Suzi's Company

This problem gives you the chance to:
• calculate and interpret mean, medium and mode in a given table of realistic data

Suzi is the chief executive of a small company, TechScale, which makes technical instruments. Fifteen people, including Suzi, work in the company. The table shows the jobs and their annual salaries.

Job Title	***Number of people***	***Annual salary***	***Total***
Chief Executive	1	$100 000	$100 000
Marketing Manager	1	$80 000	
Production Manager	1	$80 000	
Technician	3	$50 000	$150 000
Office worker	2	$40 000	$80 000
Assembly worker	5	$30 000	
Cleaner	2	$20 000	
Total	**15**	***Total***	

1. a. Complete the final column of the table to find the total annual salary bill for TechScale.

b. Use your answer to question 1a to calculate the mean annual salary for the 15 employees in the company. Give your answer correct to the nearest $.

$_____

Show your calculations.

2. John looks at the table and says, “The mode of the salary at TechScale is eighty thousand dollars a year.”

a. What mistake has John made?

b. What is the correct mode of the salary? _____

3. a. What is the median annual salary at TechScale? _____

b. Explain how you figured it out.

4. Which of the three averages, mean, median or mode, would you use to show that the average wage at TechScale is very good? _____

Explain your answer.

5. Last year, TechScale did not do very well so Suzi decided not to pay herself any salary for a year.

Which of the averages (mean, median and mode) will **not** change?

Suzi's Company — Rubric

The core elements of performance required by this task are: • calculate and interpret mean, median and mode in a given table of realistic data Based on these, credit for specific aspects of performance should be assigned as follows	points	section points
1.a Table completed correctly. Gives correct answer: total **$680 000** b Gives correct answer: **$45 333** and shows calculation $\frac{680000}{15}$ *Total*: $100 000; **$80 000**; **$80 000**; $150 000; $80 000; **$150 000**; **$40 000**; **$680 000**	1 1 1ft	3
2.a Gives correct explanation such as: He has not looked at how many people earn each salary b Gives correct answer: **$30 000**	1 1	2
3.a Gives correct answer: **$40 000** b There are 15 people. The middle person, the 8th person, gets $40 000. This point is dependent on giving a correct answer to 3.a.	1 1	2
4. Gives correct answer: **Mean** Gives correct explanation such as: That is the highest of the three.	1ft 1ft	2
5.a Gives correct answer: **Mode**	1	1
Total Points		**10**

Suzi's Company

Work the task. Look at the rubric. What are the big mathematical ideas being assessed in this task?

How many of your students were able to find the correct total for salaries? _____
How many put
$580,000_____$600,0000_____Other_____

Now look at the work for finding mean in part 1b. How many of your students divided by 7 (categories) instead of 15 workers?_____
What other types of errors did you see?

Now look at work for part 2. How many of your students thoughtthat there was no error? _____

How many of your students thoughtthe mode was $80,000?
How many thoughtthe mode was $150,000?

Now look at the answers for median. How many of your students put:

$40,000	$50,000	$80,000	$150,000	$35,000	No response	Other

How do you think students foundthese answers? Can you figure out what they were thinking?
In part 4, 25% of the students thoughtthe answer was mean for incorrect reasons, such as because it's the average. What types of responses did you want from students? What did you want them to understand aboutthe situation?
What were some of you students' incorrect responses? How might you use these responses to plan a class discussion to dig into the mathematics of this task?

Now look at part 5. How many of your students put:

Mode	Median	Mean	No repsonse

What are some of the issues aboutmeasure of center that arise from context that don't arise when working with just a set of numbers? Look at your text to see how these nuances are or are not developed. What additional activities or experiences do you need to add the materials when planning for next year?

Suzi's Company

Student A shows good thinking with clear explanations for thinking about the measures of center. The student is able to distinguish between categorical data (size of salary) and frequency data (number of people with a particular salary). The student appears to have access to a calculator, so the focus can be about the situation and meaning of the measures of center, rather than computation. Student A has a realistic reason for choosing mean in part 4 related to context of the problem.

