What does the numerator of that fraction represent in this story?

Can we write any decimal number as a fraction? How do you know?

What fractions are represented? ●●●○

Can you show and explain more about how you used your drawing to find the answer to the problem?

Is it true that a number with three digits will always be greater than a number with two digits?

I'm not sure I understand how you solved the problem. Can you explain it a different way?

Which fractions are greater than $\frac{1}{2}$?

When you write the expression $n + 0.5 = 3$, what is the value of n ?

What are some different ways we can model $\frac{1}{3}$? How are they the same?

Who can prove that $\frac{3}{4} = 75\%$?

How did you know that $\frac{3}{4}$ is greater than $\frac{3}{5}$? What strategy did you use?

Can someone else describe the pattern you see while pointing to the numbers on the board?

gether to develop authentic, reliable, and valid measures to assess these more holistic aspects of mathematical learning and problem solving.

Having students involved in problem-based learning that develops their persistence and communication skills will also enhance their future workplace success (Boaler). American students who experience non-standard problem solving in classrooms aligned to the 5 C's and CaCCSSM, especially problem solving which employs collaboration and communication in tasks that require evidence of reasoning, will be better prepared for the demands of PISA, similar types of assessments, college, the work place, and social participation.

Reference

National Academies Press. *Assessing 21st Century Skills; Summary of a Workshop*: **http://www.nap.edu/cataglo.php?record_id=13215d**

As this article goes to press, California, as one of the "Governing States," will have already voted upon Smarter Balanced Assessment Consortium (SBAC)'s (**www.k12.wa.us/smarter**) claims for what its summative, CaCCSSM-aligned tools will assess, and item writing will commence. It is our hope that California will assert its vision for student learning outcomes that prepare our children for the 21st century. **http://www.k12.wa.us/SMARTER/ContentSpecs/MathContentSpecifications.pdf**

Practicing Questioning Skills as a Tool to Assess Student Understanding

by Robert Kaplinsky, Downey USD, rkaplinsky@dusd.net; and Melissa Canham, Downey USD, mcanham@dusd.net

Educators struggle to meaningfully assess students in a timely manner. Multiple choice and written-answer tests take time to process and often lack evidence of student reasoning. Asking students "Does everyone understand?" or "Does anyone have any questions?" gives some information, but often students either say they understand or say nothing at all. One potential solution to this problem is as simple as teachers modifying their questions. Teachers can quickly assess students' knowledge and immediately adjust the lesson by asking questions that facilitate classroom discussions and encourage elaborate responses.

Teachers are aware that some questions require students to think more meaningfully, yet research shows that these questions are rarely asked. According to Gall (1970), "About 60% of teachers' questions require students to recall facts; about 20% require students to think; and the remaining 20% are procedural." These percentages are not surprising since it takes practice and patience for teachers to develop questioning skills.

It is critical that teachers refine their questioning skills since they are an effective tool in implementing the Common Core's Standards for Mathematical Practice that call for teachers to develop students' reasoning ability. Standard 3—Construct viable arguments and critique the reasoning of others—requires "[students to] justify their conclusions, communicate them to others, and respond to the arguments of others." Also Standard 1—Make sense of problems and persevere in solving them—states: "[students] can understand the approaches of others to solving complex problems and identify correspondences between different approaches." Teachers need opportunities to focus on their questioning skills to prepare to implement these standards.

As the mathematics teacher specialists for our school district, we developed an activity

called Questioning Scenarios to help teachers practice questioning skills. The activity begins with teachers in groups of three taking the roles of teacher, student, or observer. The individuals playing the role of teacher and student each receive a slip of paper that describes their corresponding scenario. Here is an example of a teacher and a student scenario:

> You are an elementary teacher. You want to find out what answer your student got to the question, "What is the area of a square with a side length of 4?" Determine what conceptual understanding the student has by asking questions, especially questions that encourage elaborated responses.

