

Performance Based Learning and Assessment Task

What is my standing height wise?

I. ASSESSMENT TASK OVERVIEW & PURPOSE:

Students will be using a variety of statistical concepts that they learned in their Algebra course to help a student named Tyler determine and describe his location in a distribution, with respect to his height. In this task, students will collaborate with a partner to come up with a plan that can be used to gather data that will hopefully support Tyler's claims that he is not as short as others think that he is. Students will also have to implement the plan, analyze the data, and make conclusions which will be presented in a short class presentation.

II. UNIT AUTHOR:

Yolonda Shields, Staunton River High School, Bedford County Public Schools

III. COURSE:

Algebra I / Algebra II

IV. CONTENT STRAND:

Statistics

V. OBJECTIVES:

- The students will find and describe the location of an individual within a distribution, using percentiles, a human dotplot, the mean, and standard deviation of collected data.
- The students will calculate and use measures of center, spread, and location (percentile and z-score) in order to analyze the relationships between Tyler's height of 62 inches and the rest of the heights that were collected.

VI. REFERENCE/RESOURCE MATERIALS:

TI-83 Plus (or higher) Graphing Calculator, computer, Internet, pencil, paper, meter stick (for helping draw the number line straight using sidewalk chalk and also for measuring equal distances between each height value marked on the number line), sidewalk chalk or masking tape for the number line scale for the human dotplot, Assessment Rubric, copy of Performance Task, spreadsheet software, word processing software (i.e Microsoft Word or Google Docs), and copy of Benchmarks.

VII. PRIMARY ASSESSMENT STRATEGIES:

While students are working on the Performance Based Assessment task in groups of 2, the teacher will be evaluating the students to make sure each stay on task. If the teacher notices students are off task, then students will be referred to the attached rubric/list, which both the student and teacher can use as a reference, a checklist, and a rubric. The assessment list for each of the activities will contain all the essential components for this mathematics activity. This includes the mathematics content, process skills, and requirements for the finished

product.

VIII. EVALUATION CRITERIA:

Students will be evaluated on their completion of the activity and by their final product. The attached Assessment List and Rubric provides more details on what is expected. Benchmarks are also attached to end of this assessment task.

IX. INSTRUCTIONAL TIME:

This activity will take approximately 90 minutes, which is an entire class period on a block schedule.

What is my standing height wise? / Task 2

Strand

Statistics

Mathematical Objective(s)

- The students will find and describe the location of an individual within a distribution, using percentiles, a human dotplot, the mean, and standard deviation of a set of collected data.
- The students will calculate and use measures of center, spread, and location (percentile and z-score) in order to analyze the relationships between Tyler's height of 62 inches and the rest of heights that were collected.

The mathematical goal of this activity is for students to use their current knowledge and to seek out additional information needed to solve this authentic statistical problem. The goal is also to help students use mathematics, collaboration, logical thinking, and research to gain evidence that could possibly support Tyler's claims about him not being as short as others may think. Students will have a deeper appreciation of mathematics and its valuable role in many areas, including the frequent conversations that are held about height. Students may also use word processing software to organize their ideas and answer questions that will be a part of their presentation (bonus points). Nevertheless, students will gain valuable skills as they gather information, analyze data, and communicate their mathematical ideas.

Related SOLs

- **SOL A.9** (Interpreting variation in real-world contexts and calculating/interpreting mean absolute deviation, standard deviation, and z-scores given a set of data)
- **SOL AII.11** (Identifying and applying properties of a normal distribution)

NCTM Standards

Students will engage in problem solving, communicating, reasoning, connecting, and representing as they...

- Apply and adapt a variety of appropriate strategies to solve problems
- Communicate mathematical thinking coherently and clearly to peers, teachers, and others

Data Analysis & Probability:

Students will:

- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
- Select and use appropriate statistical methods to analyze data.
- Develop and evaluate inferences and predictions that are based on data.

Problem Solving:

Students will:

- Build new mathematical knowledge through problem solving;
- Solve problems that arise in mathematics and in other contexts;
- Apply and adapt a variety of appropriate strategies to solve problems;
- Monitor and reflect on the process of mathematical problem solving.

