CHAPTER 14

Using Scale Anchoring to Interpret the TIMSS 2015 Achievement Scales

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Introduction

As described in Chapter 13: Scaling the TIMSS 2015 Achievement Data, the TIMSS 2015 achievement results are summarized using item response theory (IRT) scaling and reported on 0 to 1,000 achievement scales, with most achievement scores ranging from 300 to 700. Countries' average scores provide users of the data with information about how achievement compares among countries and whether scores are improving or declining over time.

To provide as much information as possible for policy and curriculum reform, however, it is important to understand the mathematics and science competencies associated with different locations within the range of scores on the achievement scales. For example, in terms of levels of student understanding, what does it mean for a country to have average achievement of 513 or 426, and how are these scores different?

The TIMSS 2015 International Benchmarks provide information about what students know and can do at different points along the achievement scales. More specifically, TIMSS has identified four points along the achievement scales to use as international benchmarks of achievement—Advanced International Benchmark (625), High International Benchmark (550), Intermediate International Benchmark (475), and Low International Benchmark (400). For each assessment, the TIMSS & PIRLS International Study Center works with the expert international committee, Science and Mathematics Item Review Committee (SMIRC), to conduct a scale anchoring analysis to describe student competencies at the benchmarks.

This chapter describes the scale anchoring procedures that were applied to describe student performance at the international benchmarks for TIMSS 2015. The analysis was conducted separately for mathematics and for science at fourth and eighth grades. In brief, scale anchoring

involved identifying items that students scoring at the international benchmarks answered correctly, and then having experts examine the content of each item to determine the kind of knowledge, skill, or reasoning demonstrated by students who responded correctly to the item. The experts then summarized the detailed list of item competencies in a brief description of achievement at each international benchmark. Thus, the scale anchoring procedure yielded a content-referenced interpretation of the achievement results that can be considered in light of the TIMSS 2015 frameworks for assessing mathematics and science.

Classifying the Items

As the first step, students scoring within 5 scale-score points of each benchmark (i.e., the benchmark point plus or minus 5) were identified for the benchmark analysis. This 10-point range provided an adequate sample of students scoring at the benchmark, and yet was small enough so that performance at one international benchmark was still distinguishable from the next. The score ranges around each international benchmark and the number of students scoring in each range are shown in Exhibit 14.1.

Exhibit 14.1: Range Around Each International Benchmark and Number of Students Within Each Range

	Low (400)	Intermediate (475)	High (550)	Advanced (625)
Range of Scale Scores	*395–405*	*470–480*	*545–555*	*620–630*
TIMSS Grade 4 Mathematics (Includes Numeracy)	6,209	10,218	11,078	5,546
TIMSS Grade 4 Science	4,021	8,717	11,554	5,421
TIMSS Grade 8 Mathematics	6,999	8,525	7,756	4,041
TIMSS Grade 8 Science	5,860	8,462	8,878	4,627

The second step involved computing the percentage of those students scoring in the range around each international benchmark that answered each item correctly. To compute these percentages, students in each country were weighted proportionally to the size of the student population in the country. For multiple-choice items and constructed response items worth 1 point, it was a straightforward matter of computing the percentage of students at each benchmark who answered each item correctly. For constructed response items scored for partial and full credit, percentages were computed for students receiving partial credit (1-point) as well as for students receiving full credit (2-points).

Third, the criteria described below were applied to identify the items that anchored at each benchmark. An important feature of the scale anchoring method is that it yields descriptions of the performance demonstrated by students reaching each of the international benchmarks on

the scales, and that the descriptions reflect demonstrably different accomplishments by students reaching each successively higher benchmark. Because the process entails the delineation of sets of items that students at each international benchmark are likely to answer correctly and that discriminate between one benchmark and the next, the criteria for identifying the items that anchor considers performance at more than one benchmark.

For multiple-choice items, 65 percent was used as the criterion for anchoring at each benchmark being analyzed, since students would be likely (about two thirds of the time) to answer the item correctly. A somewhat less strict criterion was used for the constructed response items, because students had much less scope for guessing. For constructed response items, the criterion of 50 percent was used for the benchmark without any discrimination criterion for the next lower benchmark. In addition, a criterion of less than 50 percent was used for the next lower benchmark, because with this response probability, students were more likely to have answered the item incorrectly than correctly.

Using a multiple-choice items as an example, the criteria for each benchmark are outlined below.