Student A

Suzi is the chief executive of a small company, TechScale, which makes technical instruments. Fifteen people, including Suzi, work in the company. The table shows the jobs and their annual salaries.

Job Title	*Number of people*	*Annual salary*	*Total*
Chief Executive	1	$100 000	$100 000
Marketing Manager	1	$80 000	$80000
Production Manager	1	$80 000	$80000
Technician	3	$50 000	$150 000
Office worker	2	$40 000	$80 000
Assembly worker	5	$30 000	$150000
Cleaner	2	$20 000	$40000
Total	**15**	***Total***	$680000

1. a. Complete the final column of the table to find the total annual salary bill for TechScale.

b. Use your answer to question 1a to calculate the mean annual salary for the 15 employees in the company. Give your answer correct to the nearest $.

$ 45333

Show your calculations.

680000 ÷ 15 = 45333

Student B understands how to find the mean and seems to think about significant digits, making a personal decision about the appropriate place for rounding. Unfortunately this does not fit with the prompt. Notice that the student puts in the operations for filling in the total in the table. This tool makes the frequency more apparent and may help the student to think about the John's error in part 2. The student should probably not have gotten credit in part 4. *What does the student not understand about mean? What questions might you ask if a response like this came up in a class discussion?*

Student B

Job Title	*Number of people*	*Annual salary*	*Total*
Chief Executive	1	$100 000	$100 000
Marketing Manager	1	$80 000	$80 000
Production Manager	1	$80 000	$80 000
Technician	3	$50 000	$150 000
Office worker	2	$40 000	$80 000
Assembly worker	5	$30 000	$150 000
Cleaner	2	$20 000	40000
Total	15	*Total*	$680,000

1. a. Complete the final column of the table to find the total annual salary bill for TechScale.

b. Use your answer to question 1a to calculate the mean annual salary for the 15 employees in the company. Give your answer correct to the nearest $.

$ 45,300

Show your calculations.

45 3
15) 680,000
60
00
75
50
45
50
45
50

Student B, part 2

a. What mistake has John made?

He saide eighty thousand dollars a year. It doesn't say anything about a year. But 80,000 dollars is annual salary. $30,000 is x by 5, so it would be the salary. $30,000

b. What is the correct mode of the salary?

$40,000

3. a. What is the median annual salary at TechScale?

$40,000

b. Explain how you figured it out.

I wrote it out like as follows:

$20,000 $20,000 $30,000 $30,000 $30,000 $30,000 $40,000 $40,000 $50,000 $50,000 $50,000 $80,000 $80,000 $100,000

4. Which of the three averages, mean, median or mode, would you use to show that the average wage at TechScale is very good?

mean

Explain your answer.

I would use the mean because it shows that at least all of the 15 employees were able to get $45,300 in all!

5. Last year, TechScale did not do very well so Suzi decided not to pay herself any salary for a year.

Which of the averages (mean, median and mode) will **not** change?

The mode, because $100,000 is the only $100,000 in the salary.

10

Student C tries to group numbers to make the long addition friendlier. Unfortunately, the student makes a slip in multiplying 150,000 by 2. The student also understands the mathematics of finding mean in this context, but makes a decimal error. Notice how the student makes an effective use of the table to find median and make sense of frequency. Student C shows a common misconception in part 4 that mean is <u>the average</u>. The student is not thinking about choosing the measure of center with greatest magnitude.

Student C

Job Title	*Number of people*	*Annual salary*	*Total*
Chief Executive	1	$100 000	$100 000
Marketing Manager	1	$80 000	$ 80 000
Production Manager	1	$80 000	$ 80 000
Technician	3	$50 000	$150 000
Office worker	2	$40 000	$80 000 √
Assembly worker	5	$30 000	$ 150 000
Cleaner	2	$20 000	$ 40 000
Total	**15**	*Total*	480,000 X 0

1. a. Complete the final column of the table to find the total annual salary bill for TechScale.

b. Use your answer to question 1a to calculate the mean annual salary for the 15 employees in the company. Give your answer correct to the nearest $.

$ 320,000 X 0

Show your calculations.

