for each mile of the yellow brick road. 6. How long is the Yellow Brick Road? **Day 13: If you have a time constraint of 30 days, how many workers do you need to hire to complete this job on time?** 5. Use information about the time it takes one worker to construct one mile and determine the time it would take one worker to construct all 33 miles. 6. How long would it take 2 workers to complete the 33 mile road, 3 workers, n workers?	

	7. How can we use this information to limit the time to 90 days? **Day 14: How can I use all of the information gathered to create a presentation to convince the City of OZ to hire my firm to build the yellow brick road? ?** 6. Determine whether you would like to create a poster, brochure, a written proposal or video segment to present your work. 7. Create a timeline to show what will be accomplished each day. 8. Create a chart to show which members will complete which parts of the presentation. 9. Create a rough draft to share with peers including a written version of scripts to be used in a video presentation. **Day 15-16: Work in groups to complete presentation?** **Day 17: Peer review presentations** **Day 18: Revise presentations for final turn in.** **Day 19: Round Robin Review and comments on final projects**	
Evidence	Written project proposal, poster, brochure or video presentation to convince the City of Oz to allow your group to construct the Yellow Brick Road.	
Rubric	Worksheet for each day (20 Points) 1. On time (5 Points) 2. Introduction problem: (5 Points) All work shown with attempts and explanations for solution. Corrections clearly made. 3. Individual work: All questions answered in complete sentences and address the question clearly. (5 Points) a. All tables, graphs, equations or forms completed neatly. Solutions are accurate and consistent. Final Presentation (25 Points) 1. On time (5 points) 2. Physical Presentation Piece: Neat, clear and accurate. (5 Points) 3. Proof of collaboration of all members (5 Points) 4. Provides convincing evidence for group bid: (5 Points) 5. Evidence of a rough draft with revisions: (5 Points)	

Final Length and Final Cost

Day 11: How much will it cost to build one mile of the brick road?

As Dorothy, the Scarecrow, Tin Man and Lion, proceed towards the Emerald City, they begin to wonder how long this road is. If they know that each section is 8 feet long, how many sections will there be in one mile? How much will it cost to purchase supplies and pay workers to install each mile? How long will it take? Because the scarecrow doesn't have a brain, the Tin Man doesn't have a heart and the Lion doesn't have courage you need to provide pictures to prove your knowledge.

Day 12:

The City of OZ is considering hiring a firm to build a Yellow Brick Road in allow visitors to travel easily to their city. You work for a construction firm and would like to earn the opportunity to bid on this project because you can earn a lot of money if you do your work correctly. Because so many firms are bidding, they want to see a written presentation regarding your work and how long it will take to build as well as how much it will cost. Prepare for your presentation by creating equations, tables and graphs to show the time and cost factors of this project for each mile. Be sure to write clearly so that this can be easily read. Your income depends on your work.

There are many interpretations on the length of the Yellow Brick Road in OZ. Some might use the mindset that the group traveled about 10 miles a day, but how many days did they travel? Using the internet, see if you can find information on the real length of the brick road?

Equations:

Part 2: Using this passage and your knowledge of equations, tables and graphs, illustrate the time and cost factors to build each mile of the brick road.

It's a "magical" road that includes modes of travel like wishes, witches, flying, etc.
There's also no mention how long it took Dorothy to reach Emerald City.

But an examination of Frank L. Baum's life reveals a possible reference.
Baum was born in 1856, a "sickly child."
He was born in Chittenago, New York.

But he was raised at the estate "Rose Lawn" in Syracuse, (first called 'Salina') NY.
He was home-schooled until he was twelve.
At age twelve, he was sent to the Peekskill Military Academy for two years.

It's said the yellow brick road may match the length of the road to Peekskill.
Or most likely the length from the Academy to Rose Lawn (maybe "Emerald City").

It's thirty-three miles between Syracuse and Peekskill, both near the Hudson River.

Yet Baum could have taken a train from Syracuse close to Peekskill.
The Syracuse Uttica Railroad, a first in New York, was running by May 1836.
The railroad system was much improved when Baum wrote this book in 1900.
By then the New York Railroad Station replaced Syracuse as a center for trains.

On the other hand, Baum could have taken a boat across the Hudson to Peekskill.
A shorter train or carriage ride would take him to the Hudson River, twelve miles wide.

It's speculation, and this influence on his first book isn't proven.
It's true Baum used his life experience and current events to inform that book.
He named "Dorothy" after his wife, for example.
Many more characters are named after family and friends, even perceived enemies.

