

Name: LaRie Hillman

Grade Level/Subject: Geometry or other higher mathematics classes.

Topic: Sine Curves

Objectives (P.A.S.S.): Geometry Standard IV. 4. Express the trigonometric functions as ratios and derive the relationship between sine, cosine, and tangent ratios, and use to solve real-world problems.

Introduction: This lesson draws a very real connection between the sine curve and the sine relationship for a function. It involves the kind of hands on activities students seem to really enjoy. I usually try to have the materials already divided up and provide one Student Directions sheet per group but I have one copy per student of the follow up questions page. The project can be completed in one class period but the students will probably have to do some of the questions as homework or you will have to give more time the following day to finish the questions.

Instructional process: Students will be divided into groups of 3 or 4 with an assortment of materials for each group: paper 2 feet wide and about 8 feet long, uncooked spaghetti, tape, protractor, straightedge, colored marker and twine or rope. I suggest that each group have a reader with the others to follow the instructions. They may change off after each step or keep the same reader for the entire assignment. If each student will record his/her own answers at the end of the activity the learning seems to increase (even when the group fills it out together). They will be given the very thorough instruction sheet and asked to go through each of the 17 steps one by one. I simply make myself available for consultation as needed. We usually display these projects high on the walls (above chalkboards) after completion for a while. They seem to create interest in other classes.

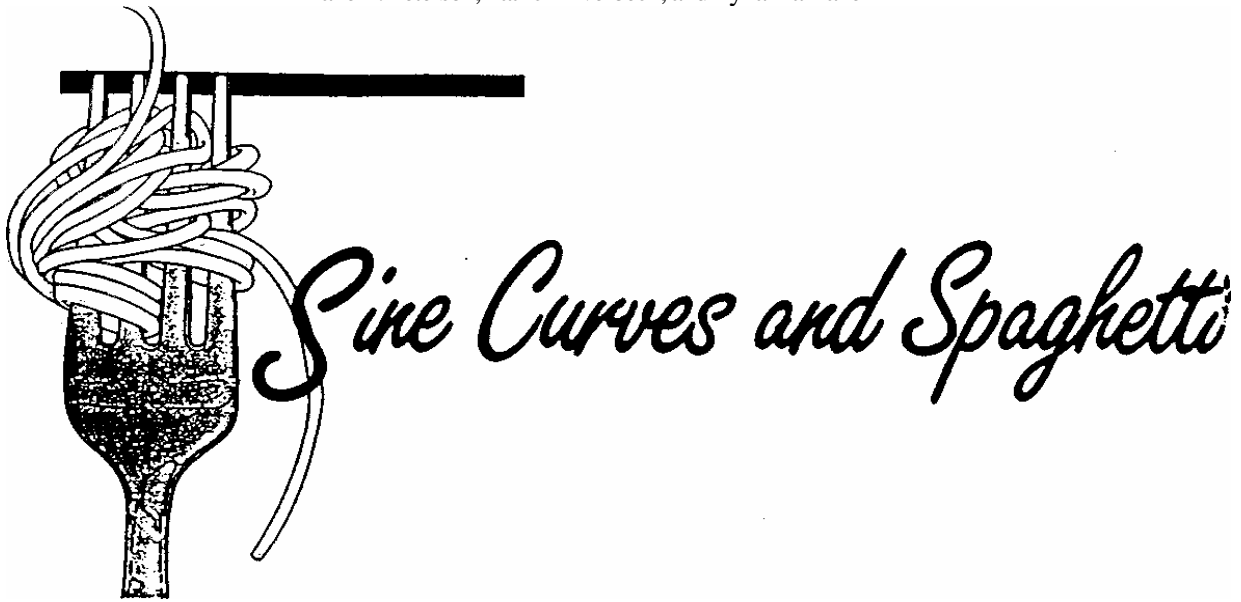
Closure: This best takes place after questions have been completed as students are allowed to share their answers to the last two questions as well as opening up discussion for any other questions that may have been problems for anyone.

Assessment: This project can lend itself to assessments for the groups and how they cooperate and work together as well as their final result. The question page also can give you an individual assessment for each student.

Modifications/Accommodations: Allow for creativity as students begin to grasp what they are doing. If you prefer not to use a food source to be wasted, we have also used drinking straws instead of the spaghetti, but it is becoming very difficult to find straws that do not have the flex joint.

