

Detailed Item Descriptions for NAEP Math Automated Scoring Challenge

Introduction

This document provides detailed item-level information about each of the ten items used within the NAEP Automated Scoring Math Challenge listed by the “Accession” identifier provided in the dataset. This document includes the intended grade and math domain and sub-domain for each item. It also includes a picture of what the examinee saw and detailed information around the scoring rules that were used to score this item, as well as the conversion of these scores into their final assigned/composite score. Note that this challenge requests predictions of scores for open-text components where possible but may also require that some predictions consider multiple components to predict the composite score, as some of these items have parts that are dependent on each other. Essentially, some of the answer fields can be scored independently of the other item parts but other items require the consideration of the constrained responses and the open text fields that contributed to the overall score. This document also includes a description of the different variables associated with each question and a short description of whether these are constructed response or constrained responses to assist participants in scoring model development.

This document may help anyone participating in this challenge to understand the unique variables/fields that are incorporated for each question from the larger dataset to better assist in designing the item-level math automated scoring algorithms needed.

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Basic Information**Item ID VH134067**

Grade	Years	Response Type	Complexity
4	2017 & 2019	SCR (Short Constructed Response)	Moderate
Content Area	Algebra		
Subtopic	Algebraic representations		
Objective	Translate between the different forms of representations (symbolic, numerical, verbal, or pictorial) of whole number relationships (such as from a written description to an equation or from a function table to a written description).		

Picture of Item

Input	Output
3	18
4	24
5	30
6	36

Write a rule that describes the relationship between the input numbers and the output numbers in the table shown.

Sample Correct Responses

Part A	The output number equals 6 times the input number. OR $6 \times \text{input} = \text{output}$
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Scoring Rules

	Score	"Assigned" Score Conversion	Description
Correct	2A	2	Acceptable rule that explicitly relates the input to the output.
	2B	2	Rule that involves multiplying by 6, but does not explicitly relate the input to the output.
Incorrect	1	1	Incorrect response.

Variable(s) Needed for Analysis

Limited Option Response(s)	
Name of Variable	Description
N/A	
Constructed Response(s)	
Name of Variable	Description
parsed_xml_v1	This is an open-ended field used for the examinees' response. It should contain a mathematical rule written in words that may also include an expression or equation. This is the only answer field for this question.

Basic Information**Item ID VH139380**

Grade	Year	Response Type	Complexity
4	2019	SCR (Short Constructed Response)	Low
Content Area	Algebra		
Subtopic	Patterns, relations, and functions		
Objective	Given a pattern or sequence, construct or explain a rule that can generate the terms of the pattern or sequence.		

Picture of Item

The first six numbers of a number pattern are shown.

5, 8, 11, 14, 17, 20, ...

The pattern continues by adding the same number each time.

What is the next number in the pattern?

Write a rule that can be used to find any number in the pattern, after the first number.

Sample Correct Responses

Part A	Answer: 23 Solution (not required in response): $20 + 3 = 23$
Part B	The other numbers can be found by adding 3 to the previous number.

Scoring Rules

	Score	Converted "Score to Predict"	Description
Correct	3	3	Both parts are correct.
Partial	2A	2	Part (a) correct only.
	2B	2	Part (b) correct only.
Incorrect	1	1	Incorrect response.

Variable(s) Needed for Analysis

Limited Option Response(s)	
Name of Variable	Description
N/A	
Constructed Response(s)	
Name of Variable	Description
parsed_xml_v1	Open-ended field but can be rule-scored as the answer to Part A. It is either 23 or not.
parsed_xml_v2	Open-ended field used for more complex scoring as the answer to Part B. It may contain a written sentence that may also contain an expression/equation.

Basic Information

Item ID VH266015

Grade	Year	Response Type	Complexity
8	2019	ECR (Extended Constructed Response)	Hard
Content Area	Number Properties and Operations		
Subtopic	Mathematical reasoning using number		
Objective	Provide a mathematical argument to explain operations with two or more fractions.		

Picture of Item

Drag a number into each box to make the following statement true.

3

4

6

7

$$\frac{7}{6} \div \frac{3}{4} = \frac{\boxed{}}{\boxed{}} \times \frac{\boxed{}}{\boxed{}}$$

Clear Answer

What must be true about the values of **a** and **b** in order for $\left(\frac{7}{6} \div \frac{3}{4}\right) \div \frac{a}{b} = \frac{7}{6} \div \left(\frac{3}{4} \div \frac{a}{b}\right)$?