> You are an elementary student who is working on finding the area of a square with a side of length 4. You are confusing finding the area of a square with finding the perimeter of a square. As such, to get your answer you count all the sides of the square and get an answer of 16. You are proficient in addition, subtraction, multiplication, and division.

The individuals playing the role of teacher and student get time to read their cards and learn their roles. Meanwhile, the individual playing the role of observer is waiting to record all of the teacher's questions to the student. Once the activity begins, the teacher will talk to the student in the context of the scenario described on the slips of paper. Here is a possible interaction for this scenario:

Teacher (T): Please tell me what the area is for a square with a side length of 4.

Student (S): 16.

T: Great. Does that make sense?

S: Yes it does.

This interaction may seem common for most mathematics classrooms. The teacher asked a question to which the student responded with a correct answer. The teacher checks to see if the question makes sense to the student and the student replies that it does. However, consider this slightly different interaction:

T: Please tell me what the area is for a square with a side length of 4.

S: 16.

T: Great. How did you get that answer?

S: The square's sides are all 4 long so I added them together and got 16.

When the teacher changed the question from "Does that make sense?" to "How did you get that answer?", the student's response of "Yes it does" was no longer a sufficient answer. The student was now forced to explain his or her thinking. In this case, asking a question that encouraged an elaborate response allowed the teacher to uncover a misunderstanding that may have otherwise gone unnoticed. Having students explain their thinking is one of the simplest and most natural forms of assessment in the mathematics classroom.

During the Questioning Scenarios activity, we emphasize that the teacher's goal is to uncover the student's misunderstandings by asking questions that will encourage the student to respond elaborately. The initial goal is not to help the student solve the problem, although the teacher can go in that direction if the misunderstanding is uncovered quickly.

The interaction between the teacher and student continues until the facilitator who is running the activity stops the groups. Most groups seem to uncover the misunderstandings within three minutes but more time may be allocated as necessary. Once stopped, the observer begins the debriefing process by reading each of the questions the teacher asked. Collectively, the group identifies those questions that led the student to respond with an elaborate mathematical explanation that consequently made it easier for the teacher to understand the student's reasoning. In general this debriefing process also takes three minutes and again the time limit can be extended if groups are having constructive conversations.

After the questioning and debriefing have been completed, the facilitator then brings all the groups back together and discusses with them which types of questions allowed the teacher to better assess the student's knowledge. The facilitator might also ask a group to share a question they found particularly effective. Most often the group responds that the "How" and "Why" questions produced the most elaborate responses. Sometimes they also

Continued on page 28 ➢ ➢

add that questions that ask students to model or draw out their thoughts are effective.

The process of acting out and debriefing the scenario takes place a total of three times, with a new scenario presented each time and the roles of the individuals changing. This gives each person the opportunity to experience questioning from three different perspectives and reflect on their own questioning skills. Completing three rounds of scenarios generally takes between thirty and forty-five minutes.

It is important to understand that the transition from asking questions that elicit uninformative responses to questions that encourage elaborate answers does not happen quickly or easily. It is difficult to come up with questions that will challenge students to make connections without simply telling them what to do. Since classroom minutes are limited, the Questioning Scenarios activity provides practice in asking questions that require meaningful responses. Finding the right balance is a process that will take many years to master, but the benefits of knowing what students are thinking and how they reason makes it all worthwhile.

In the past, many students have been trained to believe that teachers only care about the answer to the problem, not how they thought about it. It will take time for students to adjust to discussing the problems and explaining themselves. Some possible activities for increasing student participation include using a Think-Pair-Share strategy, giving students sentence stems to structure their responses, and modeling the teacher's thought process using think-alouds.

