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## From a Seventh Grade Classroom

## Test Scores

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*My students are a great group of seventh graders. They are very eager to work on interesting problems. I chose to use this collection of problems because my class has been working on data. I decided to start with Test Scores 1 to see if my students could make sense of how the stem-and-leaf plot was organized. All of our experiences with stem-and-leaf plots have the stems listed from smallest to largest. I thought the way the stems were arranged in the task might be confusing to my students.*

*I gave them Test Scores 1 to complete individually. When everyone finished, I gave them two minutes to share their thinking with others in their group. I suggested that they try to understand how each person was reasoning. If there was a disagreement, try to resolve it.*

**Teacher:** What did you get for an answer and how did you find it?

Brooke: I counted the leaves that had a stem of 8 or 80, so I got 7 students.

**Teacher:** How many of you got 7 students?  
[Everyone raised their hand.]

**Teacher:** Did anyone get a something other than 7 students?

**Teacher:** This seems to have been a very easy problem for you.

**Eric:** This would have been an easy problem for a third grader if they knew anything about stem-and-leaf plots.

**Teacher:** With multiple-choice items, sometimes it's interesting to look at the distractors and consider why they are there. How might a student be reasoning to choose 2 students for an answer?

**Jackie:** Maybe they see the two zero's in the 80s and think two students scored 80 instead of the seven scores in the 80s.

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### Test Scores 1

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The table below shows test scores for a class.

How many students scored in the 80s?

| Stem | Leaf          |
|------|---------------|
| 9    | 0 1 1 5 7     |
| 8    | 0 0 2 4 6 7 9 |
| 7    | 7 7 8 9       |
| 6    | 9             |
| 5    | 2 3           |
| 4    | 4             |

- a. 2 students
- b. 6 students
- c. 7 students
- d. 9 students

*(Pennsylvania Department of Education)*

*I was somewhat reassured after discussing Test Scores 1 that this task might not be quite as problematic as I originally thought. Next the students worked on Test Scores 2. Again, the students worked individually then shared their reasoning with others in their group. I walked around the room to listen to how students were reasoning. Everyone seemed to have used the same strategy, except Eric. Eric rewrote the numbers from smallest to largest and got a different answer from his group. His group was trying to understand why Eric's answer was different. I left them to figure this out.*

*I tallied the responses then had a discussion about how they were reasoning to find the median score. Out of 24 students 23 selected 86.5 as the median score. I was missing one student's response but didn't worry about it at the time.*

|          | #Responding |
|----------|-------------|
| a. 79.05 | 0           |
| b. 86    | 0           |
| c. 86.5  | 23          |
| d. 87    | 0           |

*I asked students how they found the median value. What follows is a transcript of our discussion.*

**Teacher:** Group 3, how did you count to find the middle score?

**Claire:** We did half of 20.

**Teacher:** Where did you get 20 from?

**Claire:** There are 20 students.

**Teacher:** Okay

**Claire:** And half of twenty is 10. That's between the 6 and the 7

**Teacher:** Stop there a minute. You said half of twenty is 10 and then you jumped between the 6 and 7.

**Claire:** In the 80s, like between 6 and 7 in the 80s

**Teacher:** In the 80s. Between there and there [pointing at the numbers on the chart]. Tell me how you got that from the number 10.

**Claire:** Because you counted in from the like from 90 and you went 10 so you'd do half so you'd do 86.5

**Teacher:** So when you count in 10 from the stem-and-leaf plot. Now look up here a second. This is something I'm very curious about. When it's listed this way normally we have the lowest stem first and we count this way. But when you have the highest stem first you have to count backwards. How many of you...just raise your hand...how many of you started counting with the zero...when you were counting in ten? [Almost all of the students raised a hand.]

