Performance Based Learning and Assessment Task

Snappy Stair Sprints

I. ASSESSSMENT TASK OVERVIEW & PURPOSE:

This task will give students the opportunity to determine patterns using self-gathered data to make predictions for a real-world problem about completing a stair athletic drill. This task does not have a predictable answer and will require students to explore and understand mathematical concepts of curve of best fit and rely on personal experiences to make appropriate predictions.

II. UNIT AUTHOR:

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III. COURSE:

Algebra 1

IV. CONTENT STRAND:

Algebra and Functions

V. OBJECTIVES:

- The learner will be able to translate a real-life scenario into algebraic expressions.
- The learner will be able to communicate in writing and verbally within their groups to clearly and effectively ensure understanding of a topic.
- The learner will interpret and make predictions about completing the athletic drill given a particular number of stairs.
- The learner will use technology (Excel, graphing calculator, Geogebra, online tool) to create an XY scatterplot and line or curve of best fit.

VI. REFERENCE/RESOURCE MATERIALS:

- Graphing technology (graphing calculator, excel, or Geogebra)
- Graph paper (optional)
- Timer

VII. PRIMARY ASSESSMENT STRATEGIES:

The task includes an assessment component that performs two functions: (1) for the student it will be a checklist and provide a self-assessment and (2) for the teacher it will be used as a rubric. The assessment list for the activity is intended to evaluate the student's use of mathematics to make reasonable decisions. It will also evaluate the use of technology for making calculations and graphing. It will also evaluate the student's ability to clearly communicate their thinking and process of solving the task.

VIII. EVALUATION CRITERIA:

Students will assess themselves using the attached rubric. The teacher will then assess the students using the same rubric.

IX. INSTRUCTIONAL TIME:

This activity should take one 90-minute block.

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Mathematical Objective(s)
The goal of this activity is to allow students to gather data and create a curve of best fit to make appropriate predictions. Students should use clear mathematical language to communicate their thinking to clearly explain their process of obtaining their solution. Students will then use technology (excel, graphing calculator, Geogebra, etc) to interpret, make predictions, and to create graphs and images that represent their data and support their prediction.

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
- represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules;
- relate and compare different forms of representation for a relationship;
- identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations
- generalize patterns using explicitly defined and recursively defined functions;
- understand relations and functions and select, convert flexibly among, and use various representations for them;
- use symbolic algebra to represent and explain mathematical relationships;
- model and solve contextualized problems using various representations, such as graphs, tables, and equations.

Materials/Resources
- Graphing technology (graphing calculator, Excel, or Geogebra)
- Graph paper (optional)
- Timer

Assumption of Prior Knowledge
- Students should be able to use Excel, graphing calculator or other technology to create graphs and algebraic equations from data.
- Students should be able to organize data and create tables.
- Students should understand the meaning of the results of an equation given the context of a real life situation.
- Students should be able to create equations based on real-life situations.
- Students may have difficulties determining how to collect data. Offer a few suggestions if needed and encourage them to collect data in a way that they can look for patterns to make predictions.

Introduction: Setting Up the Mathematical Task

In this activity, students will collect data and make predictions for an athletic drill. The teacher will introduce the task by asking how many students play sports. Also discuss and ask what types of conditioning drills the students complete during practices. Are all drills directly related to the sport? Or is it the goal of some conditioning drills to work on endurance or strength? What happens during an athletic drill as you continue the drill for a length of time?

Student Exploration

Small Group Work

Students will work in groups of two or three.

Student/Teacher Actions:

- Students should begin by first reading and discussing the given problem.
- Students will need to develop a plan on what data they are going to collect when they are given their 60 seconds on the staircase (for both attempts). They will not have enough time to complete the entire drill, so they will have to determine what information will be most important to make accurate predictions.
- Teachers should be walking around observing groups and answering questions and providing guidance where necessary.
- After students have gathered their data, they will then need to organize their data and make appropriate calculations. Using Excel will be very helpful for data input. As an option, students can also organize their data in tables using paper, however, this may take a bit longer.
- Students will need to determine what information is important. They may also take into consideration that the athlete may become more and more tired (therefore slower) as the drill continues for all stairs.
- After students have organized their data, they will need to complete a visual such as a graph or table to show their data and predictions.
- Students must also develop a formula that they can use to predict the time it would take to complete the athletic drill given a certain number of stairs. Encourage students to look for patterns or trends in their data to help develop an accurate equation using line or curve of best fit.
- Teachers should be encouraging students to work together and to check each other's work.
- As a final task, students will choose one group member to complete the athletic drill. This is a fun way to determine the accuracy of their equation and predictions.

