Performance Based Learning and Assessment Task #1

Can I create a line/curve of best fit to model water drainage?

I. ASSESSSMENT TASK OVERVIEW & PURPOSE:

The task is to provide real world experience for students involving quadratic equations and specifically finding the curve of best fit using data they have gathered. Students will model water draining from a water tower. They will take measurements of how much water has drained at specific intervals and plot and then derive the equation and curve of best fit.

II. UNIT AUTHOR:

Arthur Madeoy, Frederick County Middle School, Frederick County, VA

III. COURSE:

Algebra I

IV. CONTENT STRAND:

Statistics

V. OBJECTIVES:

The learner will be able to gather data, represent properly on a Cartesian plane, and determine whether to derive the line of best fit or curve of best fit utilizing the data gathered.

VI. REFERENCE/RESOURCE MATERIALS:

Students will use a 16.9 oz. empty water bottle, measuring cup, bowl, graph paper, clock, and TI-84 calculator.

VII. PRIMARY ASSESSMENT STRATEGIES:

Students will be assessed on:

- Gathering the data correctly
- Analyzing the data to choose whether to derive the a line/curve of best fit
- Deriving the proper line/curve of best fit

VIII. EVALUATION CRITERIA:

See attached rubric and data sheet.

IX. INSTRUCTIONAL TIME:

This task should take one 50 minute class period.

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Statistics

Mathematical Objective(s)

The learner will be able to gather data, represent properly on a Cartesian plane, and determine whether to derive the line of best fit or curve of best fit utilizing the data gathered.

Related SOL

A.11 The student will collect and analyze data, determine the equation of the curve of best fit in order to make predictions, and solve real world problems, using mathematical models. Mathematical models will include linear and quadratic functions.

NCTM Standards

- Make conjectures about possible relationships between two characteristics of a sample on the basis of scatter plots of the data and approximate lines of fit
- Draw reasonable conclusions about a situation being modeled
- Model and solve contextualized problems using various representations, such as graphs, tables, and equations

Additional Objectives for Student Learning (include if relevant; may not be math-related):
Students should understand that most events in the universe do not occur at constant rates and thus the importance of calculus.

Materials/Resources

Students will use a 16.9 oz. empty water bottle, measuring cup, bowl, graph paper, clock, and TI-84 calculator.

Assumption of Prior Knowledge

- Graphing data on a Cartesian plane
- Using scatter plots to determine if they represent a curve or a line
- Using data to find the line/curve of best fit
- Students may struggle in determining whether to use line/curve of best fit

- ✓ To help prevent this issue, lines and curves will be reviewed before the activity

Introduction: Setting Up the Mathematical Task

In this activity you will determine if water flows out of a water tower at a constant rate or if it varies. The task will take one class period (50 minutes). You will model a water tower by using a bottle of water with a hole in the side near the bottom. Each water bottle has a different sized hole. This task will be done with a partner.

1. You will fill the water bottle with 10 ounces of water and then set the water in the bowl so that the water begins to drain.

2. Using the clock on the wall, you will allow water to drain for 5 seconds.

3. Check the bottle to see how much water is left using the measuring lines drawn on the sides.

Estimate t the nearest quarter ounce.

4. You will then use the measuring cup to determine how much water has flowed. The water in the

bowl will be added to whatever water is in the measuring cup to find the total amount of water flow.

5. Record your data in the table on the next page.

6. Then you will repeat the process until all the water is emptied from the bottle.

Teacher will demonstrate how to do the steps properly.

Student Exploration

Small Group Work

Students will work together in pairs. One student should be doing the time while the other student measures the water and records the data. Students should work together to interpret the data and deciding on the best type of trend line.

Student/Teacher Interactions

Students should be communicating about the task. When completed they should be asking themselves and each other (in their group) why they chose to use a line or curve of best fit. Students should also be asking why they think that the water exiting the bottle was constant or varied. The teacher will go around the room and ensure that the students are following procedure and using questioning to guide students in their exploration.

Monitoring Student Responses

Any group not following procedure will be explained where they are straying from the proper way to gather their data. Those students who need extra help in understanding lines and curves will be given assistance.

