This document provides information about a diagnostic assessment developed by the Eliciting Mathematical Misconceptions project (EM2) at Education Development Center. The Representing Fractions I assessment is designed to elicit information about a common misconception that students have when representing fractions visually:

- **Misconception 1: Seeing Fractions As Part-to-Whole with Unequal Parts.**

The Representing Fractions I assessment is one of two EM2 diagnostic assessments that target students understanding about graphical representation of fractions.

Before you use the assessment with your students, although you can access the assessment here at any time, we strongly recommend that you reference the information below to learn more about this misconception, including how it appears in student work, and how to score the pre- and post-assessments once you have given the assessments to students.

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Topic Background

» Learn about representing fractions using area models concepts.

The topic of “representing fractions” includes many different concepts for students to understand and many places for potential misconceptions to develop. Here, we focus on the aspect of representing fractions that is targeted in these diagnostic assessments.

The primary conceptual understanding on which this diagnostic assessment focuses is the idea that a pictorial representation of a fraction must show parts that are the same size, meaning that they have equal area. To work with pictorial representations of fractions, students must learn to distinguish between correct representations and incorrect representations.

As a prerequisite foundation for this understanding, students also need to understand the meaning of the numerator and the denominator in a fraction. This becomes a little more challenging if we think about the different concepts that a fraction can represent, including part-whole relationships, division, ratios, or measurements. Students need to understand the meaning of the numerator and denominator across all these uses of fractions.

Students benefit from working with a variety of pictorial representations of fractions. Students should have opportunities to work with representations of fractions in which the parts are all the same size and shape as well as those with parts that have equal area but are different shapes.

They should also work with representations in which the parts are grouped together as well as those with parts that are not grouped together.
Topic Background

Finally, they should work with representations in which the partitioning is clearly indicated, those where the partitioning needs to be inferred from the shape, and those where the partitioning may appear unequal.

Opportunities to work with this variety of pictorial representations will deepen students’ understanding of the meaning of the numerator and denominator as well as their understanding of the necessity of same-size (equal-area) parts.

This diagnostic assessment is restricted to pictorial representations that are called “simple representations”; here, the total number of parts in the shape matches the denominator of the fraction, and the number of shaded parts is associated with the numerator.

(Note that the Representing Fractions 2 diagnostic assessment includes a wider variety of pictorial representations.)

Connections to Common Core Standards in Mathematics (CCSS)

The CCSS outline specific understandings that students should be able to meet at each grade level.

At grade 3, students should be able to:

» Use fractions along with visual fraction models to represent parts of a whole.

» Develop understanding of fractions as numbers.

» 3.NF.1: Understand a fraction \( \frac{1}{b} \) as the quantity formed by 1 part when a whole is partitioned into \( b \) equal parts; understand a fraction \( \frac{a}{b} \) as the quantity formed by a parts of size \( \frac{1}{b} \).

At grade 3, students should also be able to:

» Reason with shapes and their attributes.

» 3.G.2: Partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole. For example, partition a shape into 4 parts with equal area, and describe the area of each part as 1/4 of the area of the shape.
Student Misconceptions

Learn about student misconceptions related to the topic.

Many learners have difficulty moving from whole-number understandings to rational-number understandings. These conceptual understandings and misunderstandings become more visible as students begin to use pictorial and symbolic representations, such as area models, linear models, and set models.

When the representation is a part/whole area or measurement model in which the total number of equal-size pieces in the whole matches the denominator and the shaded part of the whole equals the numerator, this is referred to as a “simple representation” of the fraction. When the representation has a whole where the total number of equal parts is a multiplicative factor of the denominator of the fraction in symbolic form, this is considered an “equivalent representation” (Wong & Evans, 2007).

One of the critical attributes of a simple or equivalent representation when partitioning a whole is that the parts need to be equal in size (area), although not necessarily the same shape. During instruction, however, students often work with models that are already the same size and shape (Van de Walle, Karp, & Bay-Williams, 2010). This has led to some students thinking that the pieces must be the same shape, and others failing to even consider size as an attribute. Students also have numerous difficulties as they move from simple representations to equivalent representations of fractions (Gould, 2005; NRC, 2001; Pearn, Stephens, & Lewis, 2003). While some students can determine equivalent fractions procedurally when given the fraction in symbolic form, many cannot connect the symbolic and pictorial representations (Wong & Evans, 2007).

The Representing Fractions I assessment targets the following common misconception about representations of fractions:

**Misconception 1 (M1): Seeing Fractions As Part-to-Whole with Unequal Parts**
Students with this misconception consistently associate the number of pieces shaded with the numerator and associate the total number of pieces for the entire figure with the denominator, but do not pay attention to the size of the pieces (or region).

Access the website to watch a brief video clip for a fuller description of this misconception.  
http://em2.edc.org/portfolio/representing-fractions-i

To see additional examples of student work illustrating this misconception, go to the Sample Student Responses tab on the website, or refer to p. 36 of this document.
Eliciting Mathematics Misconceptions

References


Administering the Pre-Assessment

» Learn how to introduce the pre-assessment to your students.

About This Assessment

The EM² diagnostic and formative pre- and post-assessments on representing fractions are composed of items with specific attributes associated with student conceptions that are specific to pictorial representations of fractions. Each item within any EM² assessment ask students to provide a selected response (multiple choice) and an explanation component.

The fractions in these assessments are all fractions less than 1.

The learning target for the Representing Fractions 1 assessment is:

When considering visual representations of fractions as a part out of a whole, the learner will understand that all the pieces must be the same size (area).