Monitoring Student Responses

- Students will be discussing in their groups how to make an accurate prediction. Students may consider time per step, turnaround time, etc. They may also take into consideration that the athlete may become more and more tired (therefore slower) as the drill continues.
- Each student should be an active participant and contribute ideas and calculations in their groups.
- The teacher will assist students by answering questions and providing suggestions for data collection or data analysis during the process.
- Students should communicate their thinking verbally and in written form when sharing their ideas and calculations with their group.
- Students may need help using Excel or other technology. YouTube has many excellent videos on how to create scatterplots and trend lines in Excel.
- As a possible extension, teachers can ask students to write an equation that represents the number of stairs climbed for any given staircase when completing the athletic drill.

Activity Worksheet

Jack completed several conditioning drills today for soccer practice. One of the drills his coach calls *Snappy Stair Sprints*. In order to complete the drill, Jack went up the first step, turned around and went back down, turned around and went up two stairs, then turned around and went all the way back down to the floor, then he turned around and ran up three stairs, then he turned around and went back down all of the stairs again. This pattern was continued until all 30 stairs have been climbed and Jack stopped running when he reached the bottom of the stairs.

You will have two attempts (60 seconds each) to gather data that you can use to make predictions about completing the *Snappy Stair Sprints* given various numbers of stairs. This is not enough time to complete the entire *Snappy Stair Sprints* drill! Make a plan before you go out of the classroom for each of your 60 seconds on what data you will need to gather.

After completing this assignment, choose one person from your group to complete a "mini-version" of the *Snappy Stair Sprints* competition for 20 stairs. This competition is not necessarily about the fastest time, but the most accurate time given your prediction.

1. Explain how your group collected data during each 60 second attempt.

2. Organize your data in a table.

3. Create a graph and equation that represents your data.

4. Using the data you collected, analyze and predict how long it would take a group member of your choice to complete the "mini" *Snappy Stair Sprints* drill for 20 stairs. Also make a prediction for 30 stairs and 50 stairs? Explain in detail how you determined each of your predictions.

5. After the class competition, analyze the accuracy of your prediction compared to the actual results. What (if any) changes would you make to how your gathered your data collection or created the formula for the predictions?

Assessment List and Benchmarks

- Students will be graded with the following rubric:

Element	Points Possible	ASSESSMENT POINTS	
		Self	Teacher
1. Data collected within allotted time and explanation of each 60 second attempt.	3		
2. Data recorded and organized in table.	3		
3. Graph(s) are complete and correct.	3		
4. Graph(s) are clearly labeled.	3		
5. Graph(s) are neat.	3		
6. Equation for prediction for any staircase.	3		
7. Prediction for 20, 30, and 50 stairs.	3		
8. Explanations of work and predictions.	3		
9. Analysis of accuracy of prediction for 20 stairs after class competition.	3		
10. Group members were on task and each member contributed to data collection and analysis.	3		
Total Points	30		