Sample Correct Responses

Part A	<p>(a): Correct placement:</p> <div style="display: flex; align-items: center; justify-content: center;"> $\frac{7}{6} \div \frac{3}{4} = \frac{\boxed{7}}{\boxed{6}} \times \frac{\boxed{4}}{\boxed{3}}$ (or any equivalent product) <div style="display: flex; align-items: center;"> <div style="background-color: #007bff; color: white; padding: 5px 10px; border: 1px solid #007bff; margin-right: 5px;">3</div> <div style="background-color: #007bff; color: white; padding: 5px 10px; border: 1px solid #007bff; margin-right: 5px;">4</div> <div style="background-color: #007bff; color: white; padding: 5px 10px; border: 1px solid #007bff; margin-right: 5px;">6</div> <div style="background-color: #007bff; color: white; padding: 5px 10px; border: 1px solid #007bff;">7</div> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 5px;"> S1S2S3S4 </div>
Part B	<p>Explanation: The values of a and b must be equal such that $a \neq 0$ and $b \neq 0$.</p>

Basic Information

Additional Notes	<p>An acceptable explanation identifies that $a = b$ (or equivalent) and that $a \neq 0$ and $b \neq 0$. Partially acceptable explanations include those that identify:</p> <ul style="list-style-type: none"> $a = b$ (or equivalent), or $a = b$ (or equivalent) and $a \neq 0$ and $b \neq 0$, or $a = -b$ (or equivalent) and $a \neq 0$ and $b \neq 0$. <p>Minimally acceptable explanations include those that:</p> <ul style="list-style-type: none"> identify that $a \neq 0$ and $b \neq 0$, or identify that $a = b$ (or equivalent) and do not identify that $a \neq 0$ and $b \neq 0$, or identify that $a = -b$ (or equivalent) and do not identify that $a \neq 0$ and $b \neq 0$.
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Scoring Rules**Part A**

	Score	Description
Correct	2	Correct response.
Incorrect	1	Incorrect response.

Part B

	Score	Description
Satisfactory	4	Acceptable explanation.
Partial	3	Partially acceptable explanation.
Minimal	2	Minimally acceptable explanation.
Incorrect	1	Incorrect response.

Composite Score Construction

Part A Score	Part B Score	Final Composite Score
2	4	5
2	3	4
2	2	3
2	1	2
1	4	4
1	3	3
1	2	2
1	1	1

Variable(s) Needed for Analysis

Limited Option Response(s)	
Name of Variable	Description
source1	Drag and drop tile "from"
source2	Drag and drop tile "from"
source3	Drag and drop tile "from"
source4	Drag and drop tile "from"
target1	Drag and drop tile "to"
target2	Drag and drop tile "to"
target3	Drag and drop tile "to"
target4	Drag and drop tile "to"
The correct answer pattern for this item is the answer to Part A.	
Constructed Response(s)	
Name of Variable	Description
parsed_xml_v1	Open-ended field used for more complex scoring as the answer to Part B. It may contain a written explanation and/or an expression or equation, depending on how the examinee explained their work.

Item ID VH266510**Basic Information**

Grade	Years	Response Type	Complexity
8	2017 & 2019	SCR (Short Constructed Response)	Moderate
Content Area	Algebra		
Subtopic	Mathematical reasoning in algebra		
Objective	Make, validate, and justify conclusions and generalizations about linear relationships.		

Picture of Item

Which of the following statements must be true about any two distinct lines that intersect at exactly one point in the xy -plane?

- A ☐ The slopes of the lines must be equal.
- B ☐ The y -intercepts of the lines must be equal.
- C ☐ The slopes of the lines cannot be equal.
- D ☐ The y -intercepts of the lines cannot be equal.

Clear Answer

Explain how you know.

