Inventing Displays Unit 1

Name:			
Grade:			
Teacher:			
Gender: Ma	ale (boy)	_Female (girl) _	

Language you speak at home:

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Jumping Rope

Dora counted how many rope jumps she can do in one minute. Here is the number of jumps she did in 20 trials of one minute each.

25, 26, 27, 27, 26, 28, 30, 26, 27, 28, 26, 25, 27, 29, 28, 19, 26, 25, 28, 29

1. Given this sample, make a display that helps you think about how you expect Dora to perform in general.

Later, Dora's father gave her a lightweight jumping rope. He suggested that this rope will help her make more jumps in one minute. Dora counted her jumps with the lightweight rope. Here are the results of her 20 trials.

27, 28, 29, 29, 28, 30, 29, 28, 29, 30, 28, 29, 29, 30, 29, 29, 27, 30, 27, 28

2. Make a display that helps you think about Dora's performance using the lightweight rope.

3. Use the two displays you've created to make an argument for whether Dora's father was right or whether the differences between the data sets happened by chance. Be sure to use information from your displays in your argument.

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Statue

30 students measured the height of a statue in front of the city hall. Two students created displays of the data they collected. The two displays show the same data set.





- 1. Which display does a better job at showing how many students got each value?
 - a. Display A
 - b. Display B
- 2. Why is this display better than the other?

- 3. Which display does a better job at showing where most of the measurements are?
 - a. Display A
 - b. Display B
- 4. Why is this display better than the other?

- 5. Which display does a better job at showing unusual measurements?
 - a. Display A
 - b. Display B
- 6. Why is this display better than the other?

- 7. We want to know the actual height of the statue. Which display is better for this purpose?
 - a. Display A
 - b. Display B
- 8. Why is this display better than the other?

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Jumping Rope, Question 1

Question	Question 1: Jumping Rope and Data Display (DaD)				
Level	Performance	Example			
DaD(4a)	Display data in ways that use its continuous scale (when appropriate) to see holes and clumps in the data. For the x-axis, the student must have continuous scale from 19-30. Students at this level should have BOTH <i>order</i> and <i>grouping</i> .	• Example 1:			
DaD(3a)	Notices similar values or clumps in the data.	• Example 1 : Student creates a display without a continuous scale (shown below)			
	the data. GROUPING, NO CONTINUOUS SCALE (at a glance, the display shows relative frequencies): Displays are made by grouping identical values (such as in a frequency display) or making bins. Students do <i>not</i> have to order the groups. Displays must show the structure of the data. Displays that show frequency but in a way that misrepresents the data's structure are NOT scored at this level. This includes, for example, displays that show the "25's" column larger than the "26's" column.	 continuous scale (shown below) 19 25 26 27 28 29 30 Example 2: Student groups (by making a frequency display) but does not write a scale on the y-axis (shown below) Example 3: Student groups with tally marks 19 25 26 27 28 29 30 			

DaD(2b)	Student manipulates data attending only to its ordinal properties. ORDER (at a glance, the display shows order but NOT relative frequencies): Student orders the data but does not use space to highlight aspects of the data's structure.	 Example 1: Student puts the numbers in order but nothing additional* Example 2: Student makes a frequency display but the display distorts the relative frequency. For example, at a glance, it appears that there are more 25's than 26's.*
DaD(1a)	Student manipulates, notices, or explores qualities or relations of data values, without relating to the question. Preliminary level of understanding is demonstrated. Here, if student attempts to use order or grouping, it does so in a way that distorts relative frequencies AND hides the frequency (see Example 3)	 Example 1: Student employs an impractical method for binning such as "grouping evens and odds". Example 2: Student treats each trial as change over time. 3 perform in general. 2 8 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
NL(ii)	Response (graphical or otherwise) is at least somewhat relevant, but is unclear, or a restatement of given information.	
NL(i)	Response (graphical or otherwise) is irrelevant to the question.	 "Don't get it." "He did better."
М	Missing Response	