**Test Scores** **2**

The table shows test scores for a class. What is the median test score?

a) 79.05  
b) 86  
c) 86.5  
d) 87

| Stem | Leaf                                      |
|------|---|
| 9    | "1 2 3 4 5<br>0 1 1 5 7<br>6 7 8 9 10 11" |
| 8    | 0 0 2 4 6 7 9                             |
| 7    | 7 7 8 9                                   |
| 6    | 9   |
| 5    | 2 3                                       |
| 4    | 4   |

**Teacher:** How many of you started at the 7 and counted in backwards like this? [A few students raised their hand.]

**Teacher:** Would it make a difference? Maybe, maybe not...in this one probably not. So when you count in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and there's the 11<sup>th</sup> one, I don't know, does it make a difference?

**Test Scores** **2**

| Stem | Leaf                                      |
|------|---|
| 9    | 5 4 3 2 1"<br>0 1 1 5 7<br>6 7 8 9 10 11" |
| 8    | 0 0 2 4 6 7 9                             |
| 7    | 7 7 8 9                                   |
| 6    | 9   |
| 5    | 2 3                                       |
| 4    | 4   |

*I was getting confused about how to count the numbers when represented this way. I gave this task to an earlier class, and I had another student who challenged the answer of 86.5. I didn't think anymore about it until now. I assumed that the correct answer had to be one of the choices given. I decided to continue pushing my students to look more closely at the representation to see if we could figure out what was problematic about the way we were counting in to find the median.*

**Teacher:** Did anyone do it differently?

**Jackie:** I made another stem-and-leaf plot with the stems from lowest to highest. I counted half towards the middle and got the same thing. The median is 86.5.

**Teacher:** If I start counting from the lowest one...here's the lowest, 1, 2, 3, 4, 5, 6, 7, 8...9, 10 11. I think I'm finding a distractor. Maybe I have an answer that's not on there yet. If we had rearranged these...and we have them arrange low to high like we normally do, and we counted in.

**Students:** Oh!

**Eric:** I rewrote the numbers and arranged them highest to lowest. I counted in 10 and 11. The 10<sup>th</sup> number is 80 and the 11<sup>th</sup> number is 82. I got 81 as the median.

**Jack:** Wait, let me check your numbers. Maybe you are missing one... [Jack checked each of Eric's numbers.] Nope, they are all there. I don't understand. I know his method works. Let me re-check mine.

**Eric:** I double-checked my numbers. They are all there.

**Teacher:** I think I'm finding why you have the answer...and I think Eric may have actually found the correct answer.

**Test Scores** **2**

The table below shows test scores for a class.  
What is the median test score?

a) 79.05  
b) 86  
c) 86.5  
d) 87

*Handwritten notes:* I counted half of 20 towards middle (10 in), and 10 is even so the median had to be in the middle. Ex: counted 10 in.

| Stem | Leaf        |
|------|-------------|
| 9    | 0 1 5 7 9   |
| 8    | 0 2 4 6 7 9 |
| 7    | 7 8 9       |
| 6    | 9           |
| 5    | 2 3         |
| 4    | 4           |

*Handwritten notes:* So the median test score is 86.5.

*Handwritten calculations:* 4/4, 5/23, 6/9, 7/17, 8/9, 8/00, 9/11, 5/4, 6/7, 9

Adapted from Pennsylvania Department of Education MG

**Test Scores** **2**

The table below shows test scores for a class.  
What is the median test score?

a) 79.05  
b) 86  
c) 86.5  
d) 87

*Handwritten note:* 87

| Stem | Leaf        |
|------|-------------|
| 9    | 0 1 5 7     |
| 8    | 0 2 4 6 7 9 |
| 7    | 7 8 9       |
| 6    | 9           |
| 5    | 2 3         |
| 4    | 4           |

*Handwritten calculations:* 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

Adapted from Pennsylvania Department of Education MG

**Teacher:** If I start with 44 and I go to the next highest, it's 52, right? There's 1, 2, 3, 4...9, 10, 11. I think the middle number is actually between the 0 and 2, right here. And if I count backwards from the highest to the lowest. 1, 2, 3, 4, 5...10, 11. If I am counting backwards...if I put all these numbers in a row, like Eric did, and find the middle. The middle is actually between 80 and 82. Isn't it? Am I right there? I think the actual answer is 81 and it's not one of the choices given.