Based on our experience, here are some suggestions for those new to Questioning Scenarios;

- ✔ When introducing Questioning Scenarios to a group of teachers for the first time, it is helpful to do an example similar to the scenario shown in this article, involving the square with a side length of 4. Modeling both ineffective and effective questions will help them understand what to focus on.
- ✔ Pick a mathematics topic that the teachers are certain to feel comfortable with even if it means picking a topic below the grade level they teach. We found that when teachers feel out of their mathematics content comfort zone, their anxiety is so high that they cannot focus on their questioning.
- ✔ Include as much information as possible about what the student knows or does not know so the individual playing the role of the student can portray it accurately.
- ✔ When including a picture, chart, or table, make sure to add it to both the teacher and student scenarios so they have the same thing to reference.
- ✔ Consider providing a list of questions for teachers to use when they struggle to find one to ask. An excellent set of questions is listed in the Introduction section of the *Professional Standards for Teaching Mathematics* from the National Council of Teachers of Mathematics.

References

Common Core State Standards (CCSS). 2010. <**http://www.corestandards.org/the-standards/mathematics**>.

Gall, Meredith D. "The Use of Questions in Teaching." *Teacher Education Division Publication Series* (1970): 713.

National Council of Teachers of Mathematics (NCTM). *Professional Standards for Teaching Mathematics*. Reston, VA: NCTM, 1991. **<http://www.nctm.org/standards/content.aspx?id=26578>**

Nominations Sought for CMC Awards!

Please consider nominating people for the following CMC awards:

★ George Polya Memorial Award
★ Edward Begle Award
★ Walter Denham Memorial Award
★ Margaret DeArmond Scholarship

Information regarding the awards, criteria for nominating a person, and about how to submit a nomination can be found at the CMC web site **www.cmc-math.org/members/awards.html**.

Student

- You are trying to find the area of a circle with a radius of 2 units.
- You are proficient with math operations including exponents.
- You do understand that a circle's area is the space in the middle and that the circumference is the circle's perimeter.
- Your do not have conceptual understanding of the formulas for circumference and area.
- You have seen the expressions $2\pi r$ (circumference) and πr^2 (area) but do not know which is which.
- You do understand how to use the formulas to find a value when you are given the radius.
- In this particular problem, instead of using the area formula, you use the easier looking circumference formula of $2\pi r$ to get "4π" as the answer.
- You are confident you are correct and don't realize that you only accidently got the correct answer because 4π is coincidently the amount of square units in the area.

Teacher

- Your student is working on finding the area of a circle whose radius is 2 units long.
- You have taught students that the formula for circumference is $2\pi r$ and the formula for area is πr^2.
- Determine what understanding the student has by asking questions, especially questions that encourage elaborate responses.

Student

- You are trying to find the area of a circle with a radius of 2 units.
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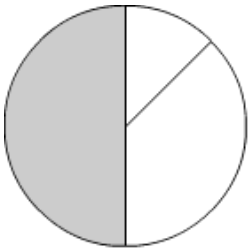
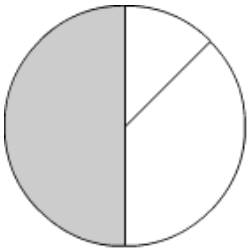
Student



- You are trying to find what fraction of the circle is shaded.
- You believe that $\frac{1}{3}$ has been shaded because one part out of the three parts has been shaded.
- You have forgotten that each of the parts of the fraction have to be equal.
- You know that the numerator represents the number of parts and that the denominator represents the number of parts in a whole.

Teacher



- Your student is working on finding what fraction of the circle is shaded.
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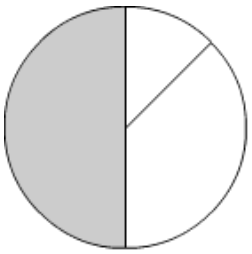
Student



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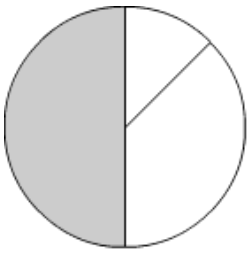
Teacher



- Your student is working on finding what fraction of the circle is shaded.
- Determine what understanding the student has by asking questions, especially questions that encourage elaborate responses.