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Jumping Rope, Question 2

Question	estion 2: Jumping Rope and Data Display (DaD)			
Level	Performance	Example		
DaD(3a)	Notices similar values or clumps in the data.GROUPING (at a glance, the display shows relative frequencies):Displays are made by grouping identical values (such as in a frequency display) or making bins.Students do not have to order the groups.Displays must show the structure of the data. Displays that show frequency but misrepresent the structure by using inconsistent markings, causing one value to inaccurately appear more frequent are NOT scored at this level. This includes, for example, displays that show the "28's" column as larger than the 29's" column. However, if the student uses consistent markings, but spacing between the markings is not consistent they will be scored 3A.	 Example 1: 21 Makela display that helps you think about Dora's performance us 9 + + + + + + + + + + + + + + + + + + +		
DaD(2b)	Student manipulates data attending only to its ordinal properties. ORDER (at a glance, the display shows order but NOT relative frequencies): Student orders the data but uses	• Example 1: 27, 27, 27, 28, 28, 28, 28, 28, 29, 29, 29, 29, 29, 29, 29, 29, 29, 30		
	inconsistent markings that misrepresent the structure of the data and do not communicate the relative frequencies of the measures.			

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DaD(1a)	Student manipulates, notices, or explores qualities or relations of data values, without relating to the question.	•	Example 1: Student treats the values as change over time.*
	Demonstrates preliminary level of understanding of what a data display is.		
	Here, if student attempts to use order or grouping, it is in a way that distorts relative frequencies AND hides the frequency		
NL(ii)	Response (graphical or otherwise) is at least somewhat relevant, but is unclear, or a restatement of given information.	•	
NL(i)	Response (graphical or otherwise) is irrelevant to the question.	•	
М	Missing response	•	

*Mock student responses

Jumping Rope, Question 3

The third question asks students to make an inference based on their displays. We will consider the Informal Inference (InI) construct in more detail later. For now, we suggest distinguishing among higher level and lower level responses.

Higher Level

Students anchor their recommendation to the displays and consider clusters of values. Typical student responses at this level:

Example 1H:

"He was right because with the lighter jump rope she got 29 and 30 12 times and when she used the regular rope, she had only 3 29 and 30."

Note that this student created 2 different looking displays but both showed regions of values (DaD 3). This student's displays were:



Example 2H:

"I think Dora's father was right because with a heavier rope, her most common number of jumps, 26, was 5 times. With a lighter rope, her most common number of jumps was 29, and it was performed 8 times." (Note: The modes are compared, which involves thinking about the frequencies, a kind of thinking about similar values. Later in instruction, we will expect students to consider a statistic of center in light of sample variability, but for now, this is a high level response.)

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Medium Level

Example 1M:

"Dora's father was right because with the first rope, she jumped only 19 times in one minute, but with the lightweight rope, her lowest jump was 27 times in a minute."

Example 2M:

"They are the same. You get 30 times in a minute with both ropes."

Example 3M:

"They both go up and down." (This student's displays showed unordered case values.)

Lower Level

Students do not anchor their recommendation to either display.

Example 1L:

"Lightweight ropes are easier to skip with."

Example 2L:

"Dora should listen to her father."

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Statue , Questions 1 and 2

Questions 1 and 2: How many students got each value?			
Level	Performance	Example	
Correct	Display B		
Incorrect	Display A		
NL(i)	Student circles both answer choices or writes an irrelevant comment	• "I don't know what this means."	
М	Student does not circle an answer choice and does not write anything.		