- A multiple-choice item anchored at the Low International Benchmark (400) if at least 65 percent of students scoring in the range answered the item correctly. Because this was the lowest benchmark described, there were no further criteria.
- A multiple-choice item anchored at the Intermediate International Benchmark (475) if at least 65 percent of students scoring in the range answered the item correctly, and less than 50 percent of students at the Low International Benchmark answered the item correctly.
- A multiple-choice item anchored at the High International Benchmark (550) if at least 65 percent of students scoring in the range answered the item correctly, and less than 50 percent of students at the Intermediate International Benchmark answered the item correctly.
- A multiple-choice item anchored at the Advanced International Benchmark (625) if at least 65 percent of students scoring in the range answered the item correctly, and less than 50 percent of students at the High International Benchmark answered the item correctly.

To include all of the multiple-choice items in the anchoring process and provide information about content domains and cognitive processes that might not otherwise have had many anchor items, the concept of items that "almost anchored" was introduced. These were items that met slightly less stringent criteria for being answered correctly. The criteria to identify multiple-choice items that "almost anchored" were that 60 to 65 percent of students scoring in the range answered the item correctly and less than 50 percent of students at the next lowest benchmark answered the

item correctly. To be completely inclusive for all items, items that met only the criterion that 60 to 65 percent of the students answered correctly (regardless of the performance of students at the next lower point) were also identified. The categories of items were mutually exclusive, and ensured that all of the items were available to inform the descriptions of student achievement at the anchor levels. A multiple-choice item was considered to be "too difficult" to anchor if less than 60 percent of students at the advanced benchmark answered the item correctly. A constructed response item was considered to be "too difficult" to anchor if less than 50 percent of students at the advanced benchmark answered the item correctly.

Exhibit 14.2 presents the number of TIMSS 2015 mathematics and science items that anchored at each international benchmark. A description of the items for mathematics at the fourth grade, science at the fourth grade, mathematics at the eighth grade, and science the eighth grade can be found in Appendix 14A, 14B, 14C, and 14D, respectively. It should be noted that a partial credit item can anchor twice, typically at a higher benchmark for full credit, and a lower benchmark for partial credit (but sometimes both anchored at the same level). Scale anchoring for the science items considered partial credit and full credit responses separately. Scale anchoring for mathematics used only the full credit anchoring results. For the mathematics scale anchoring at the fourth grade, TIMSS took advantage of data from the Numeracy assessment items in developing the descriptions for the Low and Intermediate Benchmarks.

Exhibit 14.2: Number of Items Anchoring and Almost Anchoring at Each International Benchmark

	Low (400)	Intermediate (475)	High (550)	Advanced (625)	Above Advanced	Total
TIMSS Grade 4 Mathematics						
Number	24	35	40	33	2	134
Geometric Shapes and Measures	10	17	21	23	3	74
Data Display	9	4	13	4	0	30
Mathematics Total*	**43**	**56**	**74**	**60**	**5**	**238**
*Includes Numeracy items at the Low and Intermediate Benchmarks						
TIMSS Grade 4 Science						
Life Science	8	15	28	23	8	82
Physical Science	4	6	21	26	5	62
Earth Science	0	5	16	10	5	36
Science Total	**12**	**26**	**65**	**59**	**18**	**180**

	Low (400)	Intermediate (475)	High (550)	Advanced (625)	Above Advanced	Total
TIMSS Grade 8 Mathematics						
Number	2	13	28	20	1	64
Algebra	0	3	24	28	6	61
Geometry	0	5	14	15	9	43
Data and Chance	2	10	14	12	3	41
Mathematics Total	**4**	**31**	**80**	**75**	**19**	**209**
TIMSS Grade 8 Science						
Biology	3	19	29	25	11	87
Chemistry	1	4	16	18	6	45
Physics	1	6	16	21	9	53
Earth Science	1	9	16	16	6	48
Science Total	**6**	**38**	**77**	**80**	**32**	**233**

Writing the Scale Anchoring Descriptions

The scale anchoring for TIMSS 2015 was conducted in the spring of 2016 at a four-day meeting in Seoul, South Korea. In preparation for review by SMIRC, staff at the TIMSS & PIRLS International Study Center used examples from previous assessments to draft short descriptions of the student competencies demonstrated by a correct (or partially correct) response to each mathematics and science item. Then, the mathematics and science items were organized separately by grade, grouped by international benchmark, and within each benchmark the items were sorted by content area. The final categorization was by the anchoring criteria the items met—items that anchored, followed by items that almost anchored, then by items that met only the 60 to 65 percent criteria. Also, in addition to the short draft descriptions, the following information was included for each item: framework classification, answer key or scoring guide, secure status, percent correct at each benchmark, and overall international percent correct.