| Stem | Leaf     |           |           |          |       |
|------|----------|-----------|-----------|----------|-------|
| 9    | 0        | 1         | 1         | 5        | 7     |
|      | <i>9</i> | <i>10</i> | <i>11</i> |          |       |
| 8    | 0        | 0         | 2         | 4        | 6 7 9 |
|      | <i>5</i> | <i>6</i>  | <i>7</i>  | <i>8</i> |       |
| 7    | 7        | 7         | 8         | 9        |       |
|      | <i>4</i> |           |           |          |       |
| 6    | 9        |           |           |          |       |
|      | <i>2</i> | <i>3</i>  |           |          |       |
| 5    | 2        | 3         |           |          |       |
|      | <i>1</i> |           |           |          |       |
| 4    | 4        |           |           |          |       |

**Teacher:** When we put the stems in order, we go from the smallest to the largest stem. Everyone in class is counting the way we normally do. So if I just rewrite my table like this. This is the same data. Let's do it again. So the reason you were all getting the same answer and were pretty confident about it is that you were doing what we normally do in class.

| Stem | Leaf     |           |           |          |       |
|------|----------|-----------|-----------|----------|-------|
|      | <i>1</i> |           |           |          |       |
| 4    | 4        |           |           |          |       |
|      | <i>2</i> | <i>3</i>  |           |          |       |
| 5    | 2        | 3         |           |          |       |
|      | <i>4</i> |           |           |          |       |
| 6    | 9        |           |           |          |       |
|      | <i>5</i> | <i>6</i>  | <i>7</i>  | <i>8</i> |       |
| 7    | 7        | 7         | 8         | 9        |       |
|      | <i>9</i> | <i>10</i> | <i>11</i> |          |       |
| 8    | 0        | 0         | 2         | 4        | 6 7 9 |
|      |          |           |           |          |       |
| 9    | 0        | 1         | 1         | 5        | 7     |

**Students:** Oh!

**Teacher:** So how do we count when the stems are ordered from largest to smallest? Chloe would you show us how to count them? [She wrote 1, 2, 3, 4, 5 then started to write 6 above the first 0]

| Stem | Leaf     |            |           |          |          |
|------|----------|------------|-----------|----------|----------|
|      | <i>5</i> | <i>4</i>   | <i>3</i>  | <i>2</i> | <i>1</i> |
| 9    | 0        | 1          | 1         | 5        | 7        |
|      |          | <i>"11</i> | <i>10</i> | <i>9</i> | <i>8</i> |
| 8    | 0        | 0          | 2         | 4        | 6 7 9    |
|      |          |            |           |          |          |
| 7    | 7        | 7          | 8         | 9        |          |
|      |          |            |           |          |          |
| 6    | 9        |            |           |          |          |
|      |          |            |           |          |          |
| 5    | 2        | 3          |           |          |          |
|      |          |            |           |          |          |
| 4    | 4        |            |           |          |          |

**Teacher:** Why would you count 8|0 instead of 8|9 next? Where's the next smallest number after 90? Please say the numbers as you do so we can focus on the value.

**Chloe:** 89 then 87, 86, 84, 82, and 80.

**Students:** Oh! I see now

**Chloe:** I did that but I thought it was wrong because my answer was not there.

**Teacher:** So you changed your answer to match one of the choices given. Normally, one of the choices should be correct. This item needs to be fixed. The writer of the item needs to make some choices about which distractors to keep.