CATEGORY	3	2	1	0
1. Data collected within allotted time and explanation of each 60 second attempt.	Collects data within 60 seconds and clearly explains the data collection process.	Collects data within 60 seconds however could further explain the data collection process.	Needed additional time to collect data and does not clearly explain data collection process.	Uses an inefficient strategy to collect data AND needed additional time.
2. Data recorded and organized in table.	The data is presented in a neat, clear, organized fashion that is easy to read.	The data is presented in an organized fashion but may be hard to read at times.	The data appears sloppy and unorganized. It is hard to know what information goes together.	The table is incomplete or missing.
3. Graph(s) are complete and correct.	Graph(s) are clear and greatly add to the reader's understanding of the procedure(s).	Graph(s) are clear and easy to understand.	Graph(s) are somewhat difficult to understand.	Graph(s) are difficult to understand or are not used.
4. Graph(s) are clearly labeled.	There is a title and the x and y-axis is labeled correctly and included proper units.	There is a title and the x and y-axis is labeled correctly but missing proper units.	The title or an axis label is missing from the graph.	There is no title or axis labels.
5. Graph(s) are neat.	The graph(s) are presented in a neat, clear, organized fashion that is easy to read.	The graph(s) are presented in a neat and organized fashion that is usually easy to read.	The graph(s) are presented in an organized fashion but may be hard to read at times.	The graph(s) appear sloppy and unorganized. It is hard to know what information goes together.
6. Equation for prediction for any staircase.	Calculation complete and accurate.	Calculation nearly complete and accurate.	Attempted to complete calculations but incorrect.	Incorrect with little/no evidence of calculations or completely missing.
7. Prediction for 20, 30, and 50 stairs.	Calculation complete and accurate based off of information in graph and table.	Calculation nearly complete and accurate based off of information in graph and table.	Attempted to complete calculations but incorrect or missing a prediction.	Incorrect with little/no evidence of calculations.
8. Explanations of work and predictions.	Uses complex and refined mathematical reasoning.	Uses some effective mathematical reasoning.	Little evidence of mathematical reasoning.	Uses no mathematical reasoning or explanation is missing.

9. Analysis of accuracy of prediction for 20 stairs after class competition.	Used precise mathematical language to clearly communicate thinking of accuracy of prediction.	Used good mathematical language to clearly communicate thinking of accuracy of prediction.	Partially communicated thinking and explanation of accuracy of prediction.	Does not include analysis of prediction.
10. Group members were on task and each member contributed to data collection and analysis.	All group members worked diligently without teacher direction.	Group member(s) had to be redirected once or twice to stay on task.	Group member(s) had to be redirected a few times and/or projects was not a product of all members.	Group member(s) were repeatedly asked to stay on task.

Benchmark

1. Explain how your group collected data during each 60 second attempt.

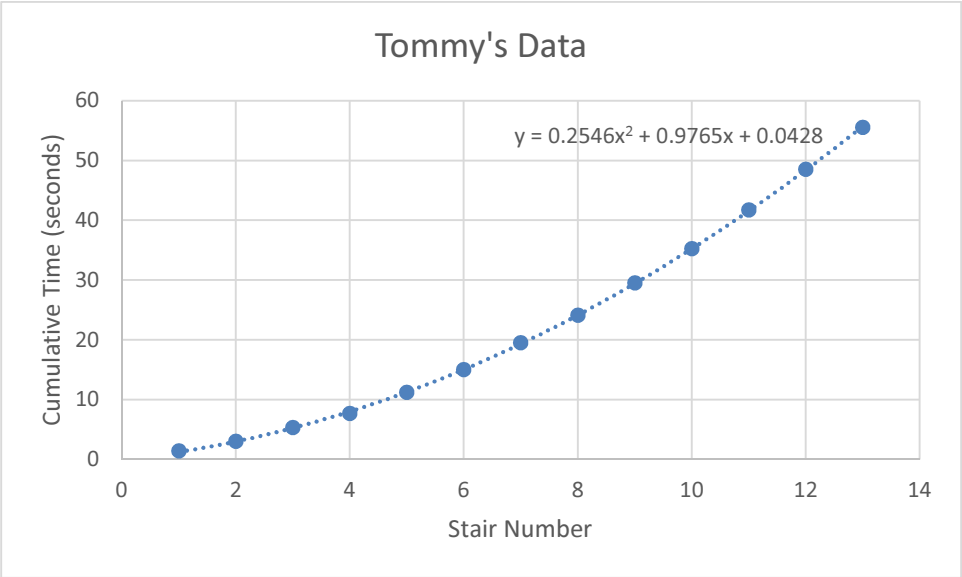
   During our first 60 seconds of collecting data, we had Tommy complete the athletic drill for as long as he could during the 60 seconds. Using our cellphones and the lap feature, we determined how long it took him to complete 1, 2, 3, 4, … stairs. Tommy was able to complete 13 stairs. The data is shown in the table below.

