PARCC Mathematics Performance Tasks

THE EQUALITY GAME

Overview

At a Glance

Playing in pairs, students take turns choosing numbers and operations to make equations in various forms. The goal is to make the equations true statements.

Grade Level

Grade 1

Task Format

- Partner game (2 students); modeled whole class or small group
- Played over a series of 3–5 days
- Student Exit Slip—Individual; completed as a culminating activity following the completion of playing over a series of 3–5 days

Materials Needed

For each student

- 1 Student Exit Slip (template provided)

For each pair of students

- 1 game sheet (either A or B)
- 2 pencils
- Extension/Elaboration: 1 game sheet (either C or D)

For the teacher

- Observation Checklist (template provided)

Prerequisite Concepts/Skills

- Distinguishing when a concrete representation of two sets of quantities is the same or different
- Comparing quantities using informal language, such as "is more than," "is less than," or "is the same as"
- Familiarity with symbolic representation of operations (+ and –)

Content Standards Addressed in This Task

1.OA.D.7

Understand the meaning of the equal sign, and determine if equations involving addition and subtraction are true or false. For example, which of the following equations are true and which are false? 6 = 6, 7 = 8 – 1, 5 + 2 = 2 + 5, 4 + 1 = 5 + 2

Standards for Mathematical Practice Embedded in This Task

MP2

Reason abstractly and quantitatively.

MP3

Construct viable arguments and critique the reasoning of others.

GET READY: Familiarize Yourself with the Mathematics

This task uses a game-like design to exercise and develop students' understanding of the equal sign in the context of evaluating whether an equation is true, and then assesses that understanding with predetermined Exit Slip problems. The activity is presented entirely with written numerals and other symbols to teach (and assess students' use of) that mathematical language. Observation notes call attention to places where students may still be developing the skills they need. For students who need to draw pictures or use fingers or objects to perform arithmetic, those are certainly allowed, and the need should be noted.

Throughout this task, students demonstrate their understanding of properties of equality. Equality is a relation between two quantities or expressions: to be considered numerically *equal*, the quantities or expressions must have the *same* value, represent the same amount. "Balance" can be a useful metaphor. Because 4 + 1 is the *same value* as 5, they are equal. They "balance."

4 + 1 = 5 is a *true* statement. The equation 4 + 1 = 6 is also a statement, but not a true one! It is an equation, but not balanced. In the equation 4 + 5 = ____ + 6, the equal sign is asserting the *intention* to make a true statement, and we balance the equation by finding just the right number to place in the blank to make both sides equal.

A very common misuse of the equal sign arises, in part, from calculator use and is illustrated below. It is important for you to be aware of this misuse, so that you can avoid it yourself, notice it in your students, and provide appropriate instruction. For example, to show how to calculate 4 + 7 + 3 – 2, students (and adults) sometimes write this false "run-on sentence":

$$4 + 7 = 11 + 3 = 14 – 2 = 12$$

In using a calculator, this would be the sequence of buttons to press. But *in writing* it is not correct, because the = signs make the false claim that 4 + 7 is the same as 11 + 3 is the same as 14 – 2 and all of these are equal to 12. One way to avoid this imprecise use of the equal sign is to write.

$$4 + 7 = 11$$
$$11 + 3 = 14$$
$$14 – 2 = 12$$

Another way is to write

$$4 + 7 \rightarrow 11 + 3 \rightarrow 14 – 2 \rightarrow 12$$

This has advantages and disadvantages. It shows the steps as they play out in one's head and it calls attention to the fact that the = sign is *not* used. But the fact that it doesn't show how = *is* used, and that it introduces a new symbol that students don't need, makes it only a second choice.

It is very important that students understand the precise use of the equal sign early on and not develop the habit—which will have to be unlearned later—of recording calculations in false "run-on sentences."

In this task, students also gain experience describing relationships using words before using written symbols. For example, when comparing quantities, students first use the language "is more than," "is less than," or "is the same as" before using the symbols >, <, or = as shortcuts. While this task focuses

primarily on the written representation, it helps students maintain the meaning (and show you that they understand the meaning) by continuing to use words to describe the relationships between numbers.