Connections:

Students will:

- Organize their mathematical thinking through discussion with peers
- Communicate their thinking clearly to teacher and peers
- Analyze and evaluate the mathematical thinking and strategies of their partners
- Use the language of mathematics to express mathematical ideas precisely
- Recognize and apply mathematics in contexts outside of mathematics
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole

Materials/Resources

TI-83 Plus (or higher) Graphing Calculator, computer, Internet, pencil, paper, meter stick (for helping draw the number line straight using sidewalk chalk and also for measuring equal distances between each height value marked on the number line), sidewalk chalk or masking tape for the number line scale for the human dotplot, Assessment Rubric, copy of Performance Task, spreadsheet software, word processing software (i.e Microsoft Word or Google Docs), and copy of Benchmarks.

Assumption of Prior Knowledge

- Knowledge of how to find the mean and standard deviation of a set of data
- Understanding of the different ways to display different types of data (quantitative vs. categorical data)
- Familiarity with z-scores and their significance
- Understanding of how to conduct experiments
- Some experience with graphing calculator technology and word processing software

Introduction: Setting Up the Mathematical Task

- Discuss the activities for the day (refer to displayed Agenda)
- Motivating activity to introduce the goal of the task/activity (Ask students if they think they are tall or short. Then, have a discussion about the benefits and disadvantages of each. This will lead into the performance task scenario.

- Distribute the task and assessment rubrics to the students; teacher will give an outline of the performance assessment task and the timeframe for completion as students look at the typed version that is passed out to them.
- Students can pick a partner or the teacher can create the groups
- In their groups of 2, students will begin brainstorming steps for addressing this real-world task and completing the additional requirements for this open-ended task.
- Teacher will act as facilitator and will ask questions or give prompts to the students, such as things they should consider as a way to help guide their understanding. The teacher will reinforce the idea that he or she is going to be in this role and that the students will be responsible for developing a plan and implementing that plan to come up with a solution.
- Students may find the need to do some Internet research if they need to refresh their memories about what information would be needed to determine Tyler's location relative to other students' heights.
- Students will be asked to draw upon their prior knowledge to come up with solutions
- Teacher will help students understand the task by effectively answering their questions if they arise.
- Students will have to use mathematics to solve the problem, but will be given access to a computer and the Internet to help them.
- To make the students' mathematical thinking and understanding public, students will collaborate with their partners, come up with a solution or solutions, and share their ideas through a culminating activity that involves the presentation of their information.

Student Exploration

- Students will be collaborating with their partner to come up with their solution. The students will be actively using mathematics, research, and exploration to do a variety of calculations. Students will have access to the computer and Internet for research, typing their results, and using a graphing calculator for calculations if desired.
- Students will make a plan, implement the plan by collecting data, display the data, analyze the data, and share the results through a conclusion. Students will also be answering higher-order questions, as part of the discussion questions.

Monitoring Student Responses

- I expect students to work together as they communicate their thinking and their new knowledge with each other and with the teacher.
- The teacher will help students with any clarification needs and assist students who are having difficulties by helping them connect their previous experiences to these new ones.
- If there are students who are ready to move forward, differentiation will be used and the students can explore additional ways to solve the problem, additional topics (listed earlier

in the student exploration section, etc.). This information could also be included in the final product.

- Students who are ready to prepare their class presentation can go ahead and move to the computer to begin typing out key ideas/information (they will earn bonus points for taking this additional step to organize their work and enhancing its neatness).

Closure will involve the students sharing their results through a culminating activity—a class presentation. This will be followed by a group discussion and with the teacher providing feedback.

Performance Based Assessment Task

Name(s): _____

Date: _____

Algebra Teacher: _____

What is my standing height wise?