At the scale anchoring meetings, the expert committees 1) worked through each item to finalize the description of the student competencies demonstrated by a correct (or a partially correct) response, 2) summarized the proficiency demonstrated by students reaching each international benchmark for publication in reports, and 3) selected example items that supported and illustrated the benchmark descriptions to publish together with the descriptions.

Following the scale anchoring meeting, the descriptions and example items published in the TIMSS 2015 reports were reviewed by National Research Coordinators at their 8th meeting in Quebec City, Canada.

Appendix 14A: TIMSS 2015 Fourth Grade Mathematics Item Descriptions Developed During the TIMSS 2015 Benchmarking

Items at Low International Benchmark (400)	
Number	
M01_01	Identifies a four-digit number given in words
M04_01	Adds a four-digit, three-digit, and two-digit number
M05_01	Subtracts a three-digit number from another three-digit number
M07_01	Identifies the rectangular representation for a unit fraction
N01_01	Adds three three-digit numbers
N01_04	Divides a two-digit number by a one-digit number
N01_05	Generates the next value in a well-defined number pattern
N01_07	Recognizes a unit fraction represented pictorially
N02_04	Multiplies a three-digit number by a one-digit number
N02_05	Identifies an expression that represents a situation
N03_01	Adds two two-digit numbers
N05_01	Identifies a four-digit number represented in words
N05_02	Solves a two-step word problem involving subtraction of one- and two-digit numbers
N06_02	Solves a word problem involving addition of two two-digit numbers
N06_08	Recognizes a non-unit fraction represented pictorially
N07_01	Solves a word problem involving multiplication of one- and two-digit numbers
N07_03	Solves a word problem involving subtraction of a one-digit number from a three-digit number
N07_07	Finds the missing value in an addition number sentence
N09_02	Solves a word problem involving subtraction of a one-digit number from a two-digit number
N09_05	Multiplies a one-digit number by a two-digit number
N10_01	Orders four three-digit numbers

N10_03A	Identifies the largest of four three-digit numbers in context
N10_06	Recognizes a unit fraction represented pictorially
N10_09	Solves a word problem involving addition of three one-digit numbers
Geometric Shapes and Measures	
M13_06B	Identifies a street perpendicular to a given street
N01_09	Reads a ruler to find the length of an object
N01_10	Identifies triangles
N02_11A	Identifies the tallest of four rectangular prisms represented pictorially
N02_11B	Identifies the greatest volume of four rectangular prisms represented pictorially
N03_10	Determines the distance around a triangle given the side lengths
N05_09	Identifies a shape with equal angles
N05_10	Completes a rectangle on a square grid
N06_10	Identifies a cube
N09_08	Identifies a cylinder
Data Display	
M01_12	Identifies the largest increase shown in a bar graph
M05_12	Completes a table from given information by counting
M06_11A	Reads data from a bar graph
N03_04A	Reads data from a bar graph
N03_04B	Compares data presented on a bar graph
N05_05A	Reads data from a table
N05_05B	Compares data presented in a table
N07_05	Uses data from a table to complete a bar graph (2 of 2 points)
N09_04A	Reads data from a bar graph

Items at Intermediate International Benchmark (475)	
Number	
M01_02	Solves a word problem involving multiplication of one-digit numbers
M02_06	Generates the next term in a well-defined number pattern
M04_02	Determines a four-digit number given the place values of the digits
M08_01	Identifies a four-digit number given in expanded form
M08_07	Identifies an expression that represents a situation
M09_01	Adds a four-digit and a three-digit number
M10_02	Divides a three-digit number by a one-digit number
M12_03	Multiplies a one-digit number by a three-digit number
M12_06	Determines the operation to complete a number sentence
M13_02	Identifies the representation of a non-unit fraction
N01_03	Solves a word problem involving multiplication of a one-digit number by 10
N01_06	Solves a two-step word problem involving subtraction and division
N01_12	Solves a word problem involving addition of money
N02_01	Identifies a four-digit number given the digits in two places
N02_02	Solves a word problem involving addition of two- and three-digit numbers
N02_03	Divides a two-digit number by a one-digit number with a remainder
N03_02	Divides a two-digit number by a one-digit number
N03_07	Solves a word problem involving addition of decimals
N03_11	Solves a word problem involving addition of hours and minutes
N05_03	Solves a word problem involving division of a two-digit number by a one-digit number
N05_04	Identifies an expression that represents a situation
N05_12	Solves a word problem involving addition of hours and minutes
N06_01	Subtracts a two-digit number from a three-digit number