Standards for Mathematical Practice Embedded In This Task

This task exercises and builds habits of mind underlying two Standards for Mathematical Practice: *MP2: Reason abstractly and quantitatively* and *MP3: Construct viable arguments and critique the reasoning of others*. Students reason abstractly and quantitatively when they describe, read, or write a number sentence that compares two quantities represented in expression forms (MP2). They also gain experience in justifying their reasoning about whether or not an equation is true (MP3). While working with a partner, students have many opportunities to critique each other's reasoning. They are prompted with questions including, "Do you agree or disagree…? Why or why not?" This dialogue fosters the development of justification and reasoning even in very young students.

For More Information

Richardson, K. (2012). *How children learn number concepts: A guide to the critical learning phases.* Bellingham, WA: Math Perspectives Teacher Development Center.

GET SET: Prepare to Introduce the Task

1. Gather the materials listed on page 1.

   Copy Game Sheet A and/or B per pair. Game Sheets C and D are for the extension activity and should be copied as needed as pairs progress through the task.

   Copy one Exit Slip per student. The purpose of this Exit Slip is to let students apply and show their understanding after playing the game over a series of days.

2. Have two students sit together, with a writing surface. The whole class can play simultaneously in pairs once they know how. Observe pairs as you feel it is most useful; the observation checklist may help.

Introducing the Task

The task begins with a game; assessment of standard 1.OA.D.7 is formalized with an Exit Slip upon completion of the game. Tell students that their goal is to compare quantities on each side of the equal sign and to make the equation true. Throughout this document, when specific language is suggested, it is shown in *italics.*

1. *Today we'll play the Equality Game. Your goal is to make each equation true, meaning that the two sides of the equation must be equal.*
2. To Player 1: *Choose one of these equations and write one number, from 0 through 10, in any blank.*
3. To Player 2: *You can choose to write another number, from 0 through 10, in a blank in that same equation, or an operation sign (+ or –) in a circle in that equation.*
4. *Take turns writing numbers or operation signs in the same equation in order to make that equation true. Then choose another equation. Together, your job is to complete each equation so that both sides are equal.*

Note: We assume that students understand what "=" means, but if you see that they do not, you might take a moment or two to illustrate its meaning and use, showing for example 9 + 1 = 5 + 5.

Preparing to Gather Observation Data and Determine Next Steps in Instruction

As students engage in the task, the notes in the next section will help you identify students' current strengths and possible next steps for instruction. As you observe, use whichever form of the Observation Checklist that best helps you record your observations of students and other relevant evidence as you see it: Individual, Partner, or Class. These varied forms, available at the end of this document and in a separate MS Excel file, are intended to give you choice about how to collect notes on your students and determine possible next steps for instruction.

Addressing Student Misconceptions/Errors

Because students too often see "=" written only at the *end* of a calculation (e.g., ___ + ___ = ___), they naturally develop the misconception that it means "put an answer here." It is very important for students to see forms like 10 = 4 + 6 as often as 4 + 6 = 10, and learn that they mean exactly the same thing. When students who think "=" means "now write the answer" see equations like 6 + 4 = ___ + 3, they are likely to add 6 + 4 and write 10 in the blank. Students who do understand the notation will realize that 6 + 4 does *not* equal 10 + 3: the correct solution is to write a 7 in the blank, to make the true statement 6 + 4 = 7 + 3.

Extensions and Elaborations

This task can be elaborated in a variety of ways. Game sheets A, B, C, and D are built in a progression.

- **Game Sheet A** uses only three equation forms, the most accessible entry point for some students.
  - ___ = ___
  - ___ = ___ ± ___
  - ___ ± ___ = ___
- **Game Sheet B** includes operations on both sides of the = sign.
  - ___ = ___
  - ___ = ___ ± ___
  - ___ ± ___ = ___
  - ___ ± ___ = ___ ± ___

- **Game Sheet C** focuses on the placement of the = sign with three numbers and one operation as well as equations with operations on both sides of the = sign.

- **Game Sheet D** focuses on equations with operations on both sides of the = sign.

When they are ready, students can create their own game sheets using blank equation forms.