Sample Correct Responses

Part A	Correct selection: C. The slopes of the lines cannot be equal.
Part B	Explanation: The slopes cannot be equal because if they were equal, the lines would be parallel. Distinct parallel lines do not intersect.
Notes	<p>Acceptable explanations include those that address the idea that if two lines in the xy-plane have the same slope then they would either</p> <ul style="list-style-type: none"> • not intersect, or • be parallel, or • be the same line, or • intersect in infinitely many points. <p>Partially acceptable explanations include those that give an acceptable explanation with additional incorrect information.</p>

Scoring Rules

	Score	Converted "Score to Predict"	Description
Correct	3	3	Correct selection with acceptable explanation.
Partial	2A	2	Correct selection with a partially acceptable explanation.
	2B	2	Incorrect selection with an explanation that supports the correct selection.
Incorrect	1A	1	Correct selection with unacceptable or no explanation.
	1B	1	Incorrect response.

Variable(s) Needed for Analysis

Limited Option Response(s)	
Name of Variable	Description
selected	Only for 2019. The MC radio button choices for Part A in logical vector form (FALSE FALSE TRUE FALSE).
eliminations	Only for 2017. MC item eliminations for Part A in a numeric vector form (1, 3, 4).
eliminated	Only for 2019. MC item eliminations for Part A in a logical vector form (TRUE FALSE FALSE TRUE).
Constructed Response(s)	

Name of Variable	Description
parsed_xml_v1	Open-ended field used for more complex scoring as the answer to Part B. It will likely contain written sentence(s), and, possibly, mathematical symbols.

Item ID VH269384

Basic Information

Grade	Year	Response Type	Complexity
4	2019	ECR (Extended Constructed Response)	Moderate
Content Area	Data Analysis, Statistics, and Probability		
Subtopic	Probability		
Objective	Determine a simple probability from a context that includes a picture.		

Picture of Item

Trent is playing a game.

He will pick one card from a bag without looking.

The bag holds the following eight cards.

1

2

3

4

5

6

7

8

If he picks a card with a number greater than 3, he wins the game.

What is the probability that Trent will win the game?

A

☐

$\frac{1}{8}$

B

☐

$\frac{3}{8}$

C

☐

$\frac{5}{8}$

D

☐

$\frac{6}{8}$

Clear Answer

Trent takes a

5

 card out of the bag.

Then he puts a

9

 card into the bag.

Does replacing the card change Trent's probability of winning the game?

A

☐

Yes

B

☐

No

Clear Answer

Explain how you know.

Sample Correct Responses

Part A	Correct Selection: C. $\frac{5}{8}$
Part B	<p>Correct Selection: No.</p> <p>Explanation:</p> <p>To start, five out of the eight cards were greater than 3. Trent takes a 5 card out, and puts in a 9 card. There are still five cards that are greater than 3 out of eight total cards. Therefore the probability that Trent will win the game will stay the same.</p>
Notes:	<p><u>Acceptable</u> explanations include those that relate both 9 and 5 to 3.</p> <p><u>Partially acceptable</u> explanations include those that only indicate that 9 is greater than 5 or that 9 is greater than 3.</p>

Scoring Rules

Part A

	Score	Description
Correct	2	Answer of $\frac{5}{8}$.
Incorrect	1	Incorrect response.

Part B

	Score	Description
Correct	3	Correct selection with acceptable explanation.
Partial	2A	Incorrect or no selection with acceptable explanation that supports the correct selection.
	2B	Correct selection with a partially acceptable explanation.
Incorrect	1A	Correct selection with incorrect or no explanation.
	1B	Other incorrect responses.

Composite Score Construction

Part A Score	Part B Score	Final Composite Score
1	1A	1
1	1B	1
1	2A	3
1	2B	2
1	3	3
2	1A	2
2	1B	2
2	2A	3
2	2B	2
2	3	4

Variable(s) Needed for Analysis

Limited Option Response(s)	
Name of Variable	Description
selected1	MC item option radio button 1. The examinee chose A for Part A.
selected2	MC item option radio button 2. The examinee chose B for Part A.
selected3	MC item option radio button 3. The examinee chose C for Part A.
selected4	MC item option radio button 4. The examinee chose D for Part A.
selected1.1	MC item option radio button 2.1. The examinee chose yes for Part B.
selected2.1	MC item option radio button 2.2. The examinee chose no for Part B.
eliminated1	MC item elimination option for radio button 1 on Part A.
eliminated2	MC item elimination option for radio button 2 on Part A.
eliminated3	MC item elimination option for radio button 3 on Part A.
eliminated4	MC item elimination option for radio button 4 on Part A.
eliminated1.1	MC item elimination option for radio button 2.1 for Part B.
eliminated2.1	MC item elimination option for radio button 2.2 for Part B.
Constructed Response(s)	
Name of Variable	Description
parsed_xml_v1	Open-ended field used for more complex scoring as the answer to Part C. It will likely contain written sentence(s), and, possibly, mathematical symbols.