N06_03	Solves a word problem involving multiplication of one- and two-digit numbers
N06_06	Determines the missing number in a well-defined number pattern
N07_02	Multiplies a one-digit number by a two-digit number
N07_04	Writes a number between two two-digit numbers
N07_06	Finds the missing term in an addition word problem
N09_01	Subtracts a two-digit number from a three-digit number
N09_03	Writes a four-digit number given the digits in two places
N09_06	Solves a multi-step word problem involving multiplication and division with a remainder
N09_07	Writes a fraction larger than a given unit fraction
N10_02	Solves a word problem involving division of a two-digit number by a one-digit number
N10_03B	Justifies the greatest number if one of four numbers is increased by 100
N10_05	Solves a word problem involving subtraction of one- and two-digit numbers
Geometric Shapes and Measures	
M01_06A	Identifies the shape made by connecting specified dots on a circle
M02_09	Identifies a time when the hands of a clock form a right angle
M03_09	Draws the reflection of a simple shape across a line
M04_08	Finds the halfway point between two positions on a number line
M05_07	Identifies a pair of parallel lines
M05_10	Identifies a net of a cube
M09_08	Identifies a shape with a right angle
M13_07	Identifies the number of triangular faces in a given three-dimensional shape
N01_11	Draws a rectangle with given dimensions on a square grid
N02_09	Draws a right angle on a square grid given one side
N05_11	Determines the number of unit cubes to fill a rectangular prism
N06_09	Identifies the appropriate metric unit of measurement for an object

N06_11	Determines the number of faces on a rectangular prism
N07_10	Identifies a common shape inside another common shape
N09_09	Identifies a triangle with given properties
N09_11	Justifies which figure made of unit cubes has the larger volume
N10_08	Writes the names of four common two-dimensional shapes
Data Display	
M01_11	Interprets information in a table to solve a problem
M02_10	Reads data from a table
M07_12	Recognizes which set of labels on a bar graph could show given information
M14_10A	Reads data from a graph

Items at High International Benchmark (550)

Number	
M01_03	Identifies multiples of a given number
M01_04	Adds two two-place decimals
M01_05	Follows a rule to complete a table
M02_01	Divides a two-digit number by a one-digit number with a remainder
M02_02	Provides numbers that round to specified conditions (2 of 2 points)
M02_03	Analyzes place value conditions to identify a four-digit number
M03_01	Subtracts a three-digit number from a four-digit number
M03_02	Solves a word problem involving division of two-digit numbers with a remainder
M04_05	Solves a word problem involving subtracting one-place decimals
M04_06	Identifies an expression that represents a situation
M05_02	Identifies the whole number closest to a given multiple of a hundred
M06_01	Identifies an expression that represents a situation
M06_05	Solves a multi-step problem involving two-place decimals and whole numbers

M07_02	Uses knowledge of place value to solve a problem involving a five-digit number
M07_04	Writes a fraction that represents a subset of a set of objects
M07_05	Identifies the largest of a set of unit fractions
M08_02	Multiplies a two-digit number by a two-digit number
M08_06	Solves for a repeated missing number in a subtraction sentence
M09_02	Identifies the number closest in size to a given four-digit number
M09_03	Solves a word problem involving division
M09_04	Solves a word problem involving addition of time
M10_01	Classifies two- and three-digit numbers as even or odd
M10_04	Solves a word problem involving non-unit fractions
M10_06	Determines the operation to complete a number sentence with operations on both sides
M10_07	Identifies an expression that represents a situation
M11_03	Solves a word problem involving multiplication of two-digit numbers
M11_04	Identifies a set of objects with a given fraction shaded
M11_05	Solves a number sentence involving multiplication facts
M11_06	Adds a whole number and a two-place decimal
M12_01	Rounds a four-digit number to the thousands place
M12_02	Identifies a number that satisfies two conditions of multiples
M12_04	Solves a problem set in a novel situation involving addition and comparison of whole numbers and justifies the solution
M13_01	Identifies the set of numbers having a given number as a factor
M13_04A	Solves a word problem involving rectangular representations of fractions
M13_04B	Solves a word problem involving rectangular representations of fractions
M13_05	Follows a two-step rule to extend a number pattern
M14_02	Determines whether three pairs of numbers follow a two-step rule
M14_03	Identifies a true statement about two- and three-digit numbers