*I wondered what my students would have done had 81 been one of the choices. I was anxious to give a revised version to a different class. I learned a very valuable lesson from giving this task to my students. When I teach stem-and-leaf plots in the future, I'm going to make sure my students have an opportunity to work with plots organized differently from the ones we routinely use in class.*

*I gave a revised version of Test Score 2 to my fourth period class. This version didn't have the mean average as one of the distractors.*

- a. 81            || (9%)
- b. 85
- c. 86            ||| (13%)
- d. 86.5        ~~|||||~~ ||||| (78%)

*Asking students to show and/or explain their thinking gave me deeper insights into their misconceptions. I learned that very few of my students were able find the median accurately (with sound reasoning) when the stems were organized from highest to low. Those who were successful counted up 10 numbers from the smallest value in the stem-and-leaf plot and kept track of how the values were changing in size (e.g., 44, 52, 53, 69, 77, 77, 78, 79, 80, 80, 82). I had one student find the mean value of 79.05 instead of the median. Maybe the mean average should be one of the distractors.*

| Test Score  |               | 2 |      |      |   |           |   |               |   |         |   |   |   |     |   |   |
|---|---------------|---|------|------|---|-----------|---|---------------|---|---------|---|---|---|-----|---|---|
| <p>The table shows test scores for a class.<br/>What is the median test score?</p> <table border="1" style="margin: 10px auto; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Stem</th> <th style="text-align: left;">Leaf</th> </tr> </thead> <tbody> <tr> <td>9</td> <td>0 1 1 5 7</td> </tr> <tr> <td>8</td> <td>0 0 2 4 6 7 9</td> </tr> <tr> <td>7</td> <td>7 7 8 9</td> </tr> <tr> <td>6</td> <td>9</td> </tr> <tr> <td>5</td> <td>2 3</td> </tr> <tr> <td>4</td> <td>4</td> </tr> </tbody> </table> |               |   | Stem | Leaf | 9 | 0 1 1 5 7 | 8 | 0 0 2 4 6 7 9 | 7 | 7 7 8 9 | 6 | 9 | 5 | 2 3 | 4 | 4 |
| Stem  | Leaf          |   |      |      |   |           |   |               |   |         |   |   |   |     |   |   |
| 9   | 0 1 1 5 7     |   |      |      |   |           |   |               |   |         |   |   |   |     |   |   |
| 8   | 0 0 2 4 6 7 9 |   |      |      |   |           |   |               |   |         |   |   |   |     |   |   |
| 7   | 7 7 8 9       |   |      |      |   |           |   |               |   |         |   |   |   |     |   |   |
| 6   | 9             |   |      |      |   |           |   |               |   |         |   |   |   |     |   |   |
| 5   | 2 3           |   |      |      |   |           |   |               |   |         |   |   |   |     |   |   |
| 4   | 4             |   |      |      |   |           |   |               |   |         |   |   |   |     |   |   |
| <ul style="list-style-type: none"> <li>a. 81</li> <li>b. 85</li> <li>c. 86</li> <li>d. 86.5</li> </ul>  |               |   |      |      |   |           |   |               |   |         |   |   |   |     |   |   |

**Test Scores**

**2**

The table below shows test scores for a class.  
What is the median test score?

- a) 79.05
- b) 86
- c) 86.5
- d) 87

(87)

| Stem | Leaf          |
|------|---------------|
| 9    | 0 1 1 5 7     |
| 8    | 0 0 2 4 6 7 9 |
| 7    | 7 7 8 9       |
| 6    | 9             |
| 5    | 2 3           |
| 4    | 4             |

44, 54, 55, 69, 77, 77, 78, 79, 80, 80, 81, 82, 83, 84, 85, 86, 87, 87, 88, 89, 90, 91, 91, 95, 99

**Test Scores**

**2**

The table below shows test scores for a class.  
What is the median test score?

- a) 79.05
- b) 86
- c) 86.5
- d) 87

(c) 86.5

86.5 I counted half of 20 towards middle (10 in), and 10 is even so the median had to be in the middle. Ex: counted 10 in.

| Stem | Leaf          |
|------|---------------|
| 9    | 0 1 1 5 7     |
| 8    | 0 0 2 4 6 7 9 |
| 7    | 7 7 8 9       |
| 6    | 9             |
| 5    | 2 3           |
| 4    | 4             |

So the median test score is 86.5.