Questions 1 and 2: Statue and meta-representational competence (MRC)			
Level Performance	Example		
 MRC(4b) Student coordinates qualities multiple displays with what the displays show and hide about data. Student recognizes that display the frequency for single values of display A doesn't differentiate the range of two values per bin. Student must mention or describinning (or lack of binning) expone display. Student may mention how the ordisplay does something that main identifying individual values under the solution. 	 Display B, "because in Display A you can't tell how many measurements they got for each height. In B, it shows how many measurements for each height." * B shows while between B, because A bins the measurements. Display B, "Display A has a number through another number. Display B has an exact number." Display B, "cause the height of data in display B got one number for example 54 in display A got 2 number for example 54 in display A got 2 number for example 54 in display A got 2 number for example 54 in display A got 2 number for example 54.55." Display B, "because, Display A goes by 2s and you don't know how many people go to what number Display B, "because the other one you can't tell whether it is 60-61 or 54-55." 		

MRC(3a)	Compare displays by indicating what each shows about the structure of the data.	•	Display B, "because it shows for each height, how many time it happened."*
	Student describes what <i>one or both</i> of the displays show about the data relevant to the question (reasonable inferences can be made about relevance) but doesn't articulate what the displays hide. Specifically, students note the differences in <i>what the display</i> <i>shows</i> regarding individual values.	•	Display B, "because it shows exact number of kids"*
	Student may discuss that Display B shows each measurement explicitly, but if the process of binning (as in what the creator of the display did to ensure each measurement would be shown explicitly) is mentioned or described, then score as 4(b)		
MRC(2b)	Student lists and compares observed characteristics of displays without	•	Display A, "because it is more bigger there the other one"
	explicit reference to data structure or purpose of data collection. Student compares observed characteristics of displays without explicit reference to data structure or purpose of data collection. **Note: "Bigger" is interpreted as focusing on the x-axis of the display	•	Display A, "because <i>it is shorter</i> and gives more information that we need." Display A, "because it has a title and labels."* Display A, "because instead of skipping the numbers that aren't
	the A dats of the display.		being used, they still have them"

NL(ii)	Student's response is somewhat relevant to the problem but unclear.	•	Display B, "Is because is easy to understand what they are doing"
	Student is clearly referring to the display but more specific referents may	•	Display B, "looks like it has all the right measurements than display A"
	This also includes responses where the	•	Display B, "cause the other is hard to explain"
	features of the display (for instance, saying Display A shows the values 50-	•	Display A, "Display A makes more sense than Display B"
	51).	•	Display A, "It shows you it more clear."
		•	Display B, "It doesn't just not give a lot of information. Display A didn't have much."
		•	Display A, "Because it doesn't skip numbers."*
NL(i)	Response is irrelevant, unclear, or a restatement of given information.	•	Display A, "because it is the best to right"
		•	"What do you mean?"
Μ	Missing response	٠	Display B (no explanation)
	Student provides no explanation.	•	Display A (no explanation)

*Mock student responses

Statue, Questions 3 and 4

Questions 3 and 4: Statue and Data Display (DaD)			
Level	Performance	Example	
DaD(3a)	DaD(3a)Student notices or constructs groups of similar values from distinct values.Student either: chooses display A and provides a reason why the grouping of the values is useful for finding, OR chooses display B and provides a reason why exact values are preferable over groupings. OR choose either by noting the clump.	• Display B, "because, Display A has (example) on numbers 64-65, people 7 people voted, how do you know how many people got 64 instead of 65"	
		• Display A, "It is because display B shows how many people got each exact thing while display a just rounds together in groups, making it easier to see were the biggest and smallest measurements are."	
		• Display A, "it shows that 2 of the bars are way higher than all of the other bars."	
		• Display A, "There more 64-65 and 66-67"	
DaD(2a)	Student concentrates on specific data points without relating these to any	• Display B, "Only two measurements were exactly the same."	
	structure in the data. Student may choose Display B, noting	• Display B, "because 64 and 65 have the most."*	
	but does NOT evaluate the advantages for this structure compared to binning.	• Display B, "because they are written one by one""	
	Students who do weigh the advantages are scored as DaD3(a).	• Display B, "because they are written one by one"	
	Students who refer to a grouping without further elaboration are also included (see last two examples).	• Display A, "Because it combines 64 and 65 and 7 people said that."	
DaD(1a)	Student interprets data displays or describes features of the display without relating to the goals of the inquiry	 "I counted and they both have the same number of people."* "Display B because it has 14 	
	Any response that interprets the display without clearly addressing the goals of the inquiry	groups."*	