Prior to Giving the Pre-Assessment

• Arrange for 15 minutes of class time to complete the administration process, including discussing instructions and student work time. Since the pre-assessment is designed to elicit misconceptions before instruction, you do not need to do any special review of this topic before administering the assessment.

Administering the Pre-Assessment

• Inform students about the assessment by reading the following:

Today you will complete a short individual activity, that is designed to help me understand how you think about representing fractions as a picture.

• Distribute the assessment and read the following:

The activity includes four problems. For each problem, choose your answer by completely filling in the circle to show which answer you think is correct. Because the goal of the activity is to learn more about how you think about fractions, it’s important for you to include some kind of explanation in the space provided. This can be a picture or words, or a combination of pictures and words that shows how you chose your answer.

You will have about 15 minutes to complete all the problems. When you are finished, please place the paper on your desk and quietly [read, work on ____] until everyone is finished.
Administering the Pre-Assessment

- Monitor the students as they work on the assessment, making sure that they understand the directions. Although this is not a strictly timed assessment, it is designed to be completed within a 15-minute timeframe. Students may have more time if needed. When a few minutes remain, say:

  You have a few minutes left to finish the activity. Please use this time to make sure that all of your answers are as complete as possible. When you are done, please place the paper face down on your desk. Thank you for working on this activity today.

- Collect the assessments.

After Administering the Pre-Assessment

Use the analysis process (found in the Scoring Guide PDF document under the Scoring Process section) to analyze whether your students have this misconception:

» Misconception 1: Seeing Fractions As Part-to-Whole with Unequal Parts
Scoring

» Learn about the scoring process by reviewing the scoring guide.

The *Representing Fractions 1* assessment is composed of four items with specific attributes associated with different misconceptions that are directly related to representing fractions visually. We encourage you to carefully read the Scoring Guide to understand these specific attributes and to find information about analyzing your students’ responses.

**How to Use This Guide**

This Scoring Guide is intended for use with both the pre-assessment and the post-assessment for *Representing Fractions 1*. To use this guide, we recommend following these steps:

- Read the Misconception Description below. You may also want to view the video found under the “Common Misconceptions” section on the website. Numerous examples of student work illustrating this misconception are included in this guide, but you may also want to refer to the additional examples of student responses found under the “Sample Student Responses” section on the website.

- Familiarize yourself with the four assessment items and what they assess.

- Consider completing the optional scoring practice items and checking your scoring against the answer key.

- Score your students’ work using the Pre- and Post-Assessment Analysis Process on p. x.

- Refer to the various examples found here and in the “Sample Student Responses” document for guidance when you are unsure about the scoring.

**Misconception Description**

Pictorial representations of rational numbers include area models, linear models, and set models, among others. When the representation is a part/whole area or measurement model in which the total number of equal-size pieces in the whole matches the denominator and the shaded part of the whole equals the numerator, this is referred to as a “simple representation” of the fraction (Wong & Evans, 2007).
Scoring

One of the critical attributes of a simple or equivalent representation when partitioning a whole is that the parts need to be equal in size, although not necessarily the same shape. However, during instruction, students often work with models that are already the same size and shape (Van de Walle, Karp, & Bay-Williams, 2010). This has led to some students thinking that the pieces must be the same shape, and other students failing to consider size as an attribute at all. The EM² Representing Fractions 1 assessments have designated this misconception in the following way:

**Misconception 1 (M1): Seeing Fractions As Part-to-Whole with Unequal Parts**

Students with this misconception consistently associate the number of pieces shaded with the numerator, and associate the total number of pieces for the entire figure with the denominator, but do not pay attention to the size of the pieces (or region).

References


Scoring

Pre-Assessment Items

The assessment is composed of four items with specific attributes associated with understandings and misunderstandings related to an area model representation of fractions. Each item may elicit information about the students’ understanding of the need for equal-size parts in a fraction.

<table>
<thead>
<tr>
<th>Item</th>
<th>Understandings and Misconceptions</th>
</tr>
</thead>
</table>
| **Is the shaded part 1/4?** | • The triangle is divided into 4 unequal parts, with 1 part shaded. Since the parts are not of equal size, the shaded part is not 1/4 of the whole.  
• This item may elicit an overgeneralization of 1/4 represented by 1 part shaded out of 4 parts, regardless of the size of the parts. |
| Correct Response: NO |
| **Is the shaded part 3/5?** | • The hexagon is divided into 5 unequal parts, with 3 parts shaded. Since the parts are not of equal size, the shaded parts are not 3/5 of the whole.  
• This item may elicit an overgeneralization of 3/5 represented by 3 parts shaded out of 5 parts, regardless of the size of the parts. |
| Correct Response: NO |
| **Is the shaded part 5/9?** | • The circle is divided into 9 equal parts, with 5 parts shaded. Since the parts are of equal size, the shaded part is 5/9 of the whole.  
• **NOTE:** This is considered a “baseline” item; it is included in the assessment to confirm that students actually understand the basic concept of a fraction as a certain number of equal-size parts out of a whole. A lack of understanding of this concept would invalidate the rest of the diagnostic assessment, so this item is a “double check” that students have the basic understanding that forms the basis of this diagnostic assessment. (See p. 6 for an example of a student response in which the baseline item is not correct.) However, in most cases, students for whom this assessment is appropriate will have this understanding. |
| Correct Response: YES |
| **Is the shaded part 1/5?** | • The pentagon is divided into 5 parts using horizontal lines. Though the lines are spaced equidistant apart, the 5 parts are not of equal size. Therefore, the shaded part is not 1/5 of the whole.  
• This item may elicit an overgeneralization of 1/5 represented by 1 part shaded out of 5 parts, regardless of the size of the parts. Some students may interpret the equally spaced horizontal lines as creating equal-size pieces, overgeneralizing from their experiences with squares and rectangles. |
| Correct Response: NO |
Scoring

Pre-Assessment Analysis Process

Some important things to know about the analysis process for this diagnostic assessment:

• This diagnostic assessment has been validated to reliably predict the likelihood that a student has Misconception 1. You can weigh the relative likelihood that your student has this misconception by considering whether the student’s written response provides “Strong Evidence” or “Weak Evidence” of Misconception 1.

