1. At a community field, 117 kids are playing football and 84 kids are playing soccer.



Can each number sentence in the chart be used to find out how many fewer students are playing soccer than playing football?

Number Sentence	Explain why you chose yes or no.
A)	
+ 84 = 117	
Circle One:	
Yes No	
B)	
117 - 🗌 = 84	
Circle One:	
Yes No	
С)	
117 + 🗌 = 84	
Circle One:	
Yes No	

Number Sentences

2. Sam is saving his money to buy a bike. He has earned \$55 doing chores and now has \$163. How much money did he have to start with?

o to

Can each number sentence in the chart be used to find out much money he had to start with?

Explain why you chose yes or no.



Number Sentences: Multiplication and Division Problems

This resource guides you in using the ACT cycle to implement this probe with your students and use the findings to plan instructional next steps.

Here are two examples from this 6-item representation probe:

1. At a community field, 117 kids are playing football and 84 kids are playing soccer. Image: Can each number sentence in the chart be used to find out how many fewer students are playing soccer than playing football?				
Number Sentence	Explain why you chose yes or no.			
A)				
+ 84 = 117				
Circle One:				
Yes No				

2.	2. Sam is saving his money to buy a bike. He has earned \$55 doing chores and now has \$163. How much money did he have to start with? Can each number sentence in the chart be used to find out much money he had to start with?		
	Number Sentence	Explain why you chose yes or no.	
	B)		
	163 - 🗌 = 55		
	Circle One:		
	Yes No		

The probe consists of 2 multiple selection items. Item 1 and 2 can be administered together or as two separate diagnostic assessments.



What is the math?

This probe gathers information about the extent to which students can represent addition and subtraction situations using a number sentence.

Do	Studen	its
 Understand the mathematical meaning of words and the relationships described in real- world situations? 		 Misrepresent or misinterpret words and/or relationships described with inaccurate mathematical operations?
 Determine a correct number sentence to represent a problem? 	OR	 Choose sentences with the correct operation but incorrect order?
 Recognize equivalent algebraic representations? 		 Only recognize one algebraic representation as being correct.

Oklahoma Academic Standards for Mathematics

Below is the associated standard related to the intended content of the probe. This may mean a direct relationship (the content directly addresses the standard), but the content focus may instead be foundational for the standard—that is, the target may be necessary before the standard can be addressed.

3.A.2.1 Find unknowns represented by symbols in arithmetic problems by solving onestep open sentences (equations) and other problems involving addition, subtraction, and multiplication. Generate real-world situations to represent number sentences.



Each probe item requires a two-part response from the student: a selected response and a written explanation using words and/or pictures. Together, these two parts provide important information about the student's understanding and thinking. Four possible combinations of student responses are described below.

- correct selected response choice AND an explanation that provides sound reasoning
- correct selected response choice AND an explanation containing flawed or no reasoning
- incorrect selected response choice AND an explanation with reasoning that reflects some understanding
- incorrect selected response choice AND an explanation containing flawed or no reasoning

In preparation for examining your own student work, review the following:

- 1. the correct selected response answers;
- 2. student work samples showing correct selected response choices supported by sound reasoning and/or successful strategies; and
- 3. student work samples to illustrate common misconceptions.

1. Correct selected response choices

Item 1:	A) Yes	B) Yes	C) No
Item 2:	A) No	B) Yes	C) Yes

2. Examples of correct selected response choices with sound reasoning and/or successful strategies

	Football/Soccer Probler	n
	<u>53</u> + 84 = 117	Yes because I counted from 84
	Circle One:	
Students are able to	Yes No	n
choose number sentences		
that can be used to solve the problem. Students'	+ 84 = 117	http://
missing quantity in the	Circle One:	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
about how the number sentence represents the situation.	Yes No	3/3
		New
	117 - 🔄 = 84	us because 117 - Blank = 84
	Circle One:	by Will See the difficance
	Yes No	petween 117 84

Examples of correct selected response choices with sound reasoning and/or successful strategies





3. Examples that reflect common misconceptions

Saving for Bike Problem B) 163 - = 55 because it has to have **Circle One:** ss then 163 Yes No C) only one with Literal translation +55 = 163Students may think the Numbers correct numbers in the number sentence must follow the ss then 163 **Circle One:** same order as in the story problem. Yes No Its not wing like the senten 163 -= 55 **Circle One:** Yes (No Saving for Bike Problem Focusing on key words When students focus on He is saving so add t is rite. Saving is more and more each time. +163 = 55key words alone, without understanding the relationship being

described, they can incorrectly associate the word with incorrect number sentences. (Yes No (+).63 = 55 He is saving so add t is rite saving is more and more each time.

Examples that reflect common misconceptions

Saving for Bike Problem

Focusing on one strategy

Students may think about the problem in only one way. Because they focus on the strategy used to solve the problem, they overlook a related number sentences that can be used to solve for the unknown quantity.