Background Information

Tyler, who is 62 inches tall and in your Algebra class, is often the topic of conversation based on his height as a young adult male. Growing tired of this, he tries to find an acceptable way of convincing his close friends and family that his height is not an outlier. So, he decides that now is the time to use mathematics and statistics to prove that he is not as short as others think he is. But, he is a little lost on what steps he needs to take in order to get an adequate amount of information to support his argument and to silence his friends and family once and for all 😊. He needs your help with developing a plan and gathering evidence to support his claims!

Your Requirements

* Work with a partner to:

1. Brainstorm
2. Write out a plan
3. Implement the plan --Make sure that whatever information you gather is relevant and convincing.
4. Display the data using a graphical display
5. Analyze data
6. Conclude – as evidenced in the written information that will be presented to Tyler
7. Answer discussion questions – based on the information that was collected (Must show work!)
 - a. What percent of the students in the class have heights less than Tyler's?
 - b. What is the mean and standard deviation of the class's height distribution?
 - c. How does Tyler's height relate to the measures stated above in part b?
 - d. What would happen if we changed each data value from inches to centimeters? Would this change affect the measures that you calculated in parts a and b? How do you know?
8. Explore more about Tyler's height by doing a web search and finding a large height database of your choice. Record any observations you find that can be shared during your class presentation.

*** See attached Assessment List & Rubric for additional details**

Assessment List, Rubric, and Benchmarks

			Earned Assessment	
#	Element	Point Value	Self	Teacher
1	Student contributed at least two suggestions in the initial planning discussions with his/her partner (indicated by initials).	2		
2	Student developed a plan for coming up with solutions for the task.	2		
3	Student documented any research done and the information gathered to address this real-world problem.	2		
4	Student began implementing the plan by collecting and recording data.	2		
5	Student displayed the data using an appropriate graphical display.	2		
6	Student provides a clear data analysis statement with references made to Tyler's height relative to the other students' heights.	2		
7	Student writes a concluding statement that addresses Tyler's concerns and summarizes all the information that was used to form the conclusion.	2		
8	Student answers each of the 4 discussion questions, shows work, and provides reasoning for each answer.	2		
9	Student explores Tyler's height on a larger scale by finding a large online height database, recording any observations that were found, and sharing the information during the class presentation.	2		
10	Student actively participates in a 2-3 minute class presentation	2		
11	Student answered all of the higher-order questions posed to him or her by the teacher and the classmates after the presentation	2		

#	Element	Point Value	Self	Teacher
1 2	Student's work and presentation is well-organized	2		
1 3	Student's work is neat	2		
1 4	Student uses word processing software to type presentation key ideas / information (Bonus Points!)	2		
	Total (Out of 26)			

	RUBRIC FOR ACTIVITY 2			
#	Element	0	1	2
1	Student contributed at least two suggestions in the initial planning discussions with his/her partner (indicated by initials).	Student did not make any contributions	Student contributed 1 time	Student contributed 2 or more times
2	Student developed a plan for coming up with solutions for the task.	No evidence of a plan provided	Evidence of plans, but incomplete	Evidence of complete plans
3	Student documented any research done and the information gathered to address this real-world problem	No documentation	Minimal documentation	Sufficient documentation
4	Student began implementing the plan by collecting and recording data.	No data collected or recorded	Some data was collected and recorded	All data was collected and recorded
5	Student displayed the data using an appropriate graphical display.	Student does not display any data.	Student attempts to display the data, but uses an inappropriate graphical display.	Student displays the data using an appropriate graphical display (i.e. dotplot, histogram, or box-and-whisker plot).
6	Student provides a clear data analysis statement with references made to Tyler's height relative to the other students' heights.	Does not provide any data analysis	Provides a data analysis statement, but it is unclear and/or no references are made to Tyler's height relative to the other students' heights.	Provides a clear data analysis statement with references made to Tyler's height relative to the other students' heights.

