NetLogo – Graphing Trig. and Coding

*Time for this lesson = 55 minutes - One Day*

1. Standards and Safety and Materials:

A. Standards - [CCSS.MATH.CONTENT.HSG.SRT.A.1](http://www.corestandards.org/Math/Content/HSG/SRT/A/1/) Verify experimentally the properties of dilations given by a center and a scale factor:

- [CCSS.MATH.CONTENT.HSG.MG.A.1](http://www.corestandards.org/Math/Content/HSG/MG/A/1/) Use geometric shapes, their measures, and their properties to describe objects

B. Safety Concerns: Minimal safety concerns with regular class activity.

C. Materials – computer lab or classroom computers, computers need NetLogo downloaded

https://ccl.northwestern.edu/netlogo/5.1.0/

2. Objectives:

A. SWBAT… **list** and **describe** parts of a trig function such as amplitude and period.

B. SWBAT… **create** new images by adjusting the code in the NetLogo program.

3. Connections, Misconceptions, and Crosscutting Concepts:

A. Real world connections: mathematician, computer programmers, computer engineers, animator, graphic design.

B. Student connections: mathematics to programing through coding.

C. Misconceptions: Math is never used in the real world, animation does not use math

D. Crosscutting Concepts: Patterns, Cause and Effect  
 E. Vocabulary: Amplitude and Period

4. Catch/*Engagement*: Show a scene from a animation movie of water moving such as an Ocean Moving https://www.youtube.com/watch?v=y1rbOpeTVQk&list=PL7C72B75003EA5CD2&index=3

5. Pre-test:

1. What is amplitude?
2. What is period?
3. How does changing the number in front of a Trig function affect the graph? Give an example.
4. How does changing the number in front of the variable in a Trig function affect the graph? Give an example.

6. Activity/*Exploration*: Listed on following page

7. Assessments (Post-test)/*Evaluation*:

A. Formative: Ask oral questions about the effect of changing the amplitude and period has on the image during the activity

portion of the lesson.

B. Post-test: Same as pre-test

C. Summative: Students will change amplitude in the code and period to specific values and describe their changes.

D. The class post-test average must be an 80% or the next class will begin with a warm-up reviewing today’s

material.

8. Timeline: A. Catch 2 min

B. Pre-test 3 min

C. Activity 40 min

D. Review and Post-test 8 min

9. Enrichment/*Elaboration*: Experiment with the NUM-TURTLES slider. How many turtles are needed to produce a realistic effect? Why doesn’t it keep getting better-looking indefinitely as you add more turtles?

10. Citations: Wilensky, U. (1998). NetLogo 3D Surface model. <http://ccl.northwestern.edu/netlogo/models/3DSurface>. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

Wilensky, U. (1999). NetLogo. <http://ccl.northwestern.edu/netlogo/>. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

(This lesson would follow students being exposed to amplitude and period of a Sine and Cosine Function in a previous lesson)

Students will have their own computer or students will be in a pairs with a computer that has NetLogo downloaded.

**Activity:** Students will open NetLogo 5.1.0 and click File, then select Models Library, then select Mathematics, then select 3D Surface and open. Click Set-up tab above the image to see the 3D surface. Next, have students click the go tab. Have them write down their observations.

Next, have students click the Code tab at the top of the window. Have them identify what part of the code is making the wave (cosesine function). Next give directions to make the wave’s bigger by making a single change in the code. (Walk around the room and encourage students to use previous trig. knowledge to identify the part of the code that would change the amplitude.) Once the students make a change, then have them click back to the Interface tab and see if their change increased the amplitude. Let students explore for a minute or two and play with different amplitudes. Have students identify what they changed in the code. (Amplitude - students need to increase the number 5 in front of the cosine function.)

Next, have students change both amplitudes and discuss the effects. Again, give them time to explore several combinations of amplitudes to see the effects.

Next, have students reset their amplitudes back to 5 and now ask them to make more waves in the image by changing something else in the coding. Give students a few minutes to explore and walk around to remind them of their past trig. knowledge. Students should be changing the other 5 in the coding right after the cos. Have students identify what they are changing (Period).

Give students a few minutes to explore and change both amplitude and period to see the effects on the 3D image.

If time permits, students can experiment with the NUM-TURTLES slider. How many turtles are needed to produce a realistic effect? Why doesn’t it keep getting better-looking indefinitely as you add more turtles?

Students can also change other parts of the code and see if they can figure out what changes in the image. Maybe try changing the color.

**3D Surface(NetLogo)**

**WHAT IS IT?**

This model maps turtles between Cartesian and spherical 3-dimensional coordinates. To create the appearance of a curved 3D surface, the program generates turtles with random x- and z-coordinates, then computes each turtle’s y-coordinate based on x and z, and time. The cosine function is used in the formula to produce a curved surface. Varying the y coordinate based on time produces motion.

**HOW IT WORKS**

To render the surface in the NetLogo view, it maps from 3D to 2D coordinates as follows:

view x = turtle x + (turtle z) / 2  
view y = turtle y + (turtle z) / 2

In other words, increasing z causes the turtle’s apparent position to move both up and to the right.

**HOW TO USE IT**

Click the SETUP button to generate the turtles and place them on the surface. Click the GO (forever) button to run the model, which continuously varies the turtles’ y-coordinates to generate a wavelike motion.

The NUM-TURTLES slider determines the number of turtles that make up the surface.

**THINGS TO NOTICE**

Notice that as the turtles move down (y-coordinate decreases) they become darker in color, and when they move up (y-coordinate increases) they become lighter.