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NL(i)	Response did not explicitly mention features of the display and/or interpret data. Any responses that did not interpret the data using information explicit in the display.	•	Display A, "I think because it got more measurements than the other." Display A, "most of them are on a line so you can tell" Display A, "it shows more." Display B, "because it has more information" Display A, "the dots are closer together." "It has a key." "it is good and perfect" Display A, "because it is higher"
М	Missing response	•	Display A, (no explanation) Display B, (no explanation)

*Mock student responses

Statue, Questions 5 and 6

Questions 5 and 6: Unusual measurements			
Level	Performance	Example	
Correct	Display A		
Incorrect	Display B		
NL(i)	Student circles both answer choices or writes an irrelevant comment	• "I don't know."*	
М	Student does not circle an answer choice and does not write anything.		

Questions 5 and 6: Statue and Meta-representational Competence (MRC)		
Level	Performance	Example
MRC(4b)	Student coordinates qualities of multiple displays with what those displays show and hide about the data. Student recognizes that display A shows the holes in the data while display B doesn't.	• Display A, "because the x-axis of the display has bins although the bins do not have any measurements in them. However, Display B only marks measurements on the x-axis that measurements exist." *
MRC(3a)	Student compares displays by indicating what each shows about the structure of the data. Students may answer either Display A or Display B and discuss what one or each shows about the data but does not discuss what they hide about the interpretation of the data.	 Students notes hole in Display A: Display A, "because the x-axis of the display has bins that do not have any measurements in them."* Display A, "There is 4 measurements between 54-55 and 60-61." Display A, "Because there are none on some." Display A, "because display B skips 56 - 59"*
MRC(2b)	Student lists and compares characteristics of displays without explicit reference to data structure or purpose of data collection.	Display B, "because its smaller"Display B, "it is longer"Both displays used squares to show

	Student makes a correct interpretation or	measurements. *
question.	observation that is not relevant to the question.	• Display, "B they all look low and about the same"
	** <i>Note:</i> "Bigger" is interpreted as focusing on the axis of the display.	• Display A, "All of them are different heights"
		• Display A, "because it goes one number to another. Example 1-5"
		• B, "because it doesn't have all the numbers."
		Student may notice what a display shows or hides, but if the student misinterprets "unusual measurements", then the response is scored as 2(b). For instance, the following two responses consider A to be the better display because the binning hides where the measurements go:
		• Display A, "This display is better because it shows heights in intervals of 2 so we don't know which height goes where."
		• Display A, "It shows 3 or 4 at a time"
		Students mention binning or grouping measurements together.
		• Display B, "because it has each different measurement."
		• B, "because it shows each individual measurement."*
NL(ii)	Student's response is somewhat relevant to the problem but unclear or without an explanation.	• Display B, "because its an unusual way of showing the measurements by little measurements of the height"
This includes responses where the student has identified non-existent features of the display (for instance, saying Display A shows the values 50- 51).	• Display A, "it gives less information."	
	saying Display A shows the values 50- 51).	• Display B, "because it is easier to explain."
	Includes responses where student's logic	• Display B, "because it is not that

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	does not match between multiple choice and explanation.	•	accurate." "Display B, because it bins the values."*
NL(i)	Response is irrelevant, unclear, or a restatement of given information.	•	"because it's just right."* "I don't know"*
М	Missing response	•	Display A, (no explanation) Display B, (no explanation)