80,000 X 3 = 240,000

150000 X 2 = 100,000

140,000 + 240,000 + 100,000 = 380,000 + 100,000 = 480,000

320,000
15 | 480,000
-45
30
-30
0

Student C, part 2

a. What mistake has John made?

He only looked at the salary not how many people had that salary. ✓ 1

b. What is the correct mode of the salary? 30,000 ✓ 1

3. a. What is the median annual salary at TechScale? 40,000 ✓ 1

b. Explain how you figured it out.

added numbers of people onto the salarys ✓ 1
And crossed them out.

4. Which of the three averages, mean, median or mode, would you use to show that the average wage at TechScale is very good? mean ✓ 1

Explain your answer.

You would because that takes everyans salary and avereges it. ✓x 1 0

5. Last year, TechScale did not do very well so Suzi decided not to pay herself any salary for a year.

Which of the averages (mean, median and mode) will **not** change?

mode ✓ 1

Student D correctly computes the average, but does not think about significant digits. The student gives the calculation to the nearest cent. Student D does not see the importance of frequency for finding mode. Students needed to think about frequency of each type of salary rather than frequency of totals. In part 3, the student ignores the frequency of each salary when finding median. The student knows a procedure but not how to work that procedure in context. *Does your current text provide enough opportunity for students to grapple with ideas about measures of center in context or is most of the instructional time spent practicing procedures with a list of numbers? Why or how does context change the thinking or understanding of the mathematical ideas?* Notice again the lack of understanding of mean in part 4.

Student D

Job Title	Number of people	Annual salary	Total
Chief Executive	1	$100,000	$100,000
Marketing Manager	1	$80,000	$80,000
Production Manager	1	$80,000	$80,000
Technician	3	$50,000	$150,000
Office worker	2	$40,000	$80,000
Assembly worker	5	$30,000	$150,000
Cleaner	2	$20,000	$40,000
Total	15	*Total*	$680,000

1. a. Complete the final column of the table to find the total annual salary bill for TechScale.

b. Use your answer to question 1a to calculate the mean annual salary for the 15 employees in the company. Give your answer correct to the nearest $.

$ 45333.33

Show your calculations.

680,000 ÷ 15 = 45333.33

2. John looks at the table and says, "The mode of the salary at TechScale is eighty thousand dollars a year."

a. What mistake has John made?

John did not make a mistake.

b. What is the correct mode of the salary?

$80,000

3. a. What is the median annual salary at TechScale?

$50,000

b. Explain how you figured it out.

100,000 80,000 50,000, 40,000, 30,000 20,000

4. Which of the three averages, mean, median or mode, would you use to show that the average wage at TechScale is very good?

The mean.

Explain your answer.

because the mode is just the # that occurs the most, and the Median is just the middle # and the mean is about how much people from Tech Scale get.

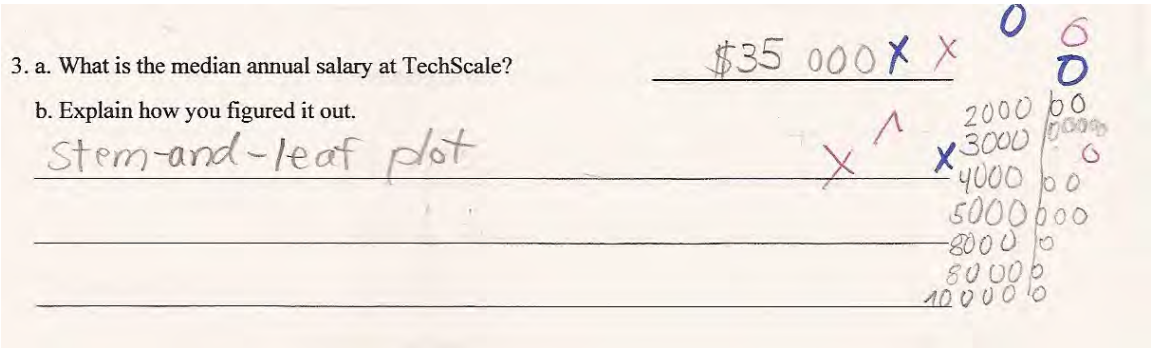
5. Last year, TechScale did not do very well so Suzi decided not to pay herself any salary for a year.