Item ID VH271613**Basic Information**

Grade	Years	Response Type	Complexity
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4	2017 & 2019	ECR (Extended Constructed Response)	High
Content Area	Algebra		
Subtopic	Mathematical reasoning in algebra		
Objective	Verify a conclusion using algebraic properties.		

Picture of Item

Use the following information to answer the questions.

Phil's age is 3 times Alex's age.
 Phil is 2 years older than Zach.
 Tim is 6 years younger than Phil.

What is the relationship between Zach's age and Tim's age?

Use the drop-down menus to show your answer.

Zach is years than Tim.

Which of the following statements will NOT be true exactly 10 years from now?

☐ A Phil's age will be 3 times Alex's age.

☐ B Phil will be 2 years older than Zach.

Explain why the statement you selected will NOT be true.

Sample Correct Responses

Part A	Correct selections: Zach is <u>4</u> years <u>older</u> than Tim.
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Part B	<p>Correct selection: A. Phil's age will be 3 times Alex's age.</p> <p>Explanation: For example, let Alex's age now be 5. Then Phil's age would be 3 times 5, or 15. In 10 years, Alex will be 15 and Phil will be 25. 25 is not 3 times 15, so Phil's age will not be 3 times Alex's age.</p> <p>OR In 10 years, Phil will be $P + 10$ years of age and Alex will be $A + 10$ years of age. $P + 10 = 3A + 10$, and $3A + 10$ is not equal to $3(A + 10)$.</p>
Notes	<p><u>Acceptable</u> explanations include those that:</p> <ul style="list-style-type: none"> • pick ages for Alex and Phil where Phil's age is three times Alex's age, and • correctly add ten to each of the ages, and • conclude that Phil's age in ten years is not three times Alex's age in ten years. <p><u>Partially acceptable</u> explanation include those that correctly address two of the three points for an acceptable explanation.</p>

Scoring Rules

Part A

	Score	Description
Correct	2	Correct selections.
Incorrect	1	Incorrect response.

Part B

	Score	Description
Correct	3	Correct selection with acceptable explanation.
Partial	2A	Incorrect or no selection with an acceptable explanation supporting the correct selection.
	2B	Correct selection with a partially acceptable explanation.
Incorrect	1A	Correct selection with unacceptable or no explanation.
	1B	Other incorrect responses.

Composite Score Construction

Part A Score	Part B Score	Final Composite Score
1	1A	1
1	1B	1
1	2A	2
1	2B	2
1	3	3
2	1A	2
2	1B	2
2	2A	3
2	2B	3
2	3	4

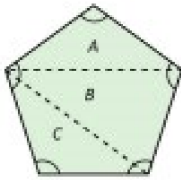
Variable(s) Needed for Analysis

Limited Option Response(s)	
Name of Variable	Description
partA_response_val	MC item drop down options for Part A. For 2017, this is a numeric vector (1,1) and for 2019, this is a logical vector.
partB_response_val	MC item drop down options for Part B. For 2017, this is a numeric vector (1,1) and for 2019, this is a logical vector.
partB_eliminations	MC item eliminations for Part B. The format is different for 2017 and 2019.
Constructed Response(s)	
Name of Variable	Description
parsed_xml_v1	Open-ended field used for more complex scoring as the answer to Part C. It will likely contain written sentence(s), and, possibly, mathematical symbols.

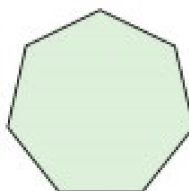
Item ID VH302907

Basic Information

Grade	Years	Response Type	Complexity
8	2017 & 2019	ECR (Extended Constructed Response)	High
Content Area	Geometry		
Subtopic	Mathematical reasoning in geometry		
Objective	Make and test a geometric conjecture about regular polygons.		

Picture of Item


Use the figure to explain why the sum of the measures of the interior angles of a polygon with 5 sides is 540° .



A polygon with 7 sides is shown.

What is the sum of the measures of the interior angles of a polygon with 7 sides?

 degrees

Based on these two examples, write a possible formula, in terms of n , for the sum of the measures of the interior angles, S , of a polygon with n sides.

$S =$

Sample Correct Responses

Part A	Explanation: The dotted lines in the figure divide the pentagon into three triangles. The sum of the measures of the interior angles of each triangle is 180° . The sum of the measures of the interior angles of the pentagon is equal to the sum of the measures of the interior angles of all three triangles. Thus, the sum of measures of the interior angles of the pentagon is $3 \times 180^\circ = 540^\circ$.
Part B	900 (or equivalent)
Part C	$S = 180(n - 2)$ (or equivalent)

Scoring Rules

Part A

	Score	Description
Correct	2	Acceptable explanation.
Incorrect	1	Incorrect response.

Part B

	Score	Description
Correct	2	Answer of 900.
Incorrect	1	Incorrect response.

Part C

	Score	Description
Correct	2	Answer of $S = 180(n - 2)$.
Incorrect	1	Incorrect response.

Composite Score Construction

Part A Score	Part B Score	Part C Score	Final Composite Score
2	2	2	5
2	2	1	4
2	1	2	4
2	1	1	3
1	2	2	3
1	2	1	2
1	1	2	3
1	1	1	1

Variable(s) Needed for Analysis

Limited Option Response(s)	
Name of Variable	Description
N/A	
Constructed Response(s)	
Name of Variable	Description
parsed_xml_v1	Open-ended field used for more complex scoring as the answer to Part A. It will likely contain written sentence(s), and, possibly, mathematical symbols.
parsed_xml_v2	Open-ended field but would likely be rule-based scoring for Part B.
parsed_xml_v3	Open-ended field used for receiving an equation for Part C.

Item ID VH304954**Basic Information**

Grade	Year	Response Type	Complexity
4	2017	SCR (Short Constructed Response)	Moderate
Content Area	Number Properties and Operations		
Subtopic	Properties of number and operations		
Objective	Apply basic properties of operations.		

Picture of Item

$$\begin{array}{r} 143 \\ - 48 \\ \hline \end{array}$$

Mark needs to solve the problem shown.

He will solve the problem in two steps.

First, Mark subtracts 43 from 143.

What does Mark need to do next to complete the problem?

What is the answer to $143 - 48$?

Sample Correct Responses

Part A	Subtract 5 from 100. OR Subtract 5 from the result found in step 1.
Part B	Answer: 95

Scoring Rules

	Score	Converted "Score to Predict"	Description
Correct	3	3	Both parts correct.
Partial	2A	2	Part (a) correct only.
	2B	2	Part (b) correct only.
Incorrect	1	1	Incorrect response.

Variable(s) Needed for Analysis

Limited Option Response(s)	
Name of Variable	Description
N/A	
Constructed Response(s)	
Name of Variable	Description
parsed_xml_v1	Open-ended field used for more complex scoring as the answer to Part A. It will likely contain written sentence(s), and, possibly, mathematical symbols.
parsed_xml_v2	Open-ended field but would likely be rule-based scoring for Part B.

Item ID VH507804**Basic Information**

Grade	Year	Response Type	Complexity
4	2019	ECR (Extended Constructed Response)	High
Content Area	Number Properties and Operations		
Subtopic	Number Operations		
Objective	Find and describe how to create the largest result in a given expression		

Picture of Item

Farelle has one hundred cards, each labeled with a different number from 1 to 100.

Farelle selects four of the cards.

How could she place three of the cards in the expression shown to get the largest result?

Drag a card into each box in the expression to show your answer.

17	27	54	62
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<input type="text"/>	×	<input type="text"/>	−	<input type="text"/>
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[Clear Answer](#)

Next, Farelle selects four new cards.

For any four cards, what is a rule about where Farelle should place the new numbers in the same expression to get the largest result?

Sample Correct Responses**Part A**

<input type="text" value="54"/>	×	<input type="text" value="62"/>	−	<input type="text" value="17"/>
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OR

<input type="text" value="62"/>	×	<input type="text" value="54"/>	−	<input type="text" value="17"/>
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Part B

Explanation: To get the largest result, Farelle needs to place the two largest numbers in the first two squares so they are multiplied and then subtract the smallest number.

