

Transformation 2013

Design Challenge

Planning Form

Guide

Design Challenge Title: Transformations & Uncle Joe's Pig Farm

Teacher(s): Eric Mann & Cassandra Ricks

School: Region XIII Education Service Center

Subject: Algebra 2

Abstract: In this lesson, students are introduced to function transformations. Specifically, they will investigate translation and dilation. Students see how changes in the algebraic representation of a function are connected to graphical changes.

MEETING THE NEEDS
OF STEM EDUCATION
THROUGH DESIGN CHALLENGES

Step 1: Begin with the End in Mind

- Does this design challenge meet the criteria for STEM student needs (21st century skills, TEKS, TAKS)?

Section 1

Summarize the theme or “big ideas” for this design challenge.

Students will graph a transformed function and describe translations and dilations and how they impact a function and its graph.

Section 2

Identify the TEKS/SEs that students will learn in the design challenge (two or three).

(2A.4) Algebra and geometry. The student connects algebraic and geometric representations of functions.

The student is expected to:

(A) identify and sketch graphs of parent functions, including linear ($f(x) = x$), quadratic ($f(x) = x^2$), exponential ($f(x) = a^x$), and logarithmic ($f(x) = \log_a x$) functions, absolute value of x ($f(x) = |x|$), square root of x ($f(x) = \sqrt{x}$), and reciprocal of x ($f(x) = 1/x$);

(2A.6) Quadratic and square root functions. The student understands that quadratic functions can be represented in different ways and translates among their various representations.

The student is expected to:

(B) relate representations of quadratic functions, such as algebraic, tabular, graphical, and verbal descriptions; and

(2A.7) Quadratic and square root functions. The student interprets and describes the effects of changes in the parameters of quadratic functions in applied and mathematical situations.

The student is expected to:

(A) use characteristics of the quadratic parent function to sketch the related graphs and connect between the $y = ax^2 + bx + c$ and the $y = a(x - h)^2 + k$ symbolic representations of quadratic functions; and

(B) use the parent function to investigate, describe, and predict the effects of changes in a , h , and k on the graphs of $y = a(x - h)^2 + k$ form of a function in applied and purely mathematical situations.

(2A.8) **Quadratic and square root functions.** The student formulates equations and inequalities based on quadratic functions, uses a variety of methods to solve them, and analyzes the solutions in terms of the situation.

(2A.9) **Quadratic and square root functions.** The student formulates equations and inequalities based on square root functions, uses a variety of methods to solve them, and analyzes the solutions in terms of the situation.

(2A.11) **Exponential and logarithmic functions.** The student formulates equations and inequalities based on exponential and logarithmic functions, uses a variety of methods to solve them, and analyzes the solutions in terms of the situation.

Section 3

Identify key performance indicators students will develop in this design challenge.

Students will investigate and graph transformed equations and develop heuristics for the changes that occur to parent functions when different values are altered.

Section 4

Identify the 21st century skills that students will practice in this design challenge (one or two).

Communication, Critical Thinking, Problem Solving, Collaboration

Section 5

Identify STEM career connections and real world applications if content learned in this design challenge.

Students will use math and technology to solve a problem encountered on a farm.

Step 2: Craft the Design Challenge

- *Have you posed an authentic problem or significant question that engages students and requires STEM knowledge to solve or answer?*

You and three of your friends have been hired by your Uncle Joe, a farmer, to build a rectangular pen for his pigs. Uncle Joe has a 200 foot roll of wire fencing and a 400 foot roll of wire fencing. Because the 200 foot roll is a different type of wire fencing than the 400 foot roll, he does not want you to combine the two rolls. He wants you and your team to use what you know about quadratic functions to provide him with the equations and graphs that shows the area of the pens you can build with each type of roll, describe the function for a 400 foot roll of fencing as a transformation of the function for a 200 foot roll of fencing, and answer the question (with a detailed explanation), “Is the largest pen that you can build with a 400 foot roll of fencing twice as large as the largest pen that you can build with a 200 foot roll?”