Which of the averages (mean, median and mode) will **not** change?

mode because the mode was 80,000 and still is 80,000 even without Suzi's salary

Student E attempts to use a stem-and- leaf plot to find median. *What are has the student made?*

Student E



Student F made an addition error in finding the total on the chart, but then correctly calculated a mean of $50,666. Notice that the student has correct reasoning for how to pick between the 3 measures of centers, but can't identify the one with the largest value. This student has made another common error in finding median using the totals for each category rather than a median of the salaries.

Student F

a. What mistake has John made?

John has not made a mistake x

b. What is the correct mode of the salary?

$80,000 x 0

3. a. What is the median annual salary at TechScale?

150,000 x 0

b. Explain how you figured it out.

100,000, 80,000, 80,000, 150,000, 80,000, 150,000, 40,000,

I figured it out by lining the numbers up and then crossing them out. x 0

4. Which of the three averages, mean, median or mode, would you use to show that the average wage at TechScale is very good?

Explain your answer.

mode x 0

Mode because it has the highest numbers. x 0

5. Last year, TechScale did not do very well so Suzi decided not to pay herself any salary for a year.

Which of the averages (mean, median and mode) will **not** change?

Mode ✓ 1

10

Student G is able to think about the need to round the answer. *Do you think the student is thinking about significant digits for comparison or is just used to rounding to the front number? What question might you ask to probe the thinking?* The student has some understanding about the importance of frequency and is able to explain John's mistake. However the student lets go of that thinking and just searches for most in part 2b. Notice that the student has trouble with magnitude of numbers. In part 4 the student wants the number "in between" but picks the lowest number. *What might be some next steps for this student?*

Student G

Job Title	*Number of people*	*Annual salary*	*Total*
Chief Executive	1	$100 000	$100 000
Marketing Manager	1	$80 000	$80,000 ✓
Production Manager	1	$80 000	$80,000 ✓
Technician	3	$50 000	$150 000
Office worker	2	$40 000	$80 000
Assembly worker	5	$30 000	$150,000 ✓
Cleaner	2	$20 000	$40,000 ✓
Total	**15**	= *Total*	$680,000 ✓

1. a. Complete the final column of the table to find the total annual salary bill for TechScale.

b. Use your answer to question 1a to calculate the mean annual salary for the 15 employees in the company. Give your answer correct to the nearest $.

Show your calculations.

$ 50,000 x 0

680,000 ÷ 15 = $ 45333. ✓ ✓

20,000, 20,000, 30,000, 30,000, 30,000, 30,000, 30,000, 40,000
50,000, 50,000, 50,000, 80,000, 80,000, 100,000

Student G, part 2

a. What mistake has John made?

John does not see that there is the Chief Executive that has 100,000 dollars for a salary, and he does not see that five ✓ people have 30,000 dollars!

He was paying more attention to how many 80,000 salarys were on the board and not how many people had them.

b. What is the correct mode of the salary? $100,000 x · 0

3. a. What is the median annual salary at TechScale? $35,000 x · 0

b. Explain how you figured it out.

I first lined up their salaries from least to greatest. Then I crossed the least out then the most and repeated. I finally found the middle x 0
salarys which were 30 thousand and 40 thousand. The I found what was in between.

4. Which of the three averages, mean, median or mode, would you use to show that the average wage at TechScale is very good? Median x · 0

Explain your answer.

I would use the median because between the highest amount you could get and the lowest the average between them is 35,000 dollars x · 0

5. Last year, TechScale did not do very well so Suzi decided not to pay herself any salary for a year.

Which of the averages (mean, median and mode) will **not** change?