Students will demonstrate their knowledge of the material by explaining their reasoning in choosing whether to use a line or a curve.

Algebra I Name(s)_____

"Can I create a line/curve of best fit to model water drainage?"

You will model a water tower to determine whether the rate at which water flows is constant or varies. Be sure to follow procedures and all work should be neat, organized, and presentable.

Part I

Steps

1. You will fill the water bottle with 10 ounces of water and then set the water in the bowl so that the water begins to drain.

2. Using the clock on the wall, you will allow water to drain for 5 seconds.

3. Check the bottle to see how much water is left using the measuring lines drawn on the sides. Estimate t the nearest quarter ounce.

4. You will then use the measuring cup to determine how much water has flowed. The water in the bowl will be added to whatever water is in the measuring cup to find the total amount of water flow.

5. Record your data in the table on the next page.

6. Then you will repeat the process until there is about 1 or 2 ounces left in the bottle.

Table

Seconds	Total Amount of Water Left in Bottle
5	
10	
15	
20	
25	
30	
35	
40	
45	
50	
55	
60	
65	
70	
75	
80	
85	
90	
95	
100	

Part II

1. Using the data from the table, plot the points on a sheet of graph paper. Be sure to label the axes clearly.

2. Analyze the data and the graph and then find the line or the curve of best fit (You may use the ti-84 to aid you). You will have to decide which one (line or curve) to find based on the data.

Part III

Questions

1. What is the line/curve of best fit that you determined?

2. Why did you chose a line or a curve? Be specific.

3. Why do you think that the water from the tanks flows at the rate it does?

4. Using your equation, determine how much water would be left after 21 seconds.

The following Rubric will be used for the Final Draft

Using the descriptions of each category on page 2 to determine the appropriate point value

Can I create a line/curve of best fit to model water drainage?

			Earned Assessment	
Number	**Element**	**Point Value**	**Self**	**Teacher**
1	Mathematics task is inquiry based	2	**2**	
2	Mathematics task is connected to the real world	2	2	
3	Mathematics task is open ended	2	2	
4	Mathematics task requires higher order thinking skills	2	2	
5	Mathematics task includes one or more performance tasks	2	2	
6	Mathematics task identifies one or more work habits	2	2	
7	Mathematics tasks are based on the SOL's	2	2	
8	The assessment list identifies all essential mathematics	2	2	
9	The assessment list identifies all performance components	2	2	
10	The assessment list includes work habits	2	2	
11	The assessment list acts as a student check list	2	2	
12	The assessment list allows for student self-assessment	2	2	
13	The assessment list allows for teacher assessment	2	2	
14	There are two mathematics tasks	2	2	
15	There are two assessment lists	2	2	
16	There are two benchmarks.	2	2	
17	The project package is well organized	2	2	
18	The project package is neat	2	2	
19	The project package is complete	2	2	
20	All recommended changes were made	2	2	

Rubric for Final

#	Element	0	1	2
1	Mathematics task is inquiry based	Not inquiry based	Somewhat inquiry based	Inquiry based
2	Mathematics task is connected to the real world	No connection to real world experiences	Connection to in-school	Connection to out-of-school
3	Mathematics task is open ended	Fully teacher directed closed task	Teacher structured but open ended task	Many entry points and multiple solutions
4	Mathematics task requires higher order thinking skills	Memorization and skill practice	Show and explain	Analysis, synthesis
5	Mathematics task includes one or more performance tasks	No performance tasks	NA	Includes one or more
6	Mathematics task identifies one or more work habits	No work habits identified	Some are identified	All work habits are identified
7	Mathematics tasks are based on the SOL's	No SOL identified	Uses unrelated SOL	Uses appropriate SOL
8	The assessment list identifies all essential mathematics	No essential elements are identified	Some are identified	All are identified
9	The assessment list identifies all performance components	None are identified	Some are identified	All are identified
10	The assessment list includes work habits	No work habits included	Some appropriate work habits included	All appropriate work habits included
11	The assessment list acts as a student check list	Fails to act as a checklist	Check list is difficult to use	Acts as a check list
12	The assessment list allows for student self-assessment	Fails to allow for self-assessment	Self-assessment difficult to perform	Allows for self-assessment
13	The assessment list allows for teacher assessment	Fails to allow for teacher assessment	Teacher assessment difficult to perform	Allows for teacher assessment
14	There are two mathematics tasks	No tasks	One task	Two tasks
15	There are two assessment lists	No lists	One list	Two lists
16	There are two benchmarks.	No benchmarks	One bench marks	Two benchmarks
17	The project package is well organized	No evidence of organization	Not fully organized	Well organized
18	The project package is neat	Lacks neatness	Needs improvement	Neat
19	The project package is complete	Incomplete in more than one area	Incomplete in one area	Complete
20	Recommended changes were addressed	No recommended changes were addressed	Some recommended changes were addressed	All recommended changes were addressed