After completing all of the mathematical calculations that your uncle wants from you, he also wants you to build a model of the fence to scale using materials that he supplies you. Are you up for the challenge?

Step 3: Map the Design Challenge

Look at the *major* product for the design challenge and analyze the tasks necessary to produce a high-quality product. What do students need to know and be able to do to complete the tasks successfully? How and when will they learn the necessary knowledge and skills?

Performance Indicators (Refer to Step I, Section 3)	Already Learned	Taught before the project	Taught during the project
1. Calculate equations for quadratic functions	X	X	X
2. Sketch graphs of quadratic functions	X	X	X
3. Describe parameter changes that occur when transforming quadratic functions		X	X
4. Calculates area of rectangular figures	X		
5. Builds a scale model	X		
6. Develop key vocabulary: transformations, vertical translation, horizontal translation, vertical/horizontal stretch, vertical/horizontal shrink, vertical/horizontal shifts, reflections, quadratics, absolute value equations, linear equations, exponential equations			
7.			
8.			
9.			

Step 4: Plan the Design Challenge 5E Lesson

TASK 1:

Enter the Design Challenge Title and TEKS/TAKS objectives for your 5E lesson in the template provided.

TASK 2:

Describe the activities that occur throughout the 5E learning cycle. Provide explicit instructions in the 5E lesson plan, such that a first year teacher can easily understand what is expected and execute the design challenge lesson. Provide discussion facilitation questions if applicable. Use the planning forms provided on the following pages to complete each section of the 5E lesson. Refer to Step 3: Map the Design Challenge to help you identify relevant activities to include in the 5E learning cycle that focus on what students need to know and be able to do to complete the design challenge

TASK 3:

Identify and define the products and artifacts for each phase of the design challenge 5E learning cycle. *Artifacts are evidence of the student's thinking. Products could include culminating products or products that provide checkpoints for progress through the learning cycle.* The table below shows some examples of artifacts and products. Many additional possibilities exist. Use the planning forms provided on the following pages to complete the 5E lesson.

ARTIFACTS

- Notes
- Journal entries
- E-mail records
- Chat records
- Records of conversations, decisions, revisions
- Interviews using a structured set of questions
- Short, reflective paragraphs
- Library search record
- Telephone logs
- Purchase receipts
- Samples
- Minutes of meetings
- Discarded ideas
- Prototypes
- Group process reports

PRODUCTS

- Research papers*
- Reports*
- Multimedia shows*
- Presentations within the school*
- Exhibitions outside the school*
- Proposals
- Outlines
- Plans
- Blueprints
- Drafts
- Edited drafts
- Revised drafts
- Models
- Product critiques
- Videos
- Final versions of papers
- Field guides
- Biographies
- Websites
- Flow charts
- Design Briefs