• If a student is determined to show evidence of the misconception on even just one of items 1, 2, or 4, the student is likely to have Misconception 1.

• For each item, you need to look at both the selected response choice and the explanation. Students will show evidence of Misconception 1 only if they select the M1 response choice and have an explanation that supports Misconception 1. To learn more about how to tell whether an explanation supports Misconception 1, go to the “Research-Based Misconceptions” section of this website and watch the video provided.

• An optional Scoring Guide Template is provided for your use when you score your own students’ diagnostic assessments. In each row of the assessment, write a student’s name, then circle the appropriate information for each item on the pre-assessment (shaded) and, later, the post-assessment (in white).

How to Determine If a Student Has Misconception 1

1. Identify any items for which the student has selected the M1 response choice.

   In this diagnostic assessment, a “Yes” response to Items 1, 2, and 4 aligns with Misconception 1.

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct Response</th>
<th>M1 Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>“No”</td>
<td>“Yes”</td>
</tr>
<tr>
<td>2</td>
<td>“No”</td>
<td>“Yes”</td>
</tr>
<tr>
<td>4</td>
<td>“No”</td>
<td>“Yes”</td>
</tr>
</tbody>
</table>

   Why isn’t Item 3 included in this list?

   Item 3 is considered a baseline item and is not used to assess whether a student has Misconception 1 (see the explanation of Item 3 under “Pre-Assessment Items”). Items 1, 2, and 4 have specific attributes associated with Misconception 1, so those are the items you’ll pay attention to when scoring and analyzing your students’ responses.
Scoring

What if there’s no multiple-choice response selected?

In that case, carefully consider the explanation the student gives. If the explanation leaves no doubt that the student would have selected “Yes,” you can code it as “Strong Evidence” of M1. However, if the explanation leaves some question about what the student was thinking, code it as “Weak Evidence” of M1. For additional guidance on determining the strength of the evidence, see the “What counts...” information provided in Step 2 below.

2. For each item with the M1 response choice, note whether the evidence of M1 from the explanation is strong or weak.

If the student answered “Yes” on Items 1, 2, or 4, look next at the student’s explanation to determine whether it supports Misconception 1. An explanation can be categorized as “Strong Evidence” of M1, “Weak Evidence” of M1, or “No Evidence” of M1.

What counts as “Strong Evidence” of M1 in the pre-assessment?

Responses with strong evidence of M1 include a clear indication that the student has paid attention to the number of shaded pieces out of the total number of pieces, but has paid no attention to the size of the pieces. Such responses make no mention of the size of the pieces.

Below are three examples of student responses with strong evidence of M1, using pre-assessment items. To see additional examples of student responses that illustrate this misconception, go to the section labeled “Sample Student Responses”.

Example A

This student chose the M1 response (“Yes”); specifically mentioned one of the pieces shaded; showed examples of 1/4, 2/4, 3/4, and 4/4; and did not mention the size of the pieces.
Scoring

Example B

This student chose the M1 response (“Yes”); specifically mentioned 3 shaded pieces out of 5; and did not mention the size of the pieces.

Example C

This student chose the M1 response (“Yes”); specifically mentioned 1 shaded piece out of 5; and did not mention the size of the pieces.

What counts as “Weak Evidence” of M1 in the pre-assessment?

Responses with weak evidence of M1 include some indication that the student has paid attention to the number of shaded pieces out of the total number of pieces. However, these responses also generally require making more inferences about what the student was thinking, or they leave some question or doubt about whether the misconception is present or to what degree it is present.

Below are three examples of student responses with weak evidence of M1, using pre-assessment items. To see additional examples of student responses that illustrate this misconception, go to the section labeled “Sample Student Responses”. 
Scoring

Example A

1. Is the shaded part $\frac{1}{4}$?

   - Yes
   - No

   **Explain your thinking**

   "Theirs [There's] 4 rectangles but $\frac{1}{4}$ of it is shaded."

This student chose the M1 response ("Yes") and specifically mentioned $\frac{1}{4}$ being shaded. However, the drawing shows a rectangle with four equal-size parts, leaving it unclear what the student understands about the need for equal-size pieces.

Example B

2. Is the shaded part $\frac{3}{5}$?

   - Yes
   - No

   **Explain your thinking**

   "It is because all the parts are the same size.

This student chose the M1 response ("Yes") and specifically mentioned the size of the parts, but did not relate that to the fraction $\frac{3}{5}$. In addition, the explanation contradicts the choice of "Yes." This leaves some question as to precisely what the student is thinking.

Example C

2. Is the shaded part $\frac{3}{5}$?

   - Yes
   - No

   **Explain your thinking**

   "$\frac{3}{5}$ is...."