The mean will change. 0

Student H seems to be confused about the meaning of table design. The student seems to be picking up clues about descending order and gives totals assembly worker and cleaner that don't make sense. The student makes errors in addition. The student makes a common error of dividing by 7 categories instead of 15 people to find the mean. The student makes significant computational errors. Notice that in part 4 the student gives a procedure for calculating mean, rather than a contextual reason about which measure of center would be most beneficial. Student H might benefit from some discussion that would help her confront the misconceptions about measure of center. The student seems to be ready to think reasonably about the grade level ideas on measure of center, but needs tools such as a calculator to help with computation. In addition to regular instruction on grade level topics, the student probably needs a second class to develop number understanding and fluency.

Student H

Job Title	*Number of people*	*Annual salary*	*Total*
Chief Executive	1	$100 000	$100 000
Marketing Manager	1	$80 000	$80 000
Production Manager	1	$80 000	$80 000
Technician	3	$50 000	$150 000
Office worker	2	$40 000	$80 000
Assembly worker	5	$30 000	$150 000
Cleaner	2	$20 000	$10 000
Total	**15**	***Total***	150 000

1. a. Complete the final column of the table to find the total annual salary bill for TechScale.

b. Use your answer to question 1a to calculate the mean annual salary for the 15 employees in the company. Give your answer correct to the nearest $.

Show your calculations.

$ 4000

100,000
80,000
50,000
150000
80000
60000
10000
7)150 000

Student H, part 2

a. What mistake has John made?

The mistake is that he only looked which number showed the most, but he didn't look at how much the people got for their salary.

b. What is the correct mode of the salary? $30.000

3. a. What is the median annual salary at TechScale? $50.000

b. Explain how you figured it out.

20000 30000 40000 50000 80000 80000 100000

The nomber in the middle, which you have to put in order to figure out.

4. Which of the three averages, mean, median or mode, would you use to show that the average wage at TechScale is very good? Mean

Explain your answer.

to find the Mean you need to add all the numbers and divide the numbers there are and thats your answer.

5. Last year, TechScale did not do very well so Suzi decided not to pay herself any salary for a year.

Which of the averages (mean, median and mode) will **not** change?

The mode will not change

3

Student Task	Calculate and interpret mean, medium and mode in a given table of realistic data. Understand the importance of frequency in dealing with statistical measures.
Core Idea 5 Statistics	**Students deepen their understanding of statistical methods used to display, analyze, compare and interpret different data sets.** • Analyze data, including finding measures of center and spread presented in a frequency distribution.

Mathematics of this task:

- Ability to reason and calculate measures of center in context
- Ability to relate frequency to categorical values in a table and use frequency in computation
- Ability to order numbers and judge accuracy based on understanding of place value

Based on teacher observations, this is what seventh graders knew and were able to do:

- Fill in the totals in the table.
- Choose the largest number in part 4
- Understand that deleting one salary would not change the mode

Areas of difficulty for seventh graders:

- Understanding frequency in finding mode
- Distinguishing between totals, categorical information, and frequency to calculate mode and median (relating between data sets for relevant information)
- Confusing mean as the only average (seeing computations as numbers rather than an attempt to describe a situation)