4/4  
5/23  
6/9  
7/7789  
8/0024679  
9/01157

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## Test Scores

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1

The table below shows test scores for a class.

How many students scored in the 80s?

| Stem | Leaf          |
|------|---------------|
| 9    | 0 1 1 5 7     |
| 8    | 0 0 2 4 6 7 9 |
| 7    | 7 7 8 9       |
| 6    | 9             |
| 5    | 2 3           |
| 4    | 4             |

- a. 2 students
- b. 6 students
- c. 7 students
- d. 9 students

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## Test Scores

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2

The table shows test scores for a class.

What is the median test score?

| Stem | Leaf          |
|------|---------------|
| 9    | 0 1 1 5 7     |
| 8    | 0 0 2 4 6 7 9 |
| 7    | 7 7 8 9       |
| 6    | 9             |
| 5    | 2 3           |
| 4    | 4             |

- a. 81
- b. 85
- c. 86
- d. 86.5



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## Test Scores

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3

The table below shows test scores for a class.

What percent of the students scored in the 80s?

| Stem | Leaf          |
|------|---------------|
| 9    | 0 1 1 5 7     |
| 8    | 0 0 2 4 6 7 9 |
| 7    | 7 7 8 9       |
| 6    | 9             |
| 5    | 2 3           |
| 4    | 4             |

- a. 70%
- b. 35%
- c. 54%
- d. 65%

*(Adapted from Pennsylvania Department of Education)*

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## Test Scores

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4

The table below shows two test scores for a class.

Which statement correctly compares the two test scores?

| First Test |   |   |   |   | Second Test |      |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|-------------|------|---|---|---|---|---|---|---|---|
| Leaf       |   |   |   |   | Stem        | Leaf |   |   |   |   |   |   |   |   |
|            |   |   |   |   | 10          | 0    | 0 |   |   |   |   |   |   |   |
|            |   |   |   |   | 9           | 2    | 3 | 5 | 5 |   |   |   |   |   |
| 9          | 7 | 6 | 4 | 2 | 0           | 0    | 8 | 0 | 1 | 1 | 2 | 8 | 9 | 9 |
|            |   |   |   |   | 7           | 9    | 8 | 7 | 7 | 7 | 0 | 3 | 5 | 5 |
|            |   |   |   |   | 6           | 8    | 9 |   |   |   |   |   |   |   |
|            |   |   |   |   | 5           | 3    | 2 |   |   |   |   |   |   |   |
|            |   |   |   |   | 4           | 4    |   |   |   |   |   |   |   |   |

- a. All of the students received a higher score on the second test.
- b. The median score is higher on the second test.
- c. The range of the data is greater for the second test.
- d. More students scored in the 80s on the second test.

*(Adapted from Pennsylvania Department of Education)*

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## Test Scores

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5

The table below shows test scores for a class.

What is the median test score?

| Stem | Leaf          |
|------|---------------|
| 4    | 4             |
| 5    | 2 3           |
| 6    | 9             |
| 7    | 7 7 8 9       |
| 8    | 0 0 2 4 6 7 9 |
| 9    | 0 1 1 5 7     |

- a. 81
- b. 85
- c. 86
- d. 86.5

*(Adapted from Pennsylvania Department of Education)*

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## Test Scores

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6

The table below shows test scores for a class.

What is the median test score?

| Stem | Leaf          |
|------|---------------|
| 4    | 4             |
| 5    | 2 3           |
| 6    | 9             |
| 7    | 7 7 8 9       |
| 8    | 0 0 2 4 6 7 9 |
| 9    | 0 1 1 5 7     |

- a. 79.05
- b. 81
- c. 86
- d. 86.5

*(Adapted from Pennsylvania Department of Education)*