M14_05	Solves for the missing number in a subtraction sentence
M14_07	Follows a two-step rule to generate the next number in a pattern
Geometric Shapes and Measures	
M01_06B	Draws a specified geometric shape by connecting dots on a circle
M01_06C	Draws a specified geometric shape by connecting dots on a circle
M01_07	Identifies the number of edges of a solid shown in a picture
M01_08	Determines the perimeter of a figure made of squares
M03_07	Identifies a shape that can be made by combining two given shapes
M03_08	Identifies a property common to two triangles
M04_09	Identifies a solid given two faces
M05_08	Uses knowledge about properties of rectangles to classify statements as true or false
M06_07	Identifies a shape that has a line of symmetry
M06_09	Identifies the stack of cubes with the largest volume
M06_10	Given a starting position on a map, follows specified moves and provides final coordinates
M07_07	Identifies a pair of shapes which are not mirror images of each other
M08_09	Finds the distance between two positions on a number line
M08_10	Relates a specified face of a cube to its net
M09_11	Solves a problem by filling a three-dimensional shape with rectangular solids
M10_09	Recognizes acute angles in an irregular quadrilateral
M11_08	Given a line, draws another line to form an angle less than a right angle
M11_09	Identifies the two-dimensional view of a three-dimensional object
M12_08	Classifies angle types in a figure
M14_08	Draws an obtuse angle on a square grid given one side
M14_09	Identifies a two-dimensional view of an irregular three-dimensional figure

Data Display	
M03_11	Compares information in a table and a bar graph to solve a problem
M03_12	Interprets data from a pie chart to solve a problem
M05_13	Completes a bar graph from information given in a tally chart (2 of 2 points)
M06_11B	Uses information from a bar graph to solve a problem
M07_11	Interprets a bar graph to solve a problem
M07_13A	Finds totals and decides which one is the least
M09_12	Completes a bar graph using information from a pictograph
M10_11	Identifies a pie chart that represents given data
M11_11	Uses information from a bar graph to solve a problem
M11_12	Identifies a pie chart that has the same information as a bar graph
M12_11A	Uses a key to retrieve data from a pictograph
M13_09A	Identifies the greatest value in a bar graph
M14_10B	Extrapolates from a graph to solve a problem

Items at Advanced International Benchmark (625)

Number	
M02_04	Solves a multi-step reasoning problem involving division
M02_05	Identifies the missing number in a number sentence with addition on both sides
M03_03	Solves a word problem involving subtraction of time
M03_05	Solves a multi-step problem involving two-place decimals and whole numbers
M03_06	Identifies a term in a repeating pictorial pattern using division with a remainder
M04_03	Devises two ways to allocate money in a given context (2 of 2 points)
M04_04	Determines the missing digit for a two-digit number that satisfies two conditions
M04_07	Identifies the missing number in a number sentence with operations on both sides
M05_03	Identifies the smallest number from a set of one- and two-place decimals

M05_04A	Identifies the circular representation of a non-unit fraction
M05_04B	Explains why a chosen circular representation shows a given non-unit fraction
M05_05	Identifies the missing first number in a number sentence involving subtraction
M05_06	Identifies the two-step rule that relates the numbers in two columns of a table
M06_02	Identifies the closest estimate to the result of a subtraction involving a five-digit number
M06_03	Given four different digits, writes two two-digit numbers with the largest sum
M06_04	Identifies a two-place decimal on a number line marked with one-place decimals
M06_06	Solves a multi-step reasoning problem involving place value of whole numbers
M07_03	Estimates the quotient of a four-digit number divided by a two-digit number
M07_06	Solves a word problem involving proportional reasoning
M08_03	Solves a multi-step word problem involving addition and subtraction of two- and three-digit numbers
M08_04	Solves a problem to identify a fraction that represents the shaded portion of a figure
M08_05	Solves a word problem involving division with a remainder and justifies the solution (2 of 2 points)
M09_05	Identifies a fraction equivalent to a given fraction
M10_03	Devises two ways of grouping objects that satisfy two conditions (2 of 2 points)
M10_05	Draws a complete shape on a grid given a picture of a fraction of the shape
M11_01	Solves a multi-step word problem involving multiplication and addition of whole numbers
M11_02	Identifies a fraction equivalent to a one place decimal
M12_05	Solves a word problem involving adding fractions with different denominators
M12_07	Identifies a number sentence that represents a situation
M13_03	Solves a multi-step problem involving division and gives a reason for their answer
M14_01	Recognizes equivalent three-digit numbers written in expanded form
M14_04	Identifies a number between a one-place decimal and two-place decimal
M14_06	Identifies an expression that represents a situation

Geometric Shapes and Measures	
M01_10	Draws all four lines of symmetry on a non-standard shape (2 of 2 points)
M02_07	Estimates the total length of a curved path given the length of a part of it
M02_08A	Given a description of a movement on a number line, determines another possible ending position
M02_08B	Given a starting point and two movements on a number line, identifies a possible ending position
M03_10	Finds the perimeter of a given figure made of a square and a rectangle
M04_10A	Draws a parallel line on a square grid given conditions
M04_10B	Draws a perpendicular line on a square grid given conditions
M05_09	Solves a multi-step word problem involving perimeter
M05_11	Identifies the area of a right triangle drawn on a grid
M06_08	Selects an appropriate unit of length to use in three different contexts
M07_08	Determines the number of cubes in a given rectangular box
M07_10	Draws a line through a given point perpendicular to a given line
M08_08	Identifies parallel lines on a geometric shape
M09_07	Identifies a rule to sort shapes into two sets
M09_09	Identifies a shape that has both line and rotational symmetry
M09_10	Determines the length of one side of an equilateral triangle and finds its perimeter
M10_08	Reads a ruler to find the length of a line segment beginning and ending at half-units
M10_10	Determines the number of square and triangular faces of three-dimensional shapes (2 of 2 points)
M11_07	Reads a ruler to find the length of an object beginning at a half-unit
M11_10	Finds the area of a rectangle given its dimensions
M12_09	Given two positions on a curved path, follows specified moves and labels another position (2 of 2 points)
M12_10	Identifies a net of a hexagonal prism
M13_06A	Identifies a street parallel to a given street

Data Display	
M07_13B	Draws and justifies a conclusion from data given in a table
M08_11	Represents data from a table in a pie chart
M12_11B	Uses information in a pictograph to solve a problem
M13_09B	Interprets a bar graph to solve a two-step problem

Items Above the Advanced International Benchmark (625)

Number	
M03_04	Solves a non-routine problem presented pictorially (2 of 2 points)
M09_06	Solves a multi-step problem involving fractions
Geometric Shapes and Measures	
M01_09	Estimates the length of a curved line in non-standard units
M07_09	Identifies the area of an isosceles triangle drawn on a grid
M13_08	Identifies a net of a given object

Appendix 14B: TIMSS 2015 Fourth Grade Science Item Descriptions Developed During the TIMSS 2015 Benchmarking

Items at Low International Benchmark (400)

Life Science	
S02_01	Identifies examples of animals that lay eggs
S03_01	Recognizes the mammal from among four pictures of animals
S05_05	States one thing necessary to maintain good physical health (1 of 2 points)
S07_01	Completes a table by matching diagrams of animals to their ecosystems
S08_03	Recognizes a living thing that produces its own food (1 of 2 points)
S10_01	Recognizes an animal that has a backbone
S14_02	States one way to avoid catching illness in a crowded space (1 of 2 points)
S14_03	Analyzes a diagram to explain which flower will grow better
Physical Science	
S04_08	Classifies materials as solids, liquids, or gases
S07_06	Recognizes ice as the solid form of water
S08_06	Identifies a way to sort objects containing metals
S10_06	Recognizes the states of matter of three different materials

Items at Intermediate International Benchmark (475)

Life Science	
S01_01	Recognizes the function of seeds
S01_02	Recognizes that the body needs more oxygen during exercise
S01_06	For four out of five human activities, identifies which have positive and which have negative effects on the environment (1 of 2 points)
S01_11	States one effect the Sun can have on unprotected skin
S02_04	Recognizes a transportation method that produces the least air pollution
S04_01	Recognizes why milk is important in a balanced diet