Football/Soccer Problem



Difficulties with multiple representations

Students have difficulty understanding how different equations can be used to solve "compare" problems. These students are sometimes able to choose other correct number sentences as is shown in the second and third example.

Examples that reflect common misconceptions

Football/Soccer Problem

(cont.) Difficulties with multiple representations

Students have difficulty understanding how different equations can be used to solve "compare" problems. These students are sometimes able to choose other correct number sentences as is shown in the second and third example.

because you can not + 84 = 117 do it because wen you are doing a Circle One: number Sente's you Gan because Yes (No) 400 Will heed to have CI ther number because you could 117 - = 84 Figer if on because + 00 COV Circle One: UN7 14 W DUI (Yes) No be

	Saving for Bike Problem
Difficulties with "start unknown" representations Students have difficulty	$\Box + 55 = 163$ $AO OECAUSC$ $VOUDOAT KNOW$ $What to add it$ $Yes \qquad 0 Ye$
understanding how a "start unknown" number sentence can be used to solve the problem, even though for item 2, this is the number sentence that models the situation. These students are sometimes able to choose other correct number sentences	B. 163- = 55 yes because you can - Each oxhur Circle One: Ves No anw Set Anw Set
as is shown in the second example.	c. + 55 = 163 Nobecause You can't
	Circle One: Yes No WOULD MARE ONY SEASE



Instructional ideas to consider

ake Action

- Students' ability to represent problem situations involving addition and subtraction depends on a number of important underlying concepts and skills for students to understand:
 - $_{\odot}$ Addition can be understood as adding items to a set or joining two or sets
 - Subtraction can be understood as taking away items, taking apart a set into two or more smaller sets, or comparing the amounts in two sets.
 - An equation, also called a number sentence, represents an equality relationship between two expressions, one expression on the left side of the equals sign and the other expression on the right side of the equals sign. The expressions can include known quantities (represented by numbers) and/or unknown quantities (typically represented by a box, a question mark, or with variables).
 - \circ Subtraction is formally defined as the inverse of addition and can be thought of as an unknown addend in situations where the total and remaining amounts are known. For example, the subtraction problem 53 27 = ? can be reframed as 27 + ? = 53.
- Prior to working on representing addition and subtraction problems with unknowns, students should have experiences with writing addition and subtraction equations to represent a situation and describing how the equation connects back to the situation.
- Students should have experiences with solving and representing different addition and subtraction problem types, including:
 - Join/separate: Start with a number, apply a change by either adding or taking away, and get a result.
 - Put together/take apart: When given two (or more) parts, figure out the total; when given the whole, break into two (or more) parts.
 - $_{\odot}$ Comparison: Compare two numbers and find how many more or less.

Providing these different types of problems is important, although there is some disagreement in the field about whether it is useful to have children learn and identify the different types of addition and subtraction situations by name. Learn more about these problem types at:

- o https://teachers.yale.edu/curriculum/viewer/initiative 07.06.01 u
- o http://www.cbv.ns.ca/consultants/uploads/MathConsultant/Join.pdf
- Have student explore the meaning of different addition and subtraction problems by first comparing the problems without any actual numbers included. For example:
 - Terry collects baseball cards. She just bought _____ more cards and now has _____. How many cards did Terry have to start with?
 - Terry has ____ more baseball cards than John. John has ____ baseball cards. How many baseball cards does Terry have?

- The relationship between addition and subtraction gives rise to equations that can be solved by addition but do not include the + symbol and equations that can be solved by subtraction, but do not include the subtraction symbol. Students often have difficulty understanding the difference between an equation that can be used to represent or solve a situation and an equation that shows the strategy s/he used.
 - 37 + 45 = ? and ? 46 = 78 both can be solved by adding the known quantities
 35 + ? = 9, ? + 82 = 127, 123 45 = ?, and 154 ? = 63 can all be solved by subtracting the known quantities
- Provide a variety of equations that do and do not represent a situation and ask students to determine which ones correctly represent the situation. Ensure that students repeatedly encounter situations in which the same numbers appear in different contexts.
- Have students create their own story problems for each of the problem types.
- As always, consider which of the Mathematics Actions and Processes will be the focus of your instruction. (i.e. have students defend their choices to other students to support ability to communicate using mathematical reasoning).

Sample Hinge-point Question to Assess Progress		
Here is one example. You will likely need to create additional hinge-point questions as you implement targeted instruction to address learning needs.		
Sue has 63 more dollars than John. Sue has 134 dollars. How much money does John have?		
Which number sentences can be used to find out much John has?		
a) b) c) $134 + 63 = 134$ 134 + 63 = 134 + 134 + 136 = 63		
d) $134 - \boxed{= 63}$ e) $\boxed{-63 = 134}$ f) $134 - 63 = $		
Correct selected response choices for Hinge-point question.		
a, d, f		