This student chose the M1 response ("Yes") and then drew a different figure, again with unequal-size pieces. As with the original figure, the student cut one of the pieces in half, on a diagonal, and shaded the pieces as they are shaded in the original figure. The student labeled this new drawing "$\frac{3}{5}$." It is unclear from this explanation how the student is thinking about the fraction representation, so it is considered weak evidence for the M1 response.
Scoring

What counts as “No Supporting Evidence” in the pre-assessment?

If a student selects the M1 response choice (“Yes”) but provides no explanation at all, this counts as “No Supporting Evidence of M1.”

3. After you have analyzed each item for a student, use the guidelines below to determine whether the student has Misconception 1.

This diagnostic assessment has been validated to predict the possible presence of Misconception 1 for a student. If a student is determined to show evidence of the misconception on even just one of items 1, 2, or 4, the student is likely to have Misconception 1, regardless of whether the evidence is coded as “Strong” or “Weak.”

What if my student only has one item coded as M1 with “Weak Evidence,” and the rest are correct?

Even if your student has only one item with “Weak Evidence” of M1, this diagnostic assessment is validated to predict that it is likely your student has Misconception 1. However, the presence of only one item with weak evidence of M1 suggests that the misconception may not be very deeply rooted in this student’s thinking.

You may want to keep an eye on this student during regular classwork to watch for other evidence of this misconception. For example, the misconception may be present when the student is working only with certain kinds of fractions, such as unfamiliar fractions that are not common benchmark fractions.

What if the student’s explanation is contradictory to the multiple-choice response chosen?

Here is one such example:

“The shaded pieces isn’t 2/5 because one hole [whole] piece is shaded and only half another pieces is shaded.”

The student responds “Yes,” suggesting M1, but then says “the shaded pieces isn’t 2/5 . . .” and provides an explanation that suggests some solid understandings. If you encounter a contradictory response such as this, consider it a possible indication of M1 and look for additional evidence, either on these assessments or from the student’s comments in class.
Scoring

What if the student does not get the baseline item correct?

Here is one such example:

```
1. Is the shaded part 1 \(\frac{1}{4}\)?
   - Yes
   - No

2. Is the shaded part 3 \(\frac{3}{5}\)?
   - Yes
   - No

3. Is the shaded part 5 \(\frac{5}{9}\)?
   - Yes
   - No
```

“No all of the picece [pieces] need to be ecuole [equal].”

“No it needs to be ecuole [equal].”

BASELINE ITEM

“No it needs to be ecuole [equal].”

The responses for Items 1 and 2 indicate that this student appears to understand the idea that the pieces need to be of equal size, but the response for Item 3, the baseline item, is puzzling.
(Optional) Scoring Practice Items—Pre-Assessment

The following sample student responses are provided as an optional practice set. If you would like to practice scoring several items to further clarify your understanding of the scoring process, you may try scoring the following 10 items.

We recommend scoring one or two at a time and checking your scoring as you go against our key, found on p. 20.

Practice Example 1

1. Is the shaded part $\frac{1}{4}$?
   - Yes
   - No

   They do not need to be perfect parts

Practice Example 2

1. Is the shaded part $\frac{1}{4}$?
   - Yes
   - No

   Explain your thinking.
   It is not right because all the pieces are different sizes

Practice Example 3

4. Is the shaded part $\frac{1}{5}$?
   - Yes
   - No

   What I shaded 5 parts
Scoring

Practice Example 4

2. Is the shaded part $\frac{3}{5}$?

- Yes
- No

Explain your thinking. Theirs 5 pieces in total and only 3 blocks are shaded.

Practice Example 5

2. Is the shaded part $\frac{3}{5}$?

- Yes
- No

Because it's $\frac{3}{5}$

Practice Example 6

2. Is the shaded part $\frac{3}{5}$?

- Yes
- No

Explain your thinking.

Practice Example 7

1. Is the shaded part $\frac{1}{4}$?

- Yes
- No

It is because it is like this.
» Scoring

Practice Example 8

4. Is the shaded part $\frac{1}{5}$?

- Yes
- No

Explain your thinking. A fraction is an equal part of the object, this is not.

Practice Example 9

7. Is the shaded part $\frac{3}{5}$?

- Yes
- No

Explain your choice using words and/or pictures.

Practice Example 10

4. Is the shaded part $\frac{3}{5}$?

- Yes
- No

$\frac{3}{5}$ is
Scoring Practice Items Answer Key—Pre-Assessment

Practice Example 1

This is an example of M1 with “Strong Evidence.” The student’s explanation (“They do not need to be perfect parts”) suggests strongly that the student thinks the size of the pieces does not matter.

Practice Example 2

This is a “Correct” example with “Strong Evidence” (though making any distinction between strong and weak correct responses is not necessary for this diagnostic assessment; it simply gives you more information about your student). The student specifically points to the different sizes of the pieces as the reason the fraction is not 1/4.

Practice Example 3

This is an example of M1 with “Strong Evidence.” The student mentions 1 shaded piece and 5 parts, but does not mention the size of the pieces.
Scoring

Practice Example 4

This is an example of M1 with "Weak Evidence." The student mentions 5 pieces in total and says "only 3 blocks are shaded," but does not mention the size of the pieces. However, the student shows something contradictory in the explanation: a fraction bar with 5 (fairly) equal-sized pieces, with 3 of the 5 pieces shaded. This leaves some question about how the student is thinking, so it is considered weak evidence of M1.

Practice Example 5

This is an example of M1 with "Weak Evidence." The student simply restates the question. The student may have the M1 misconception, but the evidence of M1 here is not strong enough to say with conviction that this is the case.