Students can progress to creating equations using both operations, (+ and –). Because standard 1.OA.D.7 calls to "determine if equations involving addition *and* subtraction" are true or false, equations *can* and *should* include both operations. In certain cases, their number choices may lead to a subtraction that, to us, results in a number below zero. Young students often ignore the order, treating 5 – 6 as if it gives the same result as 6 – 5 (perhaps generalizing from their certainty that 2 + 3 does give the same result as 3 + 2). Some students even in grade 1—especially those who have had experience moving tokens on a number line—have some sense of the possibility of "moving to the other side of zero," even though they have not studied (and should not be expected to know about) negative numbers. But even for those who have no such knowledge from experience or from siblings or parents, it is important to know that 5 – 6 and 6 – 5 are not the same, to recognize *when* a subtraction equation does not result in a number they recognize (greater than or equal to zero), and to be able to explain that in some way that makes sense to them: e.g., if I have only 5 pennies, I *can't* give away six of them. (We can say, of course, that 6 – 5 and 5 – 6 are not the same, but we don't want to say "you can't subtract bigger from smaller," because that's not true and will have to be unlearned in later grades.)

If a student builds the equation 3 + 2 – 6 and is not sure how to handle the result (or treat the subtraction as 6 – 5), you might suggest, "Could you change a number to make this equation work better?" For students who *do* have a sense that 3 + 2 – 6 yields a negative number or "a number on the other side of zero," you can still ask them to find a way to change it so that it works entirely with whole numbers (0, 1, 2, and so on). For example, a student who had started with 3 + 2 – 6, might change the 3 to 5, because 5 + 2 – 6 will result in a positive whole number.

Finally, you can set certain constraints for students as they play, when students complete a game sheet or even within a game. Any of these constraints can help students develop *flexibility* as they deepen their understanding about equality and creating true equations. Some possibilities include:

- *Let's write operation signs first (last).*
- *Let's only use addition (subtraction).*
- *Let's use sums of 10 (or 18) or less.*
- *Let's let the largest (smallest) number that we use be _____.*
- *Let's use only this form* ___ ⊕ ___ = ___ ⊕ ___ *and use one (+) and one (–).*

GO: Carry Out the Task—The Equality Game

Task Steps	Keep in Mind	Observations of Students
1. Give pairs of students Game Sheet A to start (or the game sheet that best meets your students' needs).	• Most students will likely begin using game sheet A or B, but others may be ready to move on to Game Sheet C or D. Feel free to provide students with the appropriate game sheet *at any point* during this task. • Game Sheet A uses only three equation forms, for easiest entry. ___ = ___ ___ = ___ ± ___ ___ ± ___ = ___ • Game Sheet B includes a fourth form. ___ ± ___ = ___ ± ___ • Sheet C emphasizes the placement of =. ___ = ___ ± ___ ___ ± ___ = ___ • Sheet D emphasizes operations on both sides of =. ___ ± ___ = ___ ± ___	

Task Steps	Keep in Mind	Observations of Students
2. SAY: *Choose a number from 0 to 10 and put that number in one of the blank spaces of an equation. Remember, as a team you are trying to make each equation true.*	• Which form does the student choose? • Note *where* Player 1 writes the number in the chosen equation. Is it always in the place of the first addend on either side of the equal sign? The second addend?	A. Student requires teacher support to write numbers in the equation.
3. Once Player 1 has written a number, ask Player 2 to work on the same equation that Player 1 began. Player 2 may choose to write a number 0 to 10 in any remaining blank space *or* to fill in an operation (+or -). SAY: *In the same equation, you either write a number or an operation (+ or –).* Only if the student doesn't seem to know, explain where numbers and operations go.	• Note that students may generate equations that require numbers below zero. If this happens, you might ask, "Could you change a number to make this equation work better?" Your goal is to have students construct equations that make sense to them (though if a student can solve an equation that uses a number below zero, notate that), and to recognize and make appropriate changes when equations do not make sense to them.	B. Student uses only addition. C. Student uses addition *or* subtraction D. Student plays using *both* addition and subtraction. E. Student considers and reconsiders what numbers or operations will make the equation true. F. Student self-corrects in an effort to make the equation true.
4. Students continue taking turns completing the selected equation. Players work as a team and may correct their entries as they play. Remind students that it is fine to erase and be flexible in trying other numbers to make the equations make sense. SAY: *As you work together, talk about whether the numbers in your equations make sense, and change the numbers if you need to.* When students are ready to write the last number in the equation, they must already	• Do students add the addends in left-to-right fashion regardless of the placement of the equal sign in the equation? If so, how do they do it? • Do they appear to demonstrate understanding of equality? • Do students require the use of fingers or drawings to model the equation? • What strategy or strategies do students use to determine the unknown numbers? – Related combinations of numbers, including pairs to 10? – Forming 10? (12 = 9 + 3, because (9 + 1)	G. Student models the equation using physical objects, fingers, or drawings. H. Student writes the sum after the equal sign regardless of its placement. I. Student understands the concept of equality, but only counts on or backwards to determine the unknown addend. J. Student understands the concept of equality and uses various addition or subtraction strategies to correctly determine the unknown addend. K. Student recognizes when an equation results in a number below zero.