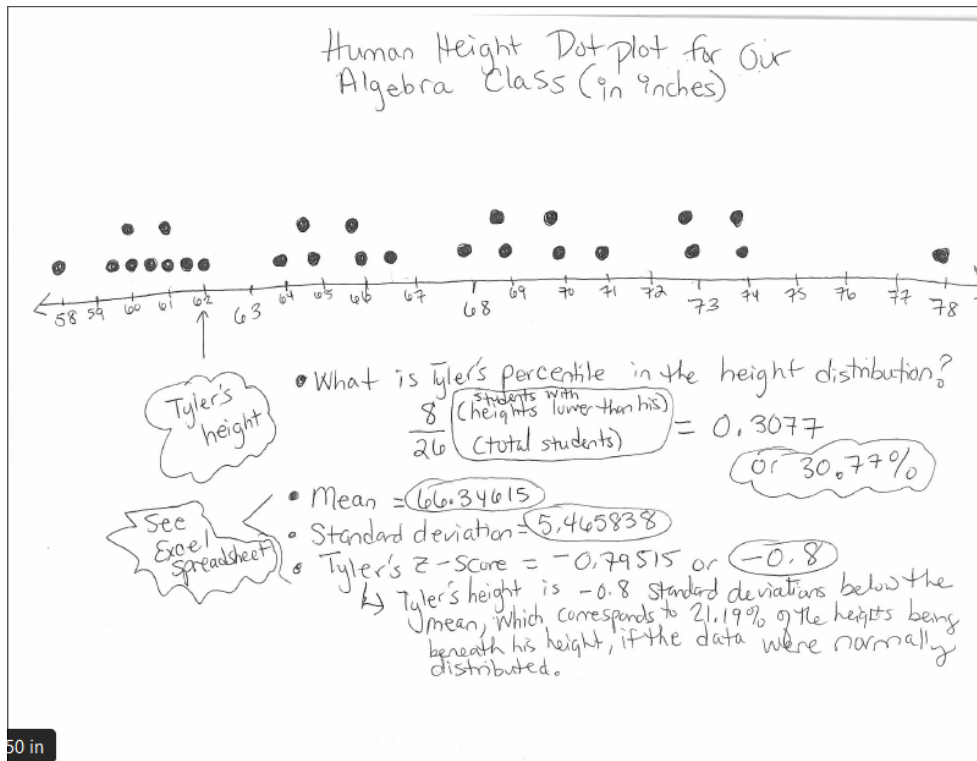
#	Element	0	1	2
7	Student writes a concluding statement that addresses Tyler's concerns and summarizes all the information that was used to formulate the conclusion.	No concluding statement written	Concluding statement written, but it is not well developed	Concluding statement is well-developed; it addresses all concerns and summarizes the information used to formulate the conclusion
8	Student answers each of the 4 discussion questions, shows work, and provides reasoning for each answer.	0 to 1 questions were answered with work shown and reasoning provided	2 to 3 questions were answered with work shown and reasoning provided	Each of the 4 questions were answered with work shown and reasoning provided
9	Student explores Tyler's height on a larger scale by finding a large online height database, recording any observations that were found, and sharing the information during the class presentation.	No exploration is evident	Student either documents the location of the online database, but fails to record observations to be shared during the class presentation or vice versa.	Student documents the location of the online database and records observations to be shared during the class presentation.
10	Student actively participates in a 2-3 minute class presentation	Student does not participate	Student passively participates	Student actively participates
11	Student answered all of the higher-order questions posed to him or her by the teacher and the classmates after the presentation	No follow-up questions answered	Follow-up questions answered, but are not correct or clear	Follow-up questions answered logically and correctly (or close to correct)
12	Student's work and presentation is well-organized	No evidence of organization	Not fully organized	Well-organized work and presentation
13	Student's work is neat.	Lacks neatness	Needs improvement	Neat and legible
14	Student uses Word Processing Software to type presentation key ideas / information (Bonus Points!)	Did not use this software	Did not use this software	Used this software

Benchmark

This is how we looked at this problem:

1. **Brainstorming:** Since Tyler wants to convince his family and peers that he is not that short, we needed to gather data from subjects who were close to his age. We also wanted to determine how his height compared to other groups of similarly aged girls and similarly aged boys to help determine his standing height wise.
 - a. Possible Steps: Choose a sample that would be useful for comparison. Similarly-aged subjects, can do comparative studies of other young adult males' height versus his height, other young adult females versus his height, the entire class' height relative to his height, and then find out more information about where he stands – in terms of height by doing a Web search for “Clinical Growth Charts” at the National Center for Health Statistics website, which is at www.cdc.gov/nchs.
2. **Our plan:** Focus on Tyler's height relative to the other students in our Algebra class. Then, gather and use the data from our classmates and included Tyler's height of 62 inches within the data. The goal was for us is to explore ways to describe where he stands within this distribution of heights. We will display the data by making a number line on the sidewalk, with sidewalk chalk, with a scale that goes from 58 to 78 inches. This will be what we use in our dotplot graphical display. By seeing this visual, we can determine if the height distribution is approximately normal and will help us in our exploration of how Tyler's height compares to others by using probability and z-scores. After displaying the data, we will use measures of center and spread to help us analyze the data and come up with conclusions that will hopefully support Tyler's claims.
3. **Implementation of the plan:** We have 26 students in our class, so we asked them about their heights in inches. Since this was a large amount of data, we used Microsoft Excel to help us with our calculations. **This spreadsheet is attached to this document.** Displaying the data was not as easy as you would think. We had to make sure that our marks were evenly spaced and that we had enough space for the students to stand on our human dotplot. So, we estimated that each student needed at least 18 inches (1.5 feet) space of their own so that we would not be too crowded. And, since the scale went from 58 to 78, that meant that there were 20 whole number values for us to mark on the number line. So, this meant that our number line had to be $20 * 1.5$ feet long or 30 feet in length. We then asked a classmate, whose shoes were 12 inches long, to make 30 steps (heel to toe) and let us know where to end the number line. Each of us then used a meter stick to mark every 18 inches and write the corresponding number that went with it from 58 to 78.

4. **Graphical Display:** To make the human dotplot, each of us had to stand in the right place along the number line based on our height in inches (to the nearest or nearest $\frac{1}{2}$ inch). The teacher used chalk to draw the dots for us above the number line while we stayed in position. When our teacher finished, we copied the dotplot on our own paper and used the data to find the following information: **A copy of this dotplot is below:**



5. (Also, includes step 7 of the Performance Based Assessment Task)

Data Analysis: See the dotplot above and the attached spreadsheet for Tyler's percentile, the mean and the standard deviation of the students' heights, and Tyler's z-score for additional information.

- The percent of students in the class that had heights less than Tyler's was 30.77%.
- The average height (mean) was 66.34615 or 66.35 inches; The standard deviation was 5.465838 or 5.47 inches.
- Analyzed where our heights and Tyler's height stood in relation to the mean. We wanted to find out if it was below or above the mean and how far away it was. So, we felt like knowing his z-score would be useful in describing how many standard deviations above or below the mean it was. Tyler's z-score was -0.8, which corresponds to a probability of 0.2119 or 21.19% of the recorded heights were less than Tyler's height,

given that the population was normally distributed. But, the population seems to be more skewed to the left and not as symmetric.

- d. To see what would happen if we changed each data value from inches to centimeters, we simulated this using the attached Excel Spreadsheet. Please refer to this document. We found that 1 inch = 2.54 cm by doing a Google Search.

6. **Conclusion:** (Written information for Tyler)

Tyler, the good news is that you are not the shortest student in the class. In fact, you have at least 8/26 students who are shorter than you and your height is less than a standard deviation below the mean. We did several calculations that are listed in the attached documents. Make sure you take the time to look at our wonderful work 😊. Height is not the most important thing – you are very smart person, especially since you weren't afraid to get our mathematical help to answer your questions about your height. We really enjoyed this opportunity, but you should stop worrying about your height, for it does not make the person!

7. Listed above in Answer #5.

8. To find out more information about where he stands heightwise, we did a Web search for “Clinical Growth Charts” at the National Center for Health Statistics website, which is at www.cdc.gov/nchs. There is a lot of information here that also confirms what we have found using a smaller data set (our classmates) and also offers additional insight into the distribution of heights by age and gender. Here is a screenshot:

