

Multipart TEIs in Math

Constructed response items play a vital role in math assessments. They require students to demonstrate advanced thinking and problem solving and allow students to show and explain their work. Constructed response items traditionally require students to enter a response on a keyboard. This is problematic because students cannot create common math responses, such as advanced equations, graphing, or tables using a keyboard.

To solve this problem, Fluence has developed multipart TEIs that are made up of a related sequence of technology enhanced and constructed response items. Students can graph, fill in tables, enter equations using a comprehensive set of math formats, etc. This greatly increases the types of questions we can ask students and the range of responses they can give.

Multipart TEIs follow the same structure as our 4-point constructed response items and include a detailed, holistic scoring rubric. Currently, all Fluence multipart TEIs are associated with clusters.

The first example is from Grade 4 NF.A – Extend understanding of fraction equivalence and ordering. The second example is from Grade 7 SP.C – Investigate chance processes and develop, use, and evaluate probability models.

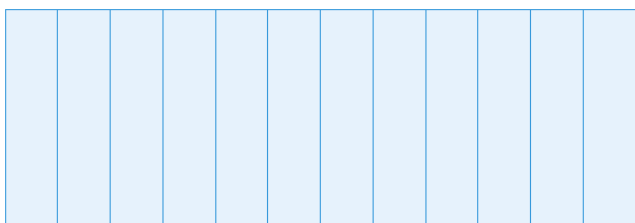
Example 1

Joe and Leo are spending the day at the carnival. They each bought 12 tickets. After the first hour, Joe says that he used $\frac{2}{6}$ of his tickets and Leo used $\frac{4}{12}$ of his tickets.

A. Use the fraction model below to shade the fraction of tickets Joe has used. Click on a section in the model to shade it.



Use the fraction model below to shade the fraction of tickets Leo has used. Click on a section in the model to shade it.



Which boy used more of his tickets? Explain how your models support your answer.

B. By lunch time Joe had used $\frac{4}{6}$ of his tickets and Leo had used $\frac{9}{12}$ of his tickets. Use the dropdown menu to choose the symbol to make the statement true.

The fraction of tickets Joe has used The fraction of tickets Leo has used

Explain how you chose the symbol in the statement.

C. By lunch time, have the boys used more than or less than half the tickets they bought? Explain your answer.

Rubric:

4. The response demonstrates a high level of understanding. A level 4 response is characterized by:
 - A correct answer in part A, namely that both boys used the same fractional amount of their tickets, with an explanation similar to "I shaded in 2 sixths of one fraction model and 4 twelfths of the other fraction model. I can see that the two fractions are equal. Joe has less rectangles shaded but they are larger, and Leo has more rectangles shaded but they are smaller. They both have used the same fractional amount of the total 12 tickets";
 - A correct answer in part B, namely "<," and an explanation similar to "I can rewrite Joe's amount of $\frac{4}{6}$ as $\frac{8}{12}$ by multiplying by $\frac{2}{2}$. Then I can compare that to Leo's fraction of $\frac{9}{12}$. Since the denominators are the same, I can see which numerator is larger. In this case Leo's is greater, so I used the < symbol to show Leo has used more of his tickets";
 - A correct answer and explanation in part C, similar to "Yes, each boy has used more than half his tickets. I know that $\frac{6}{12}$ equals $\frac{1}{2}$, and Joe has used $\frac{8}{12}$ of his tickets and Leo has used $\frac{9}{12}$ of his tickets, each of which is more than $\frac{6}{12}$ or one-half."
3. The response demonstrates a strong understanding, but the work contains minor errors. A level 3 response is characterized by:
 - An answer and explanation in part A that may contain a minor error or omission;
 - An answer and explanation in part B that may contain a minor error or omission;
 - An answer and explanation in part C that may contain a minor error or omission.
2. The response demonstrates a basic but incomplete understanding. A level 2 response is characterized by:
 - An answer and explanation in part A that may contain multiple minor errors or omissions;
 - An answer and explanation in part B that may contain multiple minor errors or omissions;
 - An answer and explanation in part C that may contain multiple minor errors or omissions.
1. The response demonstrates minimal understanding. A level 1 response is characterized by
 - An answer and explanation in part A that contains major errors, but is not entirely incorrect;
 - An answer and explanation in part B that contains major errors, but is not entirely incorrect;
 - An answer and explanation in part C that contains major errors, but is not entirely incorrect.
0. The response is completely incorrect, there is no response, or the response is off topic.