*Mock student responses

Questions 5 and 6: Statue and Data Display (DaD)			
Level	Performance	Example	
DaD4(a)	Student displays data in ways that use its continuous scale (when appropriate) to see holes and clumps in the data. Student chooses display A because display B does not have a constant scale.	 Display A, "because display B skips 56 - 59" * Display A, "because display A shows all values even if there are no boxes" * Display A, "because it shows 54-55 way farther then the others" Display A, "Because there are none on some." 	
DaD3(a)	Student notices or constructs groups of similar values from distinct values. Student identifies possible unusual values. Student may choose Display B and provide a reason why exact values are preferable over groupings.	 Display B, "because on Display A shows 72-73 you can't know if it's a 72 or 73" Display B, "Because on A you can't tell if its 54 or 55" * 	
DaD2(a)	Student concentrates on specific data points without relating these to any structure in the data. Student may choose Display B, noting that the values are written individually, but does NOT evaluate the advantages for this structure compared to binning.	 Display B, "because it shows each height."* Display B, "because it shows what each student measured." The following two responses consider A to be the better display because the binning hides where the 	

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	Students who do weigh the advantages are scored as DaD3(a). Student may also choose Display A and concentrate on particular points that are not relevant to highlighting how the structure of the display shows unusual measurements.	 measurements go (a noticing irrelevant to how the display's structure highlights unusual measurements): Display A, "This display is better because it shows heights in intervals of 2 so we don't know which height goes where." Display A, "It shows 3 or 4 at a time"
DaD1(a)	Student interprets data displays or describes features of the display without relating to the goals of the inquiry. Any response that interprets the display without clearly addressing the goals of the inquiry	 Display B, "all of the measurements is there on the graph" Display B "its more spread apart" Display A, "because it counts by twos and doesn't skip numbers" "I counted and they both have the same number of people."* "Display B because it has 14 groups."*
NL(i)	Response did not explicitly mention features of the display and/or interpret data. Any responses that did not interpret the data using information explicit in the display.	 Display A, "because it is the one that is write." (uninformative) Display A, "All of them are different heights" (not true) Display B, "because its smaller" (unclear what "its" refers to) Display, "B they all look low and about the same" (not true) Display A, "because it goes one number to another. Example 1-5" (unclear) Display A, "it gives less information." (not true)
М	Missing response	Display A, (no explanation)Display B, (no explanation)

*Mock student responses

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Statue, Questions 7,8

Questions 7 and 8: Actual height of the statue / Meta-representational Competence (MRC)			
NOTE: Depending on students' reasoning, either A or B can be chosen. Because of this, there is			
no coding of "correct" or "incorrect" responses.			
Level	Performance	Example	
MRC(4b)	Student coordinates qualities of multiple displays with what those displays show and hide about the data. Students may either answer A or B as being better for showing the actual height of the statue.	 Display B, "it shows what each person got and helps estimating the greatest measurement while on display A, you can't figure out how many people got an answer." Display A, "because it's easier to see 	
	Students must mention what one of the displays did to show or hide something about the data.	where most of the measurements are and that's probably where the actual height of the statue is."*	
	Student may recognize that display B shows the frequency for single values while display A doesn't differentiate between the range of two values per bin.		
	Student may recognize that display A shows a tighter clump of values around the center.		
MRC(3a)	Student compares displays by indicating what each shows about the	Student notes that Display B shows the frequency for each statue height:	
structure of the data. Students may answer either Display A or B and discuss what either or both	• Display B, because it has the numbers by itself. (example: 55, 54, 56, 57)		
	 displays show but do not discuss what they hide. Students may refer to "measurement" or "measurements" rather than "height" or "heights." In contrast to 2(b) where students may misinterpret the meaning of "actual 	• Display B, because it's not like all in one measurement and that one has its	
		 In different measurements. Display B, because A gives you whole lot number to work with. B 	
		give you certain numbers.	
	height" to mean "individual height," students may mention individual heights	• Display B, because it goes one by one.	
	in the context of what the display shows (one shows individual measurements,	• Display B, it shows what most	