**indicates culminating projects*

<p>Design Challenge Title: <i>Transformations and Uncle Joe’s Pig Farm</i></p> <p>TEKS/TAKS objectives: 2A.4A; 2A.6B; 2A.7A,B; 2A.8; 2A.9; 2A.11</p>	
<p>Engage Activity</p> <p>Identify/focus on instructional task, connect between past & present learning experiences, lay groundwork for activities (ex. Ask a question, define a problem, show a surprising event, act out a problematic situation)</p> <p>The particular subject area is introduced to the students with common examples that have meaning in their lives.</p>	<p>Show the following clips to engage the students:</p> <p>http://video.aol.com/video/home-build-a-fence-around-your-yard/1805983 (This video demonstrates what goes into building a fence)</p> <p>http://www.teachertube.com/view_video.php?viewkey=93b89d8fbee5667d077f&page=1&viewtype=&category= (This video is just for fun!)</p> <p>Introduce the students to the design challenge:</p> <p><i>“You and three of your friends have been hired by your Uncle Joe, a farmer, to build a rectangular pen for his pigs. Uncle Joe has a 200 foot roll of wire fencing and a 400 foot roll of wire fencing. Because the 200 foot roll is a different type of wire fencing than the 400 foot roll, he does not want you to combine the two rolls. He wants you and your team to use what you know about quadratic functions to provide him with the equations and graphs that shows the area of the pens you can build with each type of roll, describe the function for a 400 foot roll of fencing as a transformation of the function for a 200 foot roll of fencing, and answer the question (with a detailed explanation), “Is the largest pen that you can build with a 400 foot roll of fencing twice as large as the largest pen that you can build with a 200 foot roll?”</i></p> <p><i>After completing all of the mathematical calculations that your uncle wants from you, he also wants you to build a model of the fence to scale using materials that he supplies you. Are you up for the challenge?”</i></p> <p>Assign students to groups of 4. Have the students reflect in a brief discussion about the math that will be involved in solving the problem and completing the design challenge. After the discussion, have the students reflect in their journals about the discussion, making sure that they identify specifics with regards to how they are going to solve the problem. Have the groups complete the Cup Stack team building activity and debrief with the students.</p>
<p>Define the products and artifacts for the Engage Activity.</p> <p><i>Artifacts (KWL charts, journal entries, etc) are evidence of the student’s thinking.</i></p> <p><i>Products (flow charts, data tables, models, etc) include checkpoints for progress through a</i></p>	<p>Class discussion</p> <p>Journal entry</p>

<i>design challenge.</i>	
Materials/Equipment: Computer, LCD Projector, Internet Access, Journals, Pencils	
Resources: http://video.aol.com/video/home-build-a-fence-around-your-yard/1805983 http://www.teachertube.com/view_video.php?viewkey=93b89d8fbee5667d077f&page=1&viewtype=&category=	
<p>Explore</p> <p>Students get involved with phenomena and materials, students work in teams to explore through inquiry.</p> <p style="text-align: center;">Directed laboratories are conducted so the students can experience the principles in a controlled manner. This experience is crucial to success in solving design challenges.</p>	<p>Have the students complete the Transformations Activity located at: http://www.transformation2013.org/vi.html</p> <p>(Please note that if you do not have LabVIEW, you will have the opportunity to download the VI at the above website.)</p>

Define the products and artifacts for the Explore Activity.

Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.

Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.

Questions from the Transformations Activity

Materials/Equipment: Computer, Internet Access, Printer, Transformations VI

Resources: <http://www.transformation2013.org/vi.html>

<p style="text-align: center;">Explain</p> <p>Students discuss observations, ideas, questions and hypotheses with peers, facilitators, groups. Learners apply labels to their experiences – thus developing common language, clarification/explanation of key concepts</p> <p>Delivery of the content begins with a discussion of the principles illustrated by the Hands-On examples. In this way, the participants’ intuition is tapped to introduce terms and concepts that they may have heard. This approach leads naturally to an in-depth discussion of the science and mathematics concepts underlying the particular subject area.</p>	<p>Have the students discuss what they learned during the Explore Activity. Be sure to bring out key vocabulary (transformations, vertical translation, horizontal translation, vertical/horizontal stretch, vertical/horizontal shrink, vertical/horizontal shifts, reflections, quadratics, absolute value equations, linear equations, exponential equations, etc.). Clear up any misunderstandings and solidify the transformations concepts.</p> <p>Remind the students about the additional mathematics concepts that were discussed in the engage and perhaps refresh them on these concepts through practice problems (calculating the area of a rectangle, scale, calculating the equation (quadratic regression) of a parabola using three points and the graphing calculator, graphing quadratics, etc.).</p> <p>Have the students work in their groups to map out a flow chart of how they plan to solve the design challenge.</p>
<p>Define the products and artifacts for the Explain activity.</p> <p><i>Artifacts (KWL charts, journal entries, etc) are evidence of the student’s thinking.</i></p> <p><i>Products (flow charts, data tables, models, etc) include checkpoints for</i></p>	<p>Flow chart</p>