S04_02	States two things that plants need from their environment to make their own food
S06_04	Uses a list of living things in a desert ecosystem to complete a food chain
S06_05	Identifies a benefit of washing hands before eating
S07_02	Describes one way people can protect their teeth from decay, in addition to brushing
S08_05	Describes how human heart rate changes during exercise
S10_04	States two reasons why a plant will not survive by analyzing given conditions
S12_03	Completes a diagram describing the stages in the life cycle of a flowering plant
S12_06	Describes one way a polar bear's fur helps it survive (1 of 2 points)
S14_04	Evaluates two diagrams to explain which environment is better for sharks
Physical Science	
S01_07	Identifies the direction of the force of Earth's gravity in a diagram
S02_08	Identifies the source of heat that causes ice cubes to melt
S04_09	Explains why one object requires more force to start its motion than another
S06_07	Identifies a property of steel that makes it a better building material than wood
S12_10	Identifies why a bulb will not light in a model of an electric circuit
S14_08	Identifies the best material to complete a circuit
Earth Science	
S03_10	Recognizes what happens to water on a sidewalk when it disappears
S05_11	States one planet other than Earth that orbits the Sun (1 of 2 points)
S05_11	States two planets other than Earth that orbit the Sun (2 of 2 points)
S06_12	Provides evidence for the existence of air inside a balloon
S09_10	Matches each item in a list of Earth's landscape features to its description

Items at High International Benchmark (550)

Life Science	
S01_06	For five human activities, identifies which have positive and which have negative effects on the environment (2 of 2 points)
S02_02	States two things that both plants and animals need to live
S03_02	States two changes which occur in the body during running in addition to feeling hot
S03_04	Identifies how having coloring similar to their surroundings helps birds stay alive
S04_04	Identifies a difference in the life cycles of a grasshopper and a butterfly
S04_06	Recognizes a way to avoid spreading the flu
S05_01	Recognizes the organ where digestion takes place
S05_03	Recognizes the body covering the protects a reptile
S05_04	From a list of plants and animals, identifies some of those that make their own food (1 of 2 points)
S06_01	Recognizes why standing water provides an environment beneficial for mosquitos
S06_02	Describes one way pollen is spread from flower to flower (1 of 2 points)
S06_06	Explains one reason why it is important to have spiders in a garden
S07_05	States one characteristic that a plant and an animal share, other than a need for water (1 of 2 points)
S08_01	Recognizes the plant part that produces seeds
S08_02	Uses a list of living things in an Arctic ecosystem to complete a food chain
S08_04	Recognizes a feature of how snakes eat
S09_01	States one difference between living things and nonliving things
S09_03	Recognizes an advantage of thin, pointed leaves compared to broad, flat leaves
S09_04	States one reason why plastic objects in the ocean are dangerous for sea animals
S09_05	Provides a possible reason why some trees in a group do not grow as well as others
S10_02	Describes two ways that a mammal helps its young survive
S10_03A	Uses a food web to identify what a predator eats
S11_03	Recognizes whether labeled features of a bird are inherited

S12_04A	Interprets data from an investigation to recognize the best condition for growing plants
S12_05	Relates factory pollution to its effect on farm fields
S13_01	Recognizes that in mammals, a male and female of the same kind are needed to reproduce
S13_02	Explains that germs can be transmitted even when people do not appear to be sick
S13_05	Identifies a function of a plant's stalk by interpreting an observation from an investigation
Physical Science	
S01_12	Names a source of energy other than coal, oil, or natural gas that is used to produce electricity
S02_07	Explains the function of a battery in an electric circuit
S02_10A	Recognizes which direction to apply a force to reverse the direction of a moving object
S03_08	Given a list of five everyday objects, recognizes which ones conduct electricity
S05_09B	Evaluates between two methods which would dissolve a piece of candy faster
S06_08	Recognizes from a list which are sources of energy and which are not
S06_10	Explains how a sweater can keep a bottle of water cold
S07_04	Identifies the cause of a shadow forming
S07_11	From a diagram, identifies the orientation of the poles on two repelling magnets
S08_08	Recognizes what happens to the water when a puddle of water on a metal tray becomes smaller
S08_10	Explains why pressing a guitar string stops the sound
S09_07	Describes a difference between ice and water in addition to their physical states
S09_09A	Identifies from a diagram how a shadow is formed
S11_06	States a reason for the color change and surface roughening of a metal object over time
S11_08	Gives a reason why two objects of the same shape and size travel different distances after a push
S11_09	Using a model of a flashlight, identifies an object that can be used to complete an electrical connection
S12_09A	Explains why boiling decreases the amount of water in a container
S12_09B	Predicts the effect on a cold window glass of boiling water nearby
S13_07	Observes that two metal bars repel and determines whether they are magnets