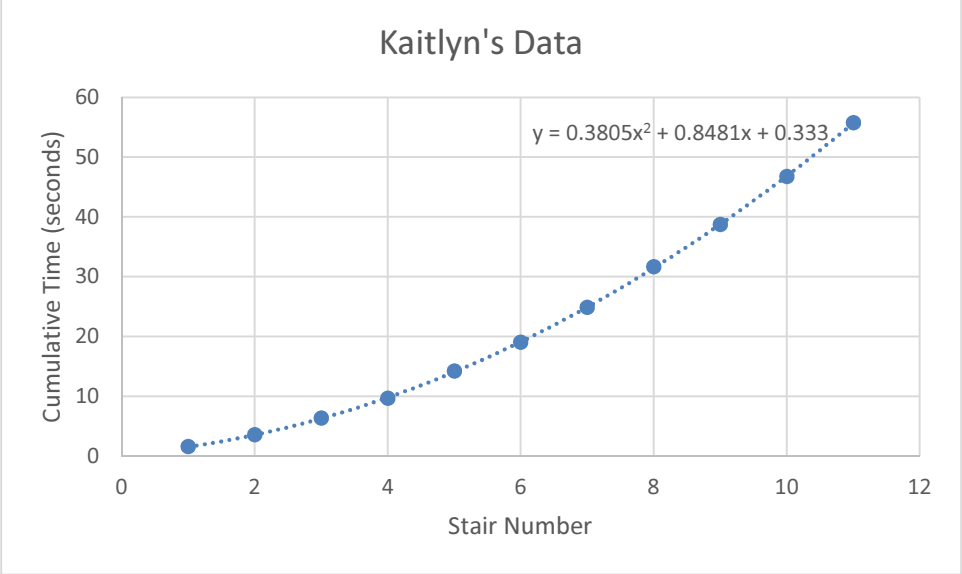
   For the second 60 seconds, we had a girl (Kaitlyn) complete the task. We collected the data the same ways as we did for Tommy. We had both Kaitlyn and Tommy complete the task so we could observe the two different sets of data and see if they showed the same graphical trends (linear vs. quadratic).

2. Organize your data in a table.

Lap	Tommy Time per Lap	Tommy Cumulative Time	Kaitlyn Time per Lap	Kaitlyn Cumulative Time
1	1.41	1.41	1.58	1.58
2	1.61	3.02	1.98	3.56
3	2.31	5.33	2.76	6.32
4	2.36	7.69	3.36	9.68
5	3.53	11.22	4.51	14.19
6	3.79	15.01	4.85	19.04
7	4.5	19.51	5.85	24.89
8	4.61	24.12	6.8	31.69
9	5.43	29.55	7.05	38.74
10	5.7	35.25	8	46.74
11	6.51	41.76	9.02	55.76
12	6.75	48.51		
13	7.03	55.54		

3. Create a graph and equation that represents your data.





Both sets of data (Tommy and Kaitlyn) showed a quadratic trend. Therefore, the curve of best fit each of them was:

Tommy: $y = 0.2546x^2 + 0.9765x + 0.0428$

Kaitlyn: $y = 0.3805x^2 + 0.8481x + 0.333$

4. Using the data you collected, analyze and predict how long it would take a group member of your choice to complete "mini" *Snappy Stair Sprints* drill for 20 stairs. Also make a prediction for 30 stairs and 50 stairs? Explain in detail how you determined each of your predictions.

   We are going to have Tommy complete the "mini" *Snappy Stair Sprint* drill for the class competition. Therefore, we have based all of our predictions from Tommy's data. Using our curve of best fit, we predict that Tommy can complete 20 stairs in 121.41 seconds. If he were to also complete the drill for 30 and 50 stairs, his time would be 258.48 seconds and 685.37 seconds respectively. We found these answers by plugging in 20, 30 and 50 into the curve of best fit to make a prediction.

5. After the class competition, analyze the accuracy of your prediction compared to the actual results. What (if any) changes would you make to how your gathered your data collection or created the formula for the predictions?

   Tommy completed the stair drill in 130.6 seconds! This was not far off from our prediction of 121.41 seconds. Tommy accidentally tripped in the middle of the drill which may have led to a higher result than our prediction. Overall though, our group believes that the prediction was very good. We would not make any changes to our method of collecting data or the formula we created.