Student

- You are trying to compare the fractions $\frac{3}{4}$ and $\frac{5}{6}$.
- You believe that $\frac{3}{4} < \frac{5}{6}$ because $3 > 4$ and $4 < 6$.
- You know that the numerator represents the number of parts and that the denominator represents the number of parts in a whole.
- You think that $\frac{5}{6}$ must be greater because it has more parts.
- You are confident you are correct and don't realize that you only accidently got the correct answer.

Teacher

- Your student is working on comparing the fractions $\frac{3}{4}$ and $\frac{5}{6}$.
- Determine what understanding the student has by asking questions, especially questions that encourage elaborate responses.

Student

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Teacher

- Your student is working on comparing the fractions $\frac{3}{4}$ and $\frac{5}{6}$.
- Determine what understanding the student has by asking questions, especially questions that encourage elaborate responses.

Student

- You are trying to find the median of 3, 7, 4, 2, 9.
- You do understand that the median is the middle number.
- You have forgotten that you first need to order the numbers from least to greatest.
- You are confident you are correct and don't realize that you only accidently got the correct answer because 4 is coincidentally the middle number when they are in order.

Teacher

- Your student is working on finding the median of 3, 7, 4, 2, 9.
- Determine what understanding the student has by asking questions, especially questions that encourage elaborate responses.

Student

- You are trying to find the median of 3, 7, 4, 2, 9.
- You do understand that the median is the middle number.
- You have forgotten that you first need to order the numbers from least to greatest.
- You are confident you are correct and don't realize that you only accidently got the correct answer because 4 is coincidentally the middle number when they are in order.

Teacher

- Your student is working on finding the median of 3, 7, 4, 2, 9.
- Determine what understanding the student has by asking questions, especially questions that encourage elaborate responses.

Student

- You are working on ordering decimals from least to greatest.
- The problem you are currently working on is ordering the decimals 0.52, 0.714, and 0.3.
- You correctly place them in the order 0.3, 0.52, 0.714.
- However, the reason you put them in this order is because you look at the number after the decimal like a whole number (3, 52, 714) and do not understand the significance of place value.
- You are confident you are correct and don't realize that you only accidently got the correct answer.

Teacher

- Your student is working on ordering decimals 0.52, 0.714, and 0.3 from least to greatest.
- Determine what understanding the student has by asking questions, especially questions that encourage elaborate responses.

Student

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- You are confident you are correct and don't realize that you only accidently got the correct answer.

Teacher

- Your student is working on ordering decimals 0.52, 0.714, and 0.3 from least to greatest.
- Determine what understanding the student has by asking questions, especially questions that encourage elaborate responses.

Student

- You are working on finding the area of a square with a side of length 4 units.
- You are proficient with math operations including exponents.
- You are confusing finding the area of a square with finding its perimeter.
- So, to get your answer you count all the sides of the square (4 + 4 + 4 + 4) and get an answer of “16”.
- You are confident you are correct and don’t realize that you only accidently got the right answer because 16 is coincidently the amount of square units in the area.

Teacher

- Your student is working on finding the area of a square with a side length of 4 units.
- Determine what understanding the student has by asking questions, especially questions that encourage elaborate responses.

Student

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Teacher

- Your student is working on finding the area of a square with a side length of 4 units.
- Determine what understanding the student has by asking questions, especially questions that encourage elaborate responses.

PLANNING PURPOSEFUL QUESTIONING
Thinking Through a Task as a PLC

Elementary: Cows & Chickens Task

http://ime.math.arizona.edu/2008-09/Algebra%20Essays/ArithtoAlg.pdf

On my brother's farm, there are cows and chickens. Together, they have 50 heads and 120 feet. How many cows are there? How many chickens?

Middle Level: Shopping Trip Task

NCTM. (2014). *Principles to actions: Ensuring mathematical success for all.* Reston, VA: NCTM.