Notes	<p>An <u>acceptable</u> explanation should explain that the largest two number must be in the multiplication and the smallest number must be subtracted.</p> <p>A <u>partially acceptable</u> explanation may either:</p> <ul style="list-style-type: none"> Version 1 - reference the placement of the two largest numbers in the first two squares without mentioning what should go in the last square, or Version 2 - select specific numbers and place them correctly without explaining in general, largest/smallest terms.
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Scoring Rules

Part A

	Code	Description
Correct	2	Three numbers correctly placed.
Incorrect	1	Incorrect response.

Part B

	Code	Description
Correct	3	Acceptable explanation.
Partial	2A	Partially acceptable explanation Version 1.
	2B	Partially acceptable explanation Version 2.
Incorrect	1	Incorrect response.

Composite Score Construction

Part A Score	Part B Score	Final Composite Score
2	3	4
2	2A	3
2	2B	3
2	1	2
1	3	3
1	2A	2
1	2B	2
1	1	1

Variable(s) Needed for Analysis

Limited Option Response(s)	
Name of Variable	Description
source1	Drag and drop tile 1 "from" in Part A
source2	Drag and drop tile 2 "from" in Part A
source3	Drag and drop tile 3 "from" in Part A
target1	Drag and drop tile 1 "to" in Part A
target2	Drag and drop tile 2 "to" in Part A
target3	Drag and drop tile 3 "to" in Part A
Open Response(s)	
Name of Variable	Description
parsed_xml_v1	Open-ended field used for more complex scoring as the answer to Part B. It will likely contain written sentence(s), and, possibly, mathematical symbols.

Item ID VH525628**Basic Information**

Grade	Year	Response Type	Complexity
8	2019	SCR (Short Constructed Response)	High
Content Area	Number Properties and Operations		
Subtopic	Number operations		
Objective	Interpret rational number operations and the relationships between them.		

Picture of Item

The letters w , x , y , and z represent four positive integers such that $w > x > y > z$.

How can w , x , y , and z be placed in the following expression to create the least value?

Drag a letter into each box to show your answer.

w

x

y

z

$$\left(\boxed{} + \boxed{} \right) - \left(\boxed{} \times \boxed{} \right)$$

Clear Answer

Explain how you know that your answer is correct for any such values for w , x , y , and z .

Sample Correct Responses

1

Correct placement:

$$\left(\boxed{y} + \boxed{z} \right) - \left(\boxed{w} \times \boxed{x} \right)$$

OR

$$\left(\boxed{y} + \boxed{z} \right) - \left(\boxed{x} \times \boxed{w} \right)$$

OR

$$\left(\boxed{z} + \boxed{y} \right) - \left(\boxed{w} \times \boxed{x} \right)$$

OR

$$\left(\boxed{z} + \boxed{y} \right) - \left(\boxed{x} \times \boxed{w} \right)$$

2	Explanation: This arrangement must be the smallest because the terms that are multiplied are subtracted from the terms that are added. This can be minimized by making the first two terms as small as possible, and the second two terms as large as possible. w and x are the largest two terms so multiplying them maximizes the two terms that are subtracted. y and z are the smallest terms, so adding them minimizes the terms that are subtracted from.
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Scoring Rules

	Score	Converted "Score to Predict"	Description
Correct	3	3	Correct placement with an acceptable explanation.
Partial	2A	2	Correct placement with incorrect or no explanation.
	2B	2	Incorrect placement but with an acceptable explanation that supports the correct placement.
Incorrect	1	1	Incorrect response.

Variable(s) Needed for Analysis

Limited Option Response(s)	
Name of Variable	Description
source1	Drag and drop tile 1 "from" in Part A
source2	Drag and drop tile 2 "from" in Part A
source3	Drag and drop tile 3 "from" in Part A
source4	Drag and drop tile 4 "from" in Part A
target1	Drag and drop tile 1 "to" in Part A
target2	Drag and drop tile 2 "to" in Part A
target3	Drag and drop tile 3 "to" in Part A
target4	Drag and drop tile 4 "to" in Part A

Constructed Response(s)	
Name of Variable	Description
parsed_xml_v1	Open-ended field used for more complex scoring as the answer to Part B. It will likely contain written sentence(s), and, possibly, mathematical symbols.