EOC Math I Remediation Lessons

Nevada Department of Education

Using the Desmos Graphing Calculator

Generalizing the Effects of k in Relation to the Parent Function $f(x)$

Enduring Understanding

(Do not tell students; they must discover it for themselves.)

Students will generalize the effects of k within the graphs of $f(x) + k$, $kf(x)$, $f(kx)$, and $f(x + k)$ in relation to the graph of the parent function $f(x)$.

Notes

Desmos is free graphing software for computers, phones, or tablets. It is available at https://www.desmos.com/calculator. This lesson can be adapted for any graphing calculator or graphing by hand.

Launch

Using the Desmos calculator, identify the effect on the graph of $f(x)$ by replacing $f(x)$ with $f(x)+k$, $kf(x)$, $f(kx)$, and $f(x+k)$ for specific values of k for three parent functions, absolute value $f(x) = /x/$, quadratic $g(x) = x^2$, and exponential $h(x) = 2^x$. Be prepared to defend your generalizations as to the effect of k in each position. You may use the slider function to change the values of k as seen above. Click on the blue arrow to activate slider. Click on the orange arrow to drag.

Understand the Problem

- Are there any words you don't understand?
- What are you asked to find?
- Is there enough information to find a solution?
- Can you restate the problem in your own words?
- Or, what information do you need to find?

Develop a Plan

- There are many reasonable ways to solve a problem. With practice students will build skill in choosing efficient strategies.
- Do not validate/invalidate any strategies, but ensure that students have a place to start (even if you know it will not work).
- Do not force your plan/reasoning on students.

Investigate

- Let students engage in a productive struggle.
- Monitor as students work.
- Do not offer feedback.
- Only ask questions.
    - Why did you choose that number?
    - What assumptions did you make?
    - Explain what you are doing here.
    - What does that solution mean?

Questions for Students as they Work

(If you observe _____, then you might ask _____.)

If students do not make connections between the graphs and the effect of k, then ask:

- Do you recognize any patterns?

If students focus on the picture and not the effects of k on the function, then ask:

- What other representations might help you see what's happening?

If students have a hard time articulating the changes they observe, then ask:

- How did the function change?
- What words might help you articulate that change? (allow for student word choice)
- How did the value of k influence that change?
- Where is the graph in relation to the parent function?

Debrief

Whole or Small Group Discussion

- Debriefing formats may differ (e.g., whole-class discussion, small-group discussion). It will be beneficial for students to view student work as a gallery walk or similar format.
- Have students sequence multiple representations in an order that moves from less to more mathematical sophistication.
- Allow students to question each other and explain their choices, using mathematical reasoning. If students struggle, model your own questioning strategies.
- Encourage students to notice similarities, differences, and generalizations across strategies.
- Provide purposeful feedback and ask questions.

Sample Solutions

(If you observe _____, then you might ask _____.)

If students are confused about comparing the effect of k across the functions, then ask:

- Can you tell me more about what you noticed?
- What changes related to k do they have in common?

If students use unclear vocabulary to articulate their thinking, then ask:

- How could you be more precise in describing the effects of k on the parent function? (Build vocabulary after students have shared their thinking in their own words and discuss/critique ideas.)

If students' justification is weak or unclear, then ask:

- How could you convince me or other students in a way they can understand? (Students should be encouraged to speak up when others' reasoning doesn't make sense to them.)

If students are confused about comparing the effect of k across the functions, then ask:

- Can you tell me more about what you noticed?
- What changes related to k do they have in common?

Synthesize and Apply

When students have independently arrived at the Enduring Understanding, engage them in solving these extension problems. Monitor student work and facilitate discussions by asking questions.

Extension Problem 1

On the website: https://teacher.desmos.com/, click either *Marbleslides: Parabolas* or *Marbleslides: Exponentials* and create a new session.

- Students go to the site: student.desmos.com and enter the class code.
- Students experiment with either quadratic equations or exponential equations to catch stars within the graphing program. The site allows the teacher to see all the attempts on each graph individually and share those graphs anonymously. This will help facilitate discussion student reasoning allow the teacher to make explicit connections to the previous lesson on transformations.

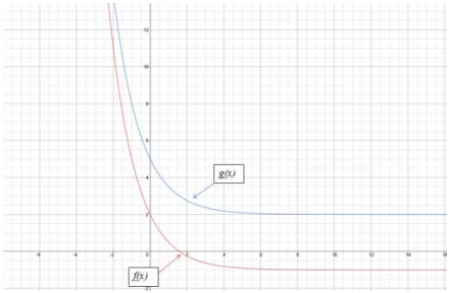
Extension Problem 2

Given the function $g(x) = x^2$ and $f(x) = 2(x-3)^2 + 5$:

- Graph $g(x)$ and $f(x)$on the same coordinate plane.
- Describe the effects of a, h, and k if $f(x) = a(x-h)^2 + k$ compared to the graph of $g(x)$.
- Use a gallery walk or other form of presentation for students to share their work.
- Discuss and critique the work presented.

Extension Problem 3

Two functions are graphed below. Describe the transformation(s) required to map $f(x)$ onto $g(x)$.



References

Common Core State Standards Initiative. (2010). *Common core state standards for mathematics.* Washington, DC: National Governors Association Center for Best Practices and the Council of Chief State School Officers.

Standards

- HSF.BF.B.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, k $f(x)$, $f(kx)$, and $f(x + k)$ for specific values of *k* (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.

Polya, G. (2014). How to solve it: *A new aspect of mathematical method.* Princeton, NJ: Princeton University Press.

Name_____

Using the Desmos Graphing Calculator

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Using the Desmos calculator, identify the effect on the graph of $f(x)$ by replacing $f(x)$ with $f(x)+k$, $kf(x)$, $f(kx)$, and $f(x+k)$ for specific values of k for three parent functions, absolute value $f(x) = /x/$, quadratic $g(x) = x^2$, and exponential $h(x) = 2^x$. Be prepared to defend your generalizations as to the effect of k in each position. You may use the slider function to change the values of k as seen above. Click on the blue arrow to activate slider. Click on the orange arrow to drag.