<p><i>progress through the design challenge.</i></p>	
<p>Materials/Equipment: Paper, pencil, possibly dry erase board, markers</p>	
<p>Resources: None</p>	
<p>Elaborate</p> <p>Expand on concepts learned, make connections to other related concepts, apply understandings to the world. (ex. Extend & apply knowledge).</p> <p>At its heart, engineering is the application of science and mathematics to design solutions to problems for humanity. Thus, providing design opportunities to students is a key component of STEM education. Opportunities to be creative in open-ended situations peak the interest of many students, providing</p>	<p>Students will work to solve the design challenge. They must document all of the steps they take using a flow chart and show all calculations and provide explanations/rationale for their thought process in their journals. The teacher must continually monitor all groups during this portion of the lesson cycle to ensure that they students are headed in the right direction.</p> <p>Provide the students with popsicle sticks, glue, and foil to use to complete the scale model of the pig pen.</p> <p>Upon completion, have the students write up a presentation on large chart paper documenting how they solved the problem.</p>

<p>an answer to the ubiquitous question: “Why do we need to know this?”</p>	
<p>Define the products and artifacts for the Elaborate activity.</p> <p><i>Artifacts (KWL charts, journal entries, etc) are evidence of the student’s thinking.</i></p> <p><i>Products (flow charts, data tables, models, etc) include checkpoints for progress through the design challenge.</i></p>	<p>Flow chart Scale model Calculations Journal entries</p>
<p>Materials/Equipment: Chart paper, popsicle sticks, glue, foil, paper, pencils, markers,</p>	
<p>Resources: None</p>	

<p style="text-align: center;">Evaluate</p> <p>Ongoing diagnostic process to determine if the learner has attained understanding of concepts & knowledge (ex. Rubrics, teacher observation with checklist, student interviews, portfolios, project products, problem-based learning products, assessments) Leads to opportunities for enrichment through further inquiry and investigation.</p> <p style="text-align: center;">What is the culminating task?</p>	<p>Students will present their results to the rest of the class using their chart paper and their model. After presenting, have the students post and display their results around the classroom. Ask the students to walk around and view all of the other groups' results.</p> <p>Grade students using the rubric below.</p>
<p>Define the products and artifacts for the Evaluate Activity.</p> <p><i>Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.</i></p> <p><i>Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.</i></p> <p><i>What is the final product (working model, portfolio, presentation, etc) you will require?</i></p>	<p>Presentation Chart paper Model</p>

Materials/Equipment: Chart paper, markers, scale model
Resources: None

Step 5: Plan the Assessment

State the criteria for exemplary performance for each artifact/product of each section of the 5E lesson.

- *Do the products and criteria align with the standards and outcomes for the design challenge?*

Engage Artifact(s)/Product(s): Journal entry – subjective grading
Explore Artifact(s)/Product(s): Transformations Activity – number/objective grading
Explain Artifact(s)/Product(s): Flow chart – subjective grading & objective grading
Elaborate Artifact(s)/Product(s): Flow chart, journal entries – subjective grading Scale model, calculations – number/objective grading
Evaluate Artifact(s)/Product(s): Presentation – rubric

Step 6: Create Rubrics

Develop rubrics for each artifact/product of the 5E learning cycle, using the criteria for exemplary performance as a foundation for the rubric.

- *Do the artifacts/ products and criteria align with the standards and outcomes for the design challenge?*

Use rubrics to demonstrate your expectations for students or create a rubric with students to determine the elements of exemplary performance.

Effective rubrics:

- are based on an analysis of student work.*
- target the central features of performance*
- provide useful feedback to students*
- use descriptors that students are able to use to self-assess or self-correct*
- provide indicators with examples to demonstrate levels of performance*

Rubric Resources:

[Math Problem Solving Rubric](#)