Task Steps	Keep in Mind	Observations of Students
know what operation will make the equation *true*. The goal of the task is to make all equations on the game sheet true. As needed, students may use fingers, counters, or drawings to help them compute. Keep track as part of your observation notes. SAY: *You may use your fingers or make drawings to help, if you like.*	+ 2 = 10 + 2 = 12) – Using easier, but equivalent known sums? (e.g., using doubles to add doubles +1 or doubles –1; 6 + 7 = 6 + 6 + 1) – Instantly recognizing and computing mentally? • Do students recognize instances when an equation results in a number below zero? • If so, do students self-correct the equation, so that it does **not** result in a negative number? • Do students treat the equal sign as meaning "write the answer so far"? For example, when seeing 4 + 5 = ____ + 2, does the student write 9?	L. Student self-corrects the equation, so that it does **not** result in a negative number.
5. After all blank spaces are filled in the equation, ask students to read the equation aloud. Then, ASK: *Are these sides equal? Talk to your partner to explain how you know.* Point to the two sides of the equation as you ask this question. Individually, students should identify the quantities as equal (or realize they are not equal) and provide justification for their reasoning. Another question you may want to ask is,	• Do students correctly determine if the sides of the equation are equal? • Does each student provide an explanation for his or her reasoning? Do you need to scaffold by presenting a sentence starter? For example, students may need to use the following sentence starters: *The sides of the equation are equal because…* *The sides of the equation are not equal because…* • How do their explanations demonstrate understanding of equality?	M. Student shows confusion as to whether both sides of the equation are equal. N. Student clearly articulates if both sides are equal. O. Student provides a limited explanation, and/or his or her reasoning is incomplete or flawed. P. Student explains his or her reasoning and provides an incomplete or flawed justification for the rationale used. Q. Student explains reasoning and provides complete and thorough justification.

Task Steps	Keep in Mind	Observations of Students
ASK: *Is the equation balanced or unbalanced? Explain to your partner how you know*. Both of these prompts are intended to assess if students can determine whether the equation is true or false. For some students, you may even choose to ask, *Is the equation true or false?* Provide the opportunity for partners to agree or disagree by constructing a viable argument. ASK: *Do you agree with _____'s explanation? Why or why not?* If at any point you need more insight into student thinking, you may choose to use the prompt, "Tell me more." This prompt is especially useful in eliciting further explanation of ideas and probing for deeper understanding.		
6. **(Optional)** To gain further insight into their understanding of the equal symbol (=), you may choose to… ASK: *What do you think this symbol in the middle (equal sign) means?* Allow wait time to think about this and see if students can generate a statement that		

Task Steps	Keep in Mind	Observations of Students
explains the equal sign clearly. If students require further prompting… SAY: *The = sign says that these two sides have the same amount. Do you think that's true in this equation? Tell me why.* Encourage students to read aloud the number sentence using the level of language formality with which they are most comfortable.		
7. As students play, you (or they) may choose to add constraints. Below is a list of options. • *Let's write operation signs first (last).* • *Let's only use addition (subtraction).* • *Let's use sums of 10 (or 18) or less.* • *Let's let the largest (smallest) number that we use be _____.* • *Let's use only the form:* ___ ± ___ = ___ ± ___		
8. Give students time to complete their game sheet or until they have played for 15–20 minutes each day they use this task.		

Note: The individual Student Exit Slip should be used after playing the game over a series of days or when you deem most appropriate.

OBSERVATION CHECKLIST

ASSESSING STUDENT UNDERSTANDING: THE EQUALITY GAME

Use this page to record individual student observations. Use the letters to note each event as you see it unfold. This record is intended to help you plan next steps in your instruction for your students.