	one does not) but it is not clear that they	people got.
	question.	Student notes that Display A bins the data
		• Display A, it shows more people agreeing to one thing.
		• A, "because it tells where most of the measurements were."
		• B, "because in A you can't see each person's measurement."
MRC(2b)	Student lists and compares characteristics of without explicit	• Display A, "because it is taller than B. B is shorter than A."
	of data collection.	• Display B, "because it has more with and height."
	** <i>Note:</i> "Bigger" is interpreted as focusing on the axis of the display.	• Display B, "because is the height of the statue is in order from least to
This includes responses where a reasonable inference can be made that the student has misinterpreted "actual height" to mean each student's measurement being shown individually. Student may refer to "height" or "heights" rather than "measurement" or "measurements."	 greatest." Display B, because you can see the heights. (<i>Note</i>: This is an example of a student misinterpreting "actual height" to mean each measurement shown individually.) 	
NL(ii)	Student's response is somewhat relevant to the problem but unclear. This includes responses where the student has identified non-existent features of the display (for instance, saying Display A shows the values 50- 51).	 Display A, because it probably is tall. Display A, if you look at it is no doubt on which one is the actual height. (The student interprets the display incorrectly): Display A, because it shows every single height from 54 to 73 Display B, "because it is easier to explain." Display A, because you can see the heights. (<i>Note:</i> This is a misinterpretation, since B shows the individual heights)

NL(i)	Response is irrelevant, unclear, or a restatement of given information.	•	Display B, "because it is a good thing to do.
		•	Display B, "because it has more display than A."
		•	Display A, "because it is the write answer."
М	Missing response	•	Display A, (no explanation) Display B, (no explanation)

Questions 7 and 8: Statue and Data Display (DaD)			
Level	Performance	Example	
DaD(5a)	Student recognizes that a display provides information about the data as a collective. Student can choose either display and	• Display B, "because on the graph it shows that it should be either 65 or 66 because they have the same number of blocks."	
	provides a reasonable explanation identifying the center clump of data as the best estimate for the actual height.	• Display A, "it shows that most measurements are between 64-67. So its easy to guess what is the real height." *	
DaD(3a)	Student notices or constructs groups of similar values from distinct values.	• Display A, "I think this one because the heights are more tall."	
Student chooses a display based upon identifying a clump of data. Student may also choose Display B at provide a reason why exact values are preferable over groupings.	Student chooses a display based upon identifying a clump of data. Student may also choose Display B and	• Display A, "because it reaches to 7"	
		• Display A, "It shows more people agreeing to one thing"	
	preferable over groupings.	• Display A, "Because it goes all the way up to 7 and the other dose not. It stops at 4."	
DaD(2a)	Student concentrates on specific data points without relating these to any	• Display B, "because it shows that 65 and 66 have the most."*	
structure in the data. Student chooses a display ba	structure in the data. Student chooses a display based upon	• Display B, "Because it shows every single height from 54 to 73."	
	Student may choose Display B, noting that the values are written individually, but does NOT evaluate the advantages	• Display B, "cause it's not like all in one measurement and that one has it in different measurements."	

	for this structure compared to binning. Students who do weigh the advantages are scored as DaD3(a).	 Display B, "because it shows 64, 65 not 64-65 like A does." Display B, "it tells you the exact measurements"
DaD(1a)	Student interprets data displays or describes features of the display without relating to the goals of the inquiry. Any response that interprets the display without clearly addressing the goals of the inquiry	 "I counted and they both have the same number of people."* "Display B because it has 14 groups."* Display B, "all of the measurements is there on the graph" Display B, "because they are in order" Display A, "it is clustered" Display A, "Because it is taller."
NL(i)	Response did not explicitly mention features of the display and/or interpret data. Any responses that did not interpret the data using information explicit in the display.	 "What do you mean?" Display A, "because it is the write answer." (uninformative) Display A, "because it probably is tall." (unclear what "it" refers to) Display A, "if you look at it is no doubt on which one is the actual height." (unclear) Display B, "Because it is more presifix than the other one." (jibberish) Display B, "because it has more with and height." (not true)
М	Missing response	Display A, (no explanation)Display B, (no explanation)