Rubric For Activity

"Can I create a line/curve of best fit to model water drainage?"

Goals	0	1	2	3
Data Gathering	No evidence	Data was found but was not correct. Did not follow proper procedure	Data was found but not correct. Proper procedure was inconsistently followed.	Data was found and is correct and proper procedure was adhered to
Represented Data on Cartesian Plane	No evidence	Data was improperly placed on the Cartesian plane with no reasoning behind the placement.	Data was improperly placed on the Cartesian plane but a slight mistake was made in doing so.	Data was properly placed on the Cartesian plane.
Chose correctly whether to create a line or curve of best fit	No evidence	Incorrectly/correctly chose line/curve of best fit and evidence of reasoning was flawed	Incorrectly/Correctly chose line/curve of best fit but reasoning was to a small extent flawed	Correctly chose line/curve of best fit and reasoning was solid
Accurately found the equation of the line or curve of best fit	No evidence	Found incorrect line or curve equation and method in doing so was incorrect	Found incorrect line or curve equation but method was correct and only a slight mistake was found in the process	Found correct equation for line or curve of best fit.
Follows Procedure and Presentable	No Evidence	Did not follow procedures and/or work is not neat, organized and presentable	Followed procedure and work is neat, organized, and presentable but has minor errors	Followed procedure and work is neat, organized, and presentable

Algebra I Name(s) Benchmark

"Can I create a line/curve of best fit to model water drainage?"

You will model a water tower to determine whether the rate at which water flows is constant or varies. Be sure to follow procedures and all work should be neat, organized, and presentable.

Part I

Steps

1. You will fill the water bottle with 10 ounces of water and then set the water in the bowl so that the water begins to drain.
2. Using the clock on the wall, you will allow water to drain for 5 seconds.
3. Check the bottle to see how much water is left using the measuring lines drawn on the sides. Estimate t the nearest quarter ounce.
4. You will then use the measuring cup to determine how much water has flowed. The water in the bowl will be added to whatever water is in the measuring cup to find the total amount of water flow.
5. Record your data in the table on the next page.
6. Then you will repeat the process until all the water is emptied from the bottle.

Table

Seconds	Total Amount of Water Left in Bottle
5	9
10	8
15	7.2
20	6.4
25	5.8
30	5.2
35	4.8
40	4.3
45	3.9
50	3.6
55	3.3
60	3
65	2.7
70	2.5
75	2.3
80	
85	
90	
95	
100	

Part II

1. Using the data from the table, plot the points on a sheet of graph paper. Be sure to label the axes clearly.

2. Analyze the data and the graph and then find the line or the curve of best fit (You may use the ti-84 to aid you). You will have to decide which one (line or curve) to find based on the data.

A curve.

Part III

Questions

1. What is the line/curve of best fit that you determined?

$y = .0011x^2 - 0.1776x + 9.6699$

2. Why did you chose a line or a curve? Be specific.

The data shows that the water did not flow at the same rate. Therefore, we would want a changing rate which would be a curve.

3. Why do you think that the water from the tanks flows at the rate it does?

Gravity is causing a force to push the water out. With less water there is less force.

4. Using your equation, determine how much water would be left after 21 seconds.

$y = .0011(21)^2 - .1776(21) + 9.6699 =$ 6.430z.

X is the axis for time.