Joseph went to the mall with his friends to spend the money that he had received for his birthday. When he got home, he had $\$24$ remaining. He had spent $\frac{3}{5}$ of his birthday money at the mall on video games and food. How much money did he spend?

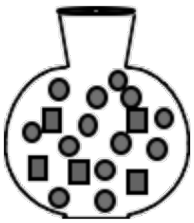
How much money had he received for his birthday?

PLANNING PURPOSEFUL QUESTIONING
Thinking Through a Task as a PLC

Secondary: Candy Jar Task

NCTM. (2014). *Principles to actions: Ensuring mathematical success for all.* Reston, VA: NCTM.

Suppose you have a new candy jar with the same ratio of Jolly Ranchers (JR) to jawbreakers (JB) as shown in the picture, but it contains 100 Jolly Ranchers.



How many jawbreakers do you have? Justify your answer.

Note: In the picture, Jolly Ranchers are represented by 5 rectangles, and jawbreakers areshown by 13 circles.

What standards might connect to this task?

©Kobett

How might you group students to encourage collaboration and problem solving?

©Kobett

How might you launch the task?

©Kobett

Can you connect this task to other content areas?

©Kobett

What materials or tools will you use to support student learning?

©Kobett

How might you transition from the launch part of the lesson to student collaboration

©Kobett

How might the arts connect to this task?

©Kobett

How might you extend this lesson if a group finishes before other groups are done?

©Kobett

What questions might you ask while students are working?

©Kobett

How might you support students persevering through the task?

©Kobett

How might you motivate a struggling learner?

©Kobett

How might you differentiate the task for differing student populations?

©Kobett

What should the students learn from the task?

©Kobett

What do you anticipate students might do?

©Kobett

What questions might the students ask?

©Kobett

Which math practices should students exhibit?

©Kobett

What misconceptions might a student have?

©Kobett

What vocabulary will the students need to know or develop for the task?

©Kobett

Select an individual student and imagine how the student will respond to the task.

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How do you envision students will work together?

©Kobett

What questions might students pose while working on the task?

©Kobett

How might you support student collaboration?

©Kobett

How might you support students in exhibiting SFMP 3? (Critique the reasoning of others?)

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How might you differentiate the task for differing student populations?

©Kobett

How will the teacher facilitate student collaboration? What specific teacher moves might you observe?

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What facilitating questions will be used to open the lesson?

©Kobett

What does the teacher look like and sound like during this lesson?

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What type of environment must the teacher develop for students to engage in this task? What does this look like?

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How does the teacher organize the physical space for this lesson? Does this look different than other lessons? How/why?

©Kobett

How does the teacher establish an environment for students that signifies respect and rapport?

©Kobett

How will the teacher communicate expectations for reasoning, thinking, and collaborating while problem solving?

©Kobett

How will the teacher engage the students in the learning (so that the students are as equally engaged as the teacher?

©Kobett

What formative assessment techniques will the teacher use during the lesson? When will this happen?

©Kobett

How might the teacher flexibly respond to student understanding during the lesson? What might this look like?

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How might the teacher manage classroom behavior during this lesson? What does this look like?

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How might the teacher communicate with families about teaching rich tasks in the classroom?

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How will the teacher close the task?
What does this look like?

©Kobett

How will the teacher select groups to share? What order? Why?

©Kobett

What explicit connections should be made from the task to mathematical understanding?

©Kobett

What are three things that will happen in the closure of this task?

©Kobett

How will the teacher ensure the students understand the point of the task?

©Kobett

What happens tomorrow?

©Kobett

How will the teacher record key ideas while closing the lesson?

©Kobett

Describe the lesson by working backwards from closure to ignite.

©Kobett

What explicit connections should be made from the task to mathematical understanding?

©Kobett

What are some things that could go wrong during the closure of this lesson? How might the teacher respond?

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How might the teacher build vocabulary during the closure ?

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What happens tomorrow to connect to the closure?

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