Tried to answer this and searched many sites.
But it's still "the magic yellow brick road."
You'll see one in Chittenago, NY, if you go to their "Oz-Stravangza," held annually.
They initially had trouble making their yellow brick road stay yellow for their festival.
It works now, though.
It's said Chittenago's older yellow bricks can be found on eBay.

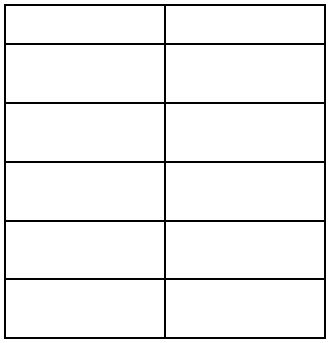
https://answers.yahoo.com/question/index?qid=20120309003206AA07jP6

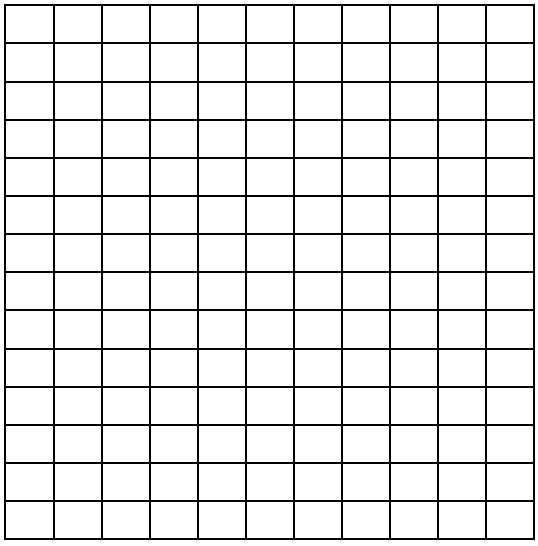
How long is the brick road?

Day 13:

The Great Oz has decided to hold a festival on July 1 and wants the Yellow Brick Road to be completed before this date. It will take a few days to choose the firm to build the road so they anticipate that the project may begin on June 1. This gives only 30 days to complete the entire project. How will this impact the choice of how many workers you will employ and how much it will cost? This is part 2 of his selection process so be sure to provide clear and concise information for him to determine your firms ability to complete this project correctly and efficiently.

1. Use information about the time it takes one worker to construct one mile and determine the time it would take one worker to construct all 33 miles.
2. How long would it take 2 workers to complete the 33 mile road, 3 workers, n workers?
3. How can we use this information to limit the time to 30 days?





Day 14: Planning Time

Discuss the strengths and weaknesses of individual group members. Just like in the Wizard of Oz, the diversity of all members provides a stronger foundation for creating a project that will appeal to others. You only have two days to prepare a presentation so plan carefully. How will you present your bid to the Great OZ? You may provide a written presentation, brochure, poster or video presentation. You have two days in class as well as any extra time your team decides is necessary to complete this project. Ipads will be available on a sign out list for videotaping. Complete the following charts to show the plans of your group.

Type of Project:

Group Members	Responsibility	Day One	Day Two	

Day 15: What have you accomplished?

Each group member is responsible for writing a short paragraph explaining their contribution towards the project. You should answer each of the questions and sign your name. If one member is absent, other group members need to document this and explain how they will accommodate their project to ensure completion.

What did you personally do to help the group today? Are you satisfied with your progress on the project?
1.
2.
3.
4.

Day 16: Are you ready?

Each group member is responsible for writing a short paragraph explaining their contribution towards the project. You should answer each of the questions and sign your name. If one member is absent, other group members need to document this and explain how they will accommodate their project to ensure completion.

Did you complete your responsibilities on this project? Are you ready to present tomorrow? If not, when and what will you be completing tonight to be prepared?
1.
2.
3.
4.

Day 17: What did you learn today?

After viewing other project today, what are some adjustments you would like to make on your project? What will be your role in these adjustments?
1.
2.
3.
4.

Day 17: It's Showtime

Each group member is responsible for writing a short paragraph explaining their contribution towards the project. You should answer each of the questions and sign your name. If one member is absent, other group members need to document this and explain how they will accommodate their project to ensure completion.

On a scale of 1-10, how ready is your group ready to present? What have you learned about planning, collaboration and revising opportunities in this project?
1.
2.
3.
4.

Day 18: Are you ready?

Provide a written review of two projects. What did they do that helped you to understand more about the mathematical concepts behind building a brick road? What suggestions do you have for this group to improve their project?
1.
2.
3.
4.