Practice Example 6

This is a "Correct" example with "Weak Evidence" (though making any distinction between strong and weak correct responses is not necessary for this diagnostic assessment; it simply gives you more information about your student). The student redraws the figure and then draws a corrected figure with pieces of equal size; however, the lack of additional explanation leaves some doubt, without making some inference, about what the student is thinking. It may be that the student is showing M1 here, but there is not enough evidence of M1 from the student to be completely convincing. Therefore, it is considered weak evidence of M1.
## Scoring

### Practice Example 7

![Image of a triangle with a shaded part and a student's answer]

This is an example of M1 with “Weak Evidence.” The student selected “Yes,” the multiple-choice response that aligns with M1. However, the student’s explanation does not make it clear why the student answered “Yes.” This leaves some question about how the student is thinking, so it is considered weak evidence of M1.

### Practice Example 8

![Image of a hexagon with shaded parts and an explanation]

This is an example in which the student did not select either of the multiple-choice answers but did provide a fairly clear explanation. The student clearly mentions that a fraction needs equal parts and that “this is not” equal. This explanation would be considered “Strong Evidence” of the student providing a “Correct” response.

### Practice Example 9

![Image of a hexagon with shaded parts and a student's answer]

This is an example of M1 with “Strong Evidence.” Though the student doesn’t use any words in the explanation, the combination of the student redrawing the figure and rewriting “3/5” is fairly convincing that the student is only paying attention to 3 parts out of 5 and is not paying attention to the size of the parts.
» Scoring

Practice Example 10

This is an example of M1 with “Weak Evidence.” The student selected “Yes,” the multiple-choice response that aligns with M1. However, the student then drew an example of 3/5 that shows 3 1/2 pieces out of 5 shaded, and the pieces are all of equal size. Because it leaves some question as to how the student is reasoning, it is considered weak evidence of M1.
Scoring

Post-Assessment Items

The post-assessment is structured exactly the same as the pre-assessment, comprising four items with specific attributes associated with understandings and misunderstandings related to the area model representation of fractions. Each item may elicit information about the students' understanding of the need for equal-size parts in a fraction.

<table>
<thead>
<tr>
<th>Item</th>
<th>Understandings and Misconceptions</th>
</tr>
</thead>
</table>
| Is the shaded part 1/4? | • The circle is divided into 4 unequal parts, with 1 part shaded. Since the parts are not of equal size, the shaded part is not 1/4 of the whole.  
  Correct Response: NO

  • This item may elicit an overgeneralization of 1/4 represented by 1 part shaded out of 4 parts, regardless of the size of the parts. |
| Is the shaded part 4/7? | • The heptagon is divided into 7 equal parts, with 4 parts shaded. Since the parts are of equal size, the shaded part is 4/7 of the whole.  
  Correct Response: YES

  • NOTE: This is considered a “baseline” item; it is included in the assessment to confirm that students actually understand the basic concept of a fraction as a certain number of equal-size parts out of a whole. A lack of understanding of this concept would invalidate the rest of the diagnostic assessment, so this item is a “double check” that students have the basic understanding that forms the basis of this diagnostic assessment. However, in most cases, students for whom this diagnostic assessment is appropriate will have this understanding. |
| Is the shaded part 2/5? | • The circle is divided into 5 unequal parts, with 2 parts shaded. Since the parts are not of equal size, the shaded parts are not 2/5 of the whole.  
  Correct Response: NO

  • This item may elicit an overgeneralization of 2/5 represented by 2 parts shaded out of 5 parts, regardless of the size of the parts. |
| Is the shaded part 1/5? | • The triangle is divided into 5 parts using horizontal lines. Though the lines are spaced equidistant apart, the 5 parts are not of equal size. Therefore, the shaded part is not 1/5 of the whole.  
  Correct Response: NO

  • This item may elicit an overgeneralization of 1/5 represented by 1 part shaded out of 5 parts, regardless of the size of the parts. Some students may interpret the equally spaced horizontal lines as creating equal-size pieces, overgeneralizing from their experiences with squares and rectangles. |
Scoring

Post-Assessment Analysis Process

Some important things to know about the analysis process for this diagnostic assessment:

- This diagnostic assessment has been validated to reliably predict the likelihood that a student has Misconception 1. You can weigh the relative likelihood that your student has this misconception by looking at the number of responses coded as either “Strong Evidence” or “Weak Evidence” of Misconception 1.

- If a student is determined to show evidence of the misconception on even just one of items 1, 3, or 4, the student is likely to have Misconception 1.

- For each item, you need to look at both the selected response choice and the explanation. Students will show evidence of Misconception 1 only if they select the M1 response choice and have an explanation that supports Misconception 1. To learn more about how to tell whether an explanation supports Misconception 1, go to the “Research-Based Misconceptions” section of this website and watch the video explanation provided.

How to Determine If a Student Has the Misconception

The post-assessment uses the same scoring process as the pre-assessment. If you are not already familiar with the steps for scoring the assessment, please review that section starting on p. 8.

1. Identify any items for which the student has selected the M1 response choice.

   Note that for the post-assessment, Item 2 is the baseline item, and Items 1, 3, and 4 are the items to score for evidence of M1.

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct Response</th>
<th>M1 Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>“No”</td>
<td>“Yes”</td>
</tr>
<tr>
<td>3</td>
<td>“No”</td>
<td>“Yes”</td>
</tr>
<tr>
<td>4</td>
<td>“No”</td>
<td>“Yes”</td>
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</table>

2. For each item with the M1 response choice, note whether the evidence from the explanation is strong or weak.

   **NOTE:** If you have not yet read the introductory section on strong and weak evidence of M1, please review that section on p. 5.