Example 2

A bag contains 7 red cubes, 8 green cubes, 3 yellow cubes, 5 blue cubes, and 2 white cubes. All of the cubes are exactly the same size.

A. Create a table that represents the contents of the bag and shows the probability of choosing each color when a cube is drawn from the bag without looking. Express the probabilities as fractions.

Click in each box in the table, then use the on-screen keyboard to enter your responses in the table.

Color	Number	Probability
Red	<input type="text"/>	<input type="text"/>
Green	<input type="text"/>	<input type="text"/>
Yellow	<input type="text"/>	<input type="text"/>
Blue	<input type="text"/>	<input type="text"/>
White	<input type="text"/>	<input type="text"/>

Keyboard below appears when student clicks on each box in the table:

?			=	
7	8	9	÷	<	>
4	5	6	×	$\frac{x}{\square}$	$x\frac{\square}{\square}$
1	2	3	-		
0	.	,	+		
◀	▶	✖	=		

B. Determine the probability of randomly drawing a green cube, returning it to the bag, and then randomly drawing a blue cube.

- Explain how you can use your table to find the probability.
- Write and solve an equation that represents the calculation of the probability.

Type your answer in the box below.

C. Explain whether it is more likely or less likely for the event described in part B to occur when the first cube is not returned to the bag before drawing the second. Use words and/or numbers to support your answer.

Type your answer in the box below.

Rubric:

4. The response demonstrates a high level of understanding. A level 4 response is characterized by:

- A correct table in part A, with probabilities expressed as fractions, similar to:

Color	Number	Probability
Red	7	$\frac{7}{25}$
Green	8	$\frac{8}{25}$
Yellow	3	$\frac{3}{25}$
Blue	5	$\frac{1}{5}$
White	2	$\frac{2}{25}$

(Accept an unsimplified fraction (5/25) for the probability of Blue);

- A correct explanation for part B indicating that the compound probability can be calculated as the product of the individual probabilities, similar to "For the green cube you use the fraction $\frac{8}{25}$ from the table, and for the blue cube you use the fraction $\frac{1}{5}$ from the table. Then you multiply them together to get $\frac{8}{125}$ ";
- A correct equation in part B, similar to $\frac{8}{25} \times \frac{1}{5} = p$, solved as $\frac{8}{125}$;
- A correct explanation with supporting work for part C indicating that the event is more likely when the green cube is not replaced. Justification should specify that without replacing the green cube the probability for the blue cube to be drawn second increases from $\frac{1}{5}$ to $\frac{5}{24}$; that the fraction $\frac{5}{24}$ is greater than $\frac{1}{5}$; and that there are fewer cubes in the box after the green cube is removed, so all cubes have a greater likelihood of being chosen on the second draw, or that the compound probability without replacing the green cube is $\frac{1}{15}$, which is greater than $\frac{8}{125}$.

3. The response demonstrates a strong understanding, but the work contains minor errors. A level 3 response is characterized by:
- A table in part A that may exhibit no more than one minor error;
 - An explanation for part B that contains minor flaws or is incomplete but correct;
 - An equation for part B that is solvable but may contain a minor flaw leading to an incorrect result;
 - An explanation in part C that indicates the event is more likely without replacement but may be incomplete or show inadequate supporting details OR leads to a well-supported conclusion that is consistent with calculation errors made in part B.
2. The response demonstrates a basic but incomplete understanding. A level 2 response is characterized by:
- A table in part A that exhibits 1–2 incorrect probabilities;
 - An explanation for part B that is vague, incomplete, or missing;
 - An expression or equation for part B that is correctly derived from the table in part A but may be incorrectly solved;
 - An explanation for part C that is incomplete.
1. The response demonstrates minimal understanding. A level 1 response is characterized by:
- A table in part A that exhibits up to 3 incorrect probabilities;
 - An explanation and an equation for part B that are incorrect, incomplete, or missing;
 - An explanation for part C that is incorrect, incomplete, or missing.
0. The response is completely incorrect, there is no response, or the response is off topic.