Student Name	Observations of Student	Possible Individual Student Observations	
		STRATEGIES and MAKING MEANING A. Student requires teacher support to write numbers in the equation. B. Student uses only addition (+). C. Student uses addition (+) *or* subtraction (–). D. Student plays using *both* addition (+) and subtraction (–). E. Student considers and reconsiders what numbers or operations will make the equation true. F. Student self-corrects in an effort to make the equation balance. **REPRESENTATION and MAKING MEANING** G. Student benefits from modeling the equation using physical objects, fingers, or drawings. H. Student writes the sum upon encountering the equal sign (=) regardless of its placement. I. Student understands the concept of equality, but only counts on or backwards to determine the unknown addend. J. Student understands the concept of equality and uses various addition or subtraction strategies to correctly determine the unknown addend. K. Student recognizes when an equation results in a number below zero. L. Student self-corrects the equation, so that it does **not** result in a negative number.	**MAKING MEANING and EXPLAINING** M. Student demonstrates confusion as to whether both sides of the equation are equal. N. Student clearly articulates if both sides are equal. O. Student provides a limited explanation and/or his or her reasoning is incomplete or flawed. P. Student explains his or her reasoning and provides an incomplete or flawed justification for the rationale used. Q. Student explains reasoning and provides complete and thorough justification.

Player 1 Name: _____ Player 2 Name: _____

The Equality Game — Game sheet A

___ = ___ ± ___	___ ± ___ = ___
___ ± ___ = ___	___ = ___
___ = ___	___ = ___ ± ___
___ = ___ ± ___	___ ± ___ = ___
___ = ___	___ = ___ ± ___

Note: This sheet only includes three equation forms. ___ = ___ ; ___ = ___ ± ___ ; ___ ± ___ = ___

Player 1 Name: _____ Player 2 Name: _____

The Equality Game — Game Sheet B

___ = ___ ± ___	___ ± ___ = ___
___ ± ___ = ___ ± ___	___ = ___
___ = ___ ± ___	___ ± ___ = ___
___ ± ___ = ___ ± ___	___ = ___
___ = ___ ± ___	___ ± ___ = ___
___ ± ___ = ___ ± ___	___ = ___

Note: This sheet includes all four equation forms. __ = __ ; __ = __ ± __ ; __ ± __ = __ ; __ ± __ = __ ± __

Player 1 Name: _____ Player 2 Name: _____

The Equality Game — Game Sheet C

___ = ___ ± ___	___ ± ___ = ___
___ = ___ ± ___	___ ± ___ = ___
___ = ___ ± ___	___ ± ___ = ___
___ ± ___ = ___ ± ___	___ ± ___ = ___ ± ___
___ ± ___ = ___ ± ___	___ ± ___ = ___ ± ___
___ ± ___ = ___ ± ___	___ ± ___ = ___ ± ___

Note: This sheet includes three equation forms. ___ = ___ ± ___ ; ___ ± ___ = ___ ; ___ ± ___ = ___ ± ___

Player 1 Name: _____ Player 2 Name: _____

The Equality Game — Game Sheet D

___ ± ___ = ___ ± ___	___ ± ___ = ___ ± ___
___ ± ___ = ___ ± ___	___ ± ___ = ___ ± ___
___ ± ___ = ___ ± ___	___ ± ___ = ___ ± ___
___ = ___ ± ___ ± ___	___ = ___ ± ___ ± ___
___ ± ___ = ___ ± ___ ± ___	
___ ± ___ = ___ ± ___ ± ___	

Note: This sheet includes three equation forms. ___ ± ___ = ___ ± ___ ___ = ___ ± ___ ___ ± ___ = ___ ± ___ ± ___

Name _____ Date _____

The Equality Game - Student Exit Slip

Directions: Place a number in each blank to make each equation true.

a) $5 + 2 = \_\_\_\_\_ + 3$

b) $11 = \_\_\_\_\_$

c) $8 = \_\_\_\_\_ - 2$

d) $7 + 8 = \_\_\_\_\_$

e) $\_\_\_\_\_ + 8 = 10 + 2$

f) $18 - 9 = \_\_\_\_\_$

g) $\_\_\_\_\_ + 7 = 3 + 4 + 5$