   **What counts as “Strong Evidence” of M1 in the post-assessment?**

   Responses with strong evidence of M1 include a clear indication that the student has paid attention to the number of shaded pieces out of the total number of pieces, but has paid no attention to the size of the pieces nor made any mention of the size of the pieces.
Scoring

Below are three examples of student responses with strong evidence of M1, using post-assessment items. To see additional examples of student responses that illustrate this misconception, go to the section labeled “Sample Student Responses”.

Example A

This student chose the M1 response (“Yes”). In addition, the student specifically stated that different-size pieces are still considered “the same.”

Example B

This student chose the M1 response (“Yes”). The student then labeled each unshaded piece with a “5” and wrote a “1” under the shaded piece. This suggests strongly that the student considers each piece 1/5 and that the shaded piece is one of those fifths.

Example C

This student chose the M1 response (“Yes”). The student explicitly stated that 1 out of 4 pieces are shaded but did not mention the size of the pieces.
What counts as “Weak Evidence” of M1 in the post-assessment?

Responses with weak evidence of M1 include some indication that the student has paid attention to the number of shaded pieces out of the total number of pieces. However, these responses also generally require making more inferences about what the student was thinking, or leave some question or doubt about whether the misconception is present or to what degree it is present.

Below are three examples of student responses with weak evidence of M1, using post-assessment items. To see additional examples of student responses that illustrate this misconception, go to the section on the webpage labeled “Sample Student Responses”.

Example A

![Image of a shaded circle with a 'Yes' response and an explanation]

“1 peace [piece] is split [split] it is 2/5.”

This student chose the M1 response (“Yes”) and noted that the piece is split; however, it is unclear how that information relates to the student’s response choice.

Example B

![Image of a shaded triangle with a 'Yes' response and an explanation]

“Is saded [shaded] in one bars.”

This student chose the M1 response (“Yes”) and noted that 1 piece is shaded in the figure. Again, it is unclear how the explanation relates to the student’s response choice.
Example C

This student chose the M1 response ("Yes") and then redrew the figure somewhat differently from the figure that is given. From what is given in the explanation, it remains unclear how the student is thinking about the representation of 2/5. Therefore, it is considered weak evidence for M1.

**What counts as “No Supporting Evidence” in the post-assessment?**

*If a student selects the M1 response choice ("Yes") but provides no explanation at all, this counts as "No Supporting Evidence."*

3. After you have analyzed each item for a student, use the guidelines below to determine whether the student has Misconception 1.

This diagnostic assessment has been validated to predict the possible presence of Misconception 1 for a student. **If a student is determined to show evidence of the misconception on even just one of items 1, 3, or 4, the student is likely to have Misconception 1,** regardless of whether the evidence is coded as “Strong” or “Weak.”
Scoring

(Optional) Scoring Practice Items—Post-Assessment

The following sample student responses are provided as an optional practice set. If you would like to practice scoring several items to further clarify your understanding of the scoring process, you may try scoring the following 10 items.

We recommend scoring one or two at a time and checking your scoring as you go against our key, found on p. 32.

Practice Example 1

Practice Example 2

Practice Example 3
» Scoring

Practice Example 4

4. Is the shaded part $\frac{1}{5}$?

- Yes
- No

Explain your thinking.

the lines are parallel

Practice Example 5

3. Is the shaded part $\frac{2}{5}$?

- Yes
- No

Explain your thinking.

about it, I thought

Practice Example 6

8. Is the shaded part $\frac{1}{5}$?

- Yes
- No

Why? I shaded on 5 parts

Practice Example 7

7. Is the shaded part $\frac{2}{5}$?

- Yes
- No

yes even though the other 4 are bigger the little one still counts
Scoring

Practice Example 8

![Diagram of a triangle with the question: Is the shaded part $\frac{1}{5}$?]

Practice Example 9

![Diagram of a circle with the question: Is the shaded part $\frac{1}{4}$?]

Practice Example 10

![Diagram of a circle with the question: Is the shaded part $\frac{1}{4}$?]

The triangle is even, so you got the same amount.

These not matter how big the size is in a circle.

Yes because there is $\frac{1}{4}$ there.
Scoring Practice Items Answer Key—Post-Assessment

Practice Example 1

This is a “Correct” example with “Strong Evidence” (though making any distinction between strong and weak correct responses is not necessary for this diagnostic assessment; it simply gives you information about your student). The student selects the correct response and then, in the explanation, describes a different division of the triangle that would result in equal-size pieces.

Practice Example 2

This is an example of M1 with “Weak Evidence.” The student selects the M1 response choice (“Yes”) and then draws a new figure. However, the new figure has four equal-size pieces and is a correct representation of 1/4 on a fraction bar. This leaves some question about how the student is thinking, so it is considered weak evidence of M1.

Practice Example 3

This is an example of M1 with “Strong Evidence.” The student clearly labels the two pieces and says “2 out of 5 is shaded. 2/5,” making no mention of the size of the pieces.
Scoring

Practice Example 4

This is an example of M1 with “Weak Evidence.” The student selects the M1 response choice (“Yes”) but focuses on the lines being parallel as the reason. Because this explanation leaves many questions about how the student is thinking, it is considered weak evidence of M1.