Reflection: This project has worked well and been successful in my Math Analysis and Calculus classes in the past, but in looking at P.A.S.S. skills, I will try it this year in Geometry when we reach our trig functions. I am anxious to see how it will work with

these students and if they will get the connections as easily as my more advanced students have in the past. I haven't ever incorporated any literature with this project, but I'm sure there are a number of poems or writing that could be included such as "SPAGHETTI Spaghetti, spaghetti, all over the place, Up to my elbow-up to my face, Over the carpet and under the chairs, Into the hammock and round the stairs, Filling the bathtub and covering the desk, Making the sofa a mad mushy mess. The party is ruined, I'm terribly worried, The guests have all left (unless they're all buried). I told them,"Bring presents." I said,"Throw confetti." I guess they all heard wrong 'Cause they all threw spaghetti! By: Shel Silverstein"



STUDENT DIRECTIONS



SUPPLIES: Butcher paper that is 2 feet wide and 8 feet long,
Uncooked spaghetti, Masking Tape, Protractor,
Straightedge, Colored Marker, Twine or rope

Directions:

1. tape paper to floor with masking tape
2. at the left end of the paper construct a circle that has a radius of one spaghetti piece
3. mark the center of the circle with the letter C
4. draw a pair of axes with the origin at the center of the circle
5. using a protractor to determine angle measure, mark around the circle every 15 degrees
6. adjacent to this circle draw another set of axes with an x axis that is about 6.5 spaghetti lengths or 65 inches long (see figure I)
7. place a string along the circle with one end at 0 degrees and transfer the 15 degree marks from the circle to the string
8. stretch the string along the x-axis of the other set of axis and transfer the marks on the string to that axis (the end of the string that was at 0 degrees must be placed at the origin of the second set of axis)
9. mark the 15 degree scale on the x-axis (0 degrees, 15 degrees, 30 degrees, etc)

10. use the spaghetti to form a right triangle on the circle in which the radius of the circle to the 15 degree mark is the hypotenuse (see figure 2)
11. drop a second side of the of the triangle vertically from the mark on the circle to the x-axis to form a right triangle
12. break pieces of spaghetti into appropriate lengths for the legs of the triangle
13. move the piece of spaghetti that was the vertical leg of the triangle to the second set of axis on the right and place it perpendicular to the point on the x-axis corresponding to the 15 degree mark (see figure 2)
14. make a dot on the paper at the top of the piece of spaghetti to show the length of the vertical leg of the 15 degree triangle (see figure 2)
15. repeat this process for each of the marks around the circle (pay attention to the marks at 0, 90, 180 and 270 degree)
16. after all triangles have been constructed, the lengths of the vertical legs have been transferred and the dots have been added, draw a smooth curve to connect the dots resulting in the sine curve
17. answer the follow-up questions

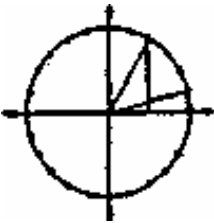


Fig. 2 i Spaghetti triangles at 15 degrees and 60 degrees

From the *Mathematics Teacher*, October 1998

SPAGHETTI SINE CURVES

NAME _____

After you have finished constructing the spaghetti sine curve, answer the following questions to help clarify the patterns seen and concepts learned during the construction.

1. What is the radius of the circle? _____

2. What is the circumference of the circle? _____

3. Where would a triangle corresponding to 375 degrees be constructed?

4. What is the period of the sine curve? That is, what is the wavelength—after how many degrees does the graph start to repeat?

5. Compared with the radius, what is the height of the triangle at 30 degrees? This number is the sine of 30 degrees.

6. Compared with the radius, what is the height of the triangle at 150 degrees, 330 degrees, and 570 degrees?

7. Compared with the radius, what is the height of the triangle at 45 degrees, 135 degrees, and 225 degrees?

8. If you build triangles only at the 15-degree, 30-degree, 45-degree, and so forth, marks, what is the smallest number of *different* triangles that you need to form to obtain the lengths needed to construct the graph of one period of the sine curve?

9. Write a one-paragraph explanation to a classmate about why $\sin 30$ equals $\sin 150$.