MARS Test Task 2 Frequency Distribution and Bar Graph, Grade 7

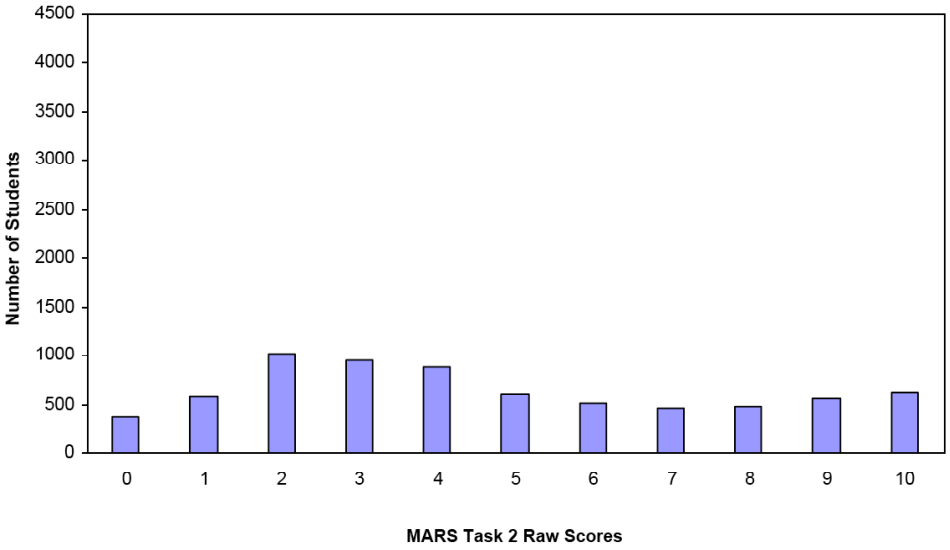
Task 2 - Suzi's Company

Mean: 4.75 StdDev: 3.00

Table 36: Frequency Distribution of MARS Test Task 2, Grade 7

Task 2 Scores	Student Count	% at or below	% at or above
0	375	5.3%	100.0%
1	578	13.5%	94.7%
2	1019	27.9%	86.5%
3	959	41.5%	72.1%
4	882	53.9%	58.5%
5	610	62.6%	46.1%
6	511	69.8%	37.4%
7	462	76.3%	30.2%
8	483	83.2%	23.7%
9	555	91.0%	16.8%
10	635	100.0%	9.0%

Figure 45: Bar Graph of MARS Test Task 2 Raw Scores, Grade 7



The maximum score available for this task is 10 points.
The minimum score for a level 3 response, meeting standards, is 5 points.

Most students, 86%, could ll in the table and nd the total of all the salaries. More than half the students, 59%, could ll in the table, nd the total of all the salaries, choose the largest number between the 3 measures of center in part 4, and note that mode would not change is one salary was eliminated. A little less than half, 46%, could reason about why John had made a mistake in nding mode. About 23% could also calculate the mean. 9% of the students could meet all the demands of the task including nding and explaining median and explaining a reason for choosing a representative measure of center in part 4. 5% of the students scored no points on this task. All the students with this score in the sample attempted the task.

Suzi's Company

Points	Understandings	Misunderstandings
0	All the students in the sample with this score attempted the task.	Students did not understand how the table worked. Some students tried to make the totals have descending values as they went through the table. Students also had trouble adding the totals.5% had a total of 580,000 and 4% had a total of 600,000. 4% had totals over 1,000,000.
2	Students could ll in the table and add up all the salaries.	Students had di culty thinking about which measure wouldn't change if one salary was eliminated. 15% of the students thought the median wouldn't change. 9% did not answer this part of the task. Almost 7% thought the mean would not change. 10% did not respond when asked to pick a very good average. Many students did not pick the largest of the 3 values.
4	Students could ll in the table, nd the total, recognize the largest measure of center, and determine that mode would not change.	Students had di culty describing why John was wrong in nding mode. 14% said that John did not make an error. 7% did not attempt this part of the task. Students also had di culty nding the mode. 23.5% thought the mode was $80,000. 4% thought the mode was $150,000. Other common responses: $60,000; $35,000; and $100,000.
5	Students could ll in the table, nd the total, recognize the largest measure of center, and determine that mode would not change. Students could also either explain John's error in nding mode or nd the mode.	Students had di culty calculating mean. They may have divided by 7 categories rather than 15 people (about 10%). About 8% rounded inappropriately or forgot to round. About 10% made signi cant place value errors somewhere in part 1. Students also struggled with mode. 20% thought the mode was $50,000. 17% thought the mode was $80,000. Almost 6% thought the mode was $150,000.
8	Students could ll in the table, nd the total, recognize the largest measure of center, and determine that mode would not change.	Students had di culty giving a correct reason for choosing a measure of center in part 4. 25% said that the mean was the average. This may have included statements about mean is how much everyone makes. Some thought mode because its in the middle or the most accurate.
9		Students were equally divided between errors in total, errors in mean, and reasons for choice in part 4.
10	Students could meet all the demands of the task including applying data about frequency to nd mean, median, and mode and justify calculations. Students could identify the largest measure of center and which measure would not be changed by eliminating one salary.	