Practice Example 5

This is a “Correct” example of M1 with “No Evidence” even though there is an explanation—a rare type of example, but one that may arise. Unlike “Weak Evidence” explanations that may provide some inconclusive mention of pieces or fractions, a response such as this, with no mention of anything mathematical or related to fractions, is considered “No Evidence.” (Other such responses include “Because it was right” and “I just saw it.”)

Practice Example 6

This is an example of M1 with “Strong Evidence.” The student clearly focuses on the 1 shaded part out of 5 parts and does not mention the size of the pieces.
Scoring

Practice Example 7

This is an example in which the student has not selected either multiple-choice answer but has provided an explanation that can be interpreted with some confidence. The student says, “Yes” and follows with “That little one still counts,” suggesting that the size of the pieces does not matter. This would be considered “Strong Evidence” of an M1 response.

Practice Example 8

This is an example of M1 with “Weak Evidence.” Saying “The triangle is evenly placed” suggests that the student is focusing on the even spacing between the horizontal lines. Saying “you get the same amount” suggests that the student is paying attention to equal-sized pieces. However, these are suppositions, and if correct they suggest that the student is in fact paying attention to the size of the pieces—not an M1 characteristic! Since there are many questions about what the student is thinking, this explanation is weak evidence of M1.

Practice Example 9

This is an example of M1 with “Strong Evidence.” The student clearly states that the size of the pieces does not matter in the circle.
Scarpe Example 10

This is an example of M1 with "Weak Evidence." Although it's possible that the student is focusing on only 1 piece out of the 4 total, there is not enough information in the explanation to know for certain how the student is thinking. Therefore, it is considered weak evidence of M1.
To determine the degree of understanding and misunderstanding in the student work, it’s important to consider both the answer to the selected response and the explanation text and representations. The example above is one of many student work samples that provide insight into student thinking about the particular misconception targeted in these diagnostic assessments (see the “Research-Based Misconceptions” tab for more information and a video about this misconception).

The Representing Fractions 1 diagnostic assessment focuses on one particular misconception students have regarding the pictorial representation of fractions. Sample student responses indicative of this misconception are provided separately below, along with samples of correct student responses. To determine the degree of understanding and misunderstanding, it’s important to consider both the student’s answer to the selected response and the student’s explanation text and representations.

We encourage you to look at the collection of student work examples provided.

**Misconception 1: Seeing Fractions As Part-to-Whole with Unequal Parts**
Students with this misconception consistently associate the number of pieces shaded with the numerator, and the total number of pieces for the entire figure with the denominator, but do not pay attention to the size of the pieces (or region).
### Sample Student Responses

The following student responses show examples of this misconception.

<table>
<thead>
<tr>
<th>Item</th>
<th>Sample Student Responses with Evidence of Misconception 1</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Assessment #1</td>
<td><img src="image1" alt="Image" /></td>
<td>• Misconception selected response is chosen AND</td>
</tr>
<tr>
<td></td>
<td>“1 space is shaded and 3 aren’t [aren’t] and 3 + 1 = 4.”</td>
<td>• Explanation includes reference to shaded and total pieces AND</td>
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<tr>
<td></td>
<td></td>
<td>• Student ignores size of pieces</td>
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<tr>
<td>Pre-Assessment #2</td>
<td><img src="image2" alt="Image" /></td>
<td>• Misconception selected response is chosen AND</td>
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<td>• Student redraws shape and writes numeric representation AND</td>
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<td>• Student ignores size of pieces</td>
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<tr>
<td>Pre-Assessment #2</td>
<td><img src="image3" alt="Image" /></td>
<td>• Misconception selected response is chosen AND</td>
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<td></td>
<td>“I chose this answer because 3 of 5 parts is shaded.”</td>
<td>• Explanation includes reference to shaded and total pieces AND</td>
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<td>• Student ignores size of pieces</td>
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<tr>
<td>Post-Assessment #4</td>
<td><img src="image4" alt="Image" /></td>
<td>• Misconception selected response is chosen AND</td>
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<td></td>
<td>“Why: 1 shaded on 5 parts.”</td>
<td>• Explanation includes reference to shaded and total parts AND</td>
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<td>• Student ignores size of pieces</td>
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</tbody>
</table>
## Sample Student Responses

<table>
<thead>
<tr>
<th>Item</th>
<th>Sample Student Responses with Evidence of Misconception 1</th>
<th>Notes</th>
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</thead>
</table>
| Post-Assessment #4    | ![Image](image1.png)                                      | • Misconception selected response is chosen AND  
                        |                                                          | • Student explicitly says, “It does not matter how big it is” (we can infer that “it” means the shaded part)                               |
| Post-Assessment #1    | ![Image](image2.png)                                      | • Misconception selected response is chosen AND  
                        |                                                          | • Explanation includes reference to shaded and total pieces AND  
                        |                                                          | • Student ignores size of pieces                                                                  |
Sample Student Responses

Correct Reasoning

Students with correct reasoning about representing fractions do both of the following:

- Recognize the need for equal-size parts
- Understand that the numerator and denominator indicate the number of shaded parts and the total number of parts, respectively