Implications for Instruction

Students need more practice using data from tables and working with data in a context. Students are used to finding statistics from a given set up numbers without thinking about the meaning attached to the numbers. The issue of a category versus a frequency or scale doesn't arise in working with strings of numbers. Too frequently students deal with such a small amount of data that the measures of center seem trivial. They need to be exposed to contexts where different measures make sense for different types of decisions or different points of view. They need to see how the measures help make sense of the information. (*For similar problems, see MARS 2001 5th grade Washington Street and 7th 2005 Ducklings*).

Action Research – The Role of Context – Investigating Different Representations

Try planning a lesson to help students compare and contrast various representations for data. Start with a simple mind set by giving students a set of numbers and asking them to find mean, median, and mode. This checks that everyone has a basic understanding of the procedures for calculating these measures.

Now have them work the tasks: 2007 6th grade Household Statistics and 7th grade Suzi's Company. For each task just give students just the table or the graph and ask them to again find the mean, median, and mode. Graph paper should be available for students.

Now we want to explore their thinking about information in these two representations. Start with Household Statistics. Pose a question for class discussion, such as:

> Lettie says," I think the equation would for mean would be":
> $$\frac{0+1+2+3+4+5}{6}$$
>
> Her partner, Nadia disagrees. Nadia thinks the solutions is:
> $$\frac{1+5+8+4+1+1}{20}$$
>
> Mary says I think neither of these is correct. I think we're forgetting something.
> Can you help them solve this? Give reasons for your answers.

During the discussion probe student thinking to explore why Lettie and Nadia are wrong. If students seem stuck ask them if they can write out the string of data numbers being represented by the graph. See if they can start to talk about frequency versus data. Have them talk about how to use the graph for finding mode and median. Try to have a student come to the board to show how he or she counted to find the median.

When they are finished, have them look at the table for Suzi's company. Ask them how they might put the information about Household Statistics into a table. What would that look like? Where are the data points? Where is the frequency in their tables?

Now pose a question about Suzi's Company. For example:

Lydia says the mean is $30,000. Bruce says that the mean is $97,142. How can their answers be so far apart? What do you think they are doing? They both started with totals of $680,000. Who do you think is right? Convince me.

See if students relate this information to the ideas that came up in the discussion for Household Statistics. Are they mentioning the difference between categories and total number of households?

Next you might pose a question, such as that on part 2 of the original task. John looks at the table and says, "The mode of the salary is eighty thousand dollars a year. What mistake has John made?"

When the class discussion is over, maybe even a day or two later, give students red pens and asked them to revise their work and write about the ideas they have learned. Why did they choose to change their answers based on new ideas or ways of thinking from the classroom discussion. What are things you have to consider when looking at a table or graph that is different from looking at a list of data?

Performance Assessment Task

Suzi's Company

Grade 7 task aligns in part to CCSSM HS Statistics & Probability

The task challenges a student to demonstrate understanding of the concepts of statistical methods used to display, analyze, compare, and interpret data. A student must make sense of the shape of the data distribution, including finding measures of center and spread. A student must be able to give a mathematical justification and argument for the use of one measure of center or spread to best support a particular stance, be it political or economic.

Common Core State Standards Math - Content Standards

High School – Statistics and Probability – Interpreting Categorical and Quantitative Data

Summarize, represent, and interpret data on a single count or measurement variable.

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

Common Core State Standards Math – Standards of Mathematical Practice

MP.2 Reason abstractly and quantitatively.

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

MP.3 Construct viable arguments and critique the reasoning of others.

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

Assessment Results

This task was developed by the Mathematics Assessment Resource Service and administered as part of a national, normed math assessment. For comparison purposes, teachers may be interested in the results of the national assessment, including the total points possible for the task, the number of core points, and the percent of students that scored at standard on the task. Related materials, including the scoring rubric, student work, and discussions of student understandings and misconceptions on the task, are included in the task packet.

Grade Level	Year	Total Points	Core Points	% At Standard
7	2007	10	5	46 %