<table>
<thead>
<tr>
<th>Item</th>
<th>Sample Student Responses with Correct Reasoning</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Assessment #1</td>
<td><img src="image1.png" alt="Image" /></td>
<td>• Correct selected response is chosen AND</td>
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<tr>
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<td>&quot;I said no because the shapes are not even.&quot;</td>
<td>• Explanation includes information about the shape's unequal division</td>
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<tr>
<td>Pre-Assessment #1</td>
<td><img src="image2.png" alt="Image" /></td>
<td>• Correct selected response is chosen AND</td>
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<tr>
<td></td>
<td>&quot;It is not equal in each shape.&quot;</td>
<td>• Explanation includes information about the shape's unequal division</td>
</tr>
<tr>
<td>Pre-Assessment #2</td>
<td><img src="image3.png" alt="Image" /></td>
<td>• Correct selected response is chosen AND</td>
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<tr>
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<td>&quot;It is 2 1/2 [over] 4.&quot;</td>
<td>• Explanation includes a numeric representation of the amount shaded</td>
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</tbody>
</table>
## Sample Student Responses

<table>
<thead>
<tr>
<th>Item</th>
<th>Sample Student Responses with Correct Reasoning</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Assessment #1</td>
<td><img src="image1.png" alt="Image" /> (Flaw: not even)</td>
<td>• Correct selected response is chosen AND</td>
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<td>“Flaw: not even”</td>
<td>• Student mentions that the parts are “not even” and draws a correct representation of 1/4</td>
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<tr>
<td>Post-Assessment #3</td>
<td><img src="image2.png" alt="Image" /> (One of the sections are not filled in all the way)</td>
<td>• Correct selected response is chosen AND</td>
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<td></td>
<td>“One of the sections are not filled in all the way”</td>
<td>• Explanation mentions sections of unequal size</td>
</tr>
<tr>
<td>Post-Assessment #4</td>
<td><img src="image3.png" alt="Image" /> (No sense [since] it is an triangle it only has one way of having even sides right down the middle)</td>
<td>• Correct selected response is chosen AND</td>
</tr>
<tr>
<td></td>
<td>“No sense [since] it is an triangle it only has one way of having even sides right down the middle”</td>
<td>• Explanation describes an alternative division that would have equal parts</td>
</tr>
</tbody>
</table>
Administering the Post-Assessment

» Learn how to introduce the post-assessment to your students.

If the *Representing Fractions 1* pre-assessment shows that one or more of your students have the misconception outlined in the Scoring Guide, plan and implement instructional activities designed to increase students’ understanding. The post-assessment provided here can then be used to determine if the misconception has been addressed.

**Prior to Giving the Post-Assessment**

- Arrange for 15 minutes of class time to complete the administration process, including discussing instructions and student work time. Since the post-assessment is designed to elicit a particular misconception after instruction, you should avoid using or reviewing items from the post-assessment before administering it.

**Administering the Post-Assessment**

- Inform the students about the assessment by reading the following:

  *Today you will complete a short individual activity, which is designed to help me understand how you now think about representing fractions as a picture, a topic we have been working on in class.*

- Distribute the assessment and read the following:

  *Like before, the activity includes four problems. For each problem, choose your answer by completely filling in the circle to show which answer you think is correct. Because the goal of the activity is to learn more about how you think about fractions, it’s important for you to include some kind of explanation in the space provided. This can be a picture or words, or a combination of pictures and words that shows how you chose your answer.*

  *You will have about 15 minutes to complete all the problems. When you are finished, please place the paper on your desk and quietly [read, work on ____] until everyone is finished.*

- Monitor the students as they work on the assessment, making sure that they understand the directions. Although this is not a strictly timed assessment, it is designed to be completed within a 15-minute timeframe. Students may have more time if needed. When a few minutes remain, say:

  *You have a few minutes to finish the activity. Please use this time to make sure that all of your answers are as complete as possible. When you are done, please place the paper face down on your desk. Thank you for working on this activity today.*

- Collect the assessments
Administering the Post Assessment

After Administering the Post-Assessment

Use the analysis process (found in the Scoring Guide PDF document under the Scoring Process section) to analyze whether your students have this misconception:

» Misconception 1: Seeing Fractions As Part-to-Whole with Unequal Parts

Some students who previously had the misconception will no longer have it—the ideal case. Consider your instructional next steps for those students who still show evidence of the misconception.
Representing Fractions I Scoring Guide
Use this scoring guide when you score your own students' diagnostic pre- or post-assessment. Circle the appropriate information for each student.

<table>
<thead>
<tr>
<th>Student</th>
<th>Pre # 1</th>
<th>Pre # 2</th>
<th>Pre # 3</th>
<th>Pre # 4</th>
<th>Likelihood of M1?</th>
<th>Post # 1</th>
<th>Post # 2</th>
<th>Post # 3</th>
<th>Post # 4</th>
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Representing Fractions I  
Pre-Assessment

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<tr>
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</table>
| For each problem below there is a bold outline around the whole figure.  
Decide if the shaded part is equal to the fraction given. | | |

1) Is the shaded part \( \frac{1}{4} \)?
   - Yes
   - No
   - Explain your thinking.

2) Is the shaded part \( \frac{3}{5} \)?
   - Yes
   - No
   - Explain your thinking.

3) Is the shaded part \( \frac{5}{9} \)?
   - Yes
   - No
   - Explain your thinking.

4) Is the shaded part \( \frac{1}{5} \)?
   - Yes
   - No
   - Explain your thinking.
For each problem below there is a bold outline around the whole figure. Decide if the shaded part is equal to the fraction given.

1) Is the shaded part \( \frac{1}{4} \)?
   - Yes
   - No

2) Is the shaded part \( \frac{4}{7} \)?
   - Yes
   - No

3) Is the shaded part \( \frac{2}{5} \)?
   - Yes
   - No

4) Is the shaded part \( \frac{1}{5} \)?
   - Yes
   - No

Explain your thinking.