S13_08	Explains that heat in a metal object reaches the nearest point soonest
S13_09	Using a diagram, identifies which hidden object could complete an electric circuit
Earth Science	
S01_08	Recognizes evidence that there were many kinds of animals on Earth that no longer exist today
S03_11	Identifies a conclusion scientists draw from fossils of shellfish found on land
S03_12	Identifies a pictorial representation of a shadow at midday
S04_11	Recognizes a diagram showing the correct relative positions of the Earth, Moon, and Sun
S04_12	From pictures of rock formations, identifies how a given rock may have looked long ago
S05_12	From a diagram showing a shadow at different times of the day, explains why the shadow changed
S06_11	Recognizes that water flows from mountains to oceans via rivers
S07_13	States one thing that makes up Earth's crust (1 of 2 points)
S07_14	From a table showing temperature and cloud cover at different locations, identifies the place where is it most likely to snow
S08_11	Using two pictures of the same location, explains that the Moon can look different at different times
S08_12	Recognizes which step in a diagram of a water cycle shows evaporation
S10_10A	Interprets information from a graph to recognize which crops will grow best in an area with given precipitation
S11_11	Recognizes a feature of the Moon from observations over a month
S12_02	Recognizes seasons north and south of the Equator
S13_11	Recognizes that the solar system is made up of the Sun and its planets
S14_12	Interprets information from temperature graphs to identify which of two places has certain climate properties

Items at Advanced International Benchmark (625)

Life Science	
S01_03	Identifies examples of animals that take care of their young
S01_04	Identifies how being poisonous to birds is an advantage for monarch butterflies
S02_03	Recognizes a food with a high protein content

S02_05	Explains how a flu-like disease can be transmitted through the air
S03_05	Analyzes statements to identify possible characteristics of predators and prey
S04_03	Identifies a reason that some mammals pant on hot days
S04_05	Predicts the consequences of removing a predator from an animal's habitat
S05_02	Recognizes the function of the flowering part of a plant
S05_06	Recognizes an animal that is classified as a mammal
S06_02	Describes two ways pollen is spread from flower to flower (2 of 2 points)
S07_07	Explains why people should drink a lot of liquid every day
S07_09	Identifies one physical change that can take place in a mammal as the weather gets colder
S10_03B	Uses a food web to determine which animals are competitors
S11_01	Recognizes the function of muscles attached to bones
S11_04	Evaluates three experimental designs and explains which is best to test if plants need light to grow
S11_05	Draws a conclusion by relating one function of feathers to keeping a body warm in the case of dinosaurs
S12_04B	Identifies a conclusion about plant growth using data from an investigation
S12_06	Describes two ways a polar bear's fur helps it survive (2 of 2 points)
S13_03A	Explains that to test the survival of plants, they should be compared under different conditions
S13_03B	Identifies a desert plant and describes one feature that helps it survive in the desert
S13_04	States two things in addition to water that animals need to survive
S14_02	States two ways to avoid catching an illness in a crowded space (2 of 2 points)
S14_05	Describes how boiling water makes it safe to drink
Physical Science	
S01_13	Recognizes that burning results in new substances
S02_06	Explains how the poles of two magnets should be oriented to cause repulsion
S02_09	Recognizes a property of metals that makes them good electrical wires
S02_10B	Recognizes which direction to apply a force to change the direction of a moving object

S03_07	Recognizes a property used to classify everyday objects into two groups
S03_09	Names the force that moves an object down a sloping track
S04_07	Predicts which of two objects is a better conductor of heat with supporting explanation
S04_10	States one form of energy present in a model of an electric circuit (1 of 2 points)
S05_09A	Evaluates between two methods which would dissolve a piece of candy faster
S05_09C	Evaluates a list of methods and predicts which method produces a less sweet drink
S05_10	Recognizes the best conductor of heat in a list of materials
S07_03	Using information in a table, identifies another item whose physical properties match those of one of the items in the table
S08_07	Analyzes a diagram to identify one way to make a shadow bigger
S09_08	Identifies that the temperature at which an object melts depends on the material from which it is made
S09_09B	Recognizes that a shadow produced in colored light is black
S10_07	Explains the process by which wet objects become dry
S10_08	Explains how to separate a mixture of two types of solids of different sizes
S10_09A	Recognizes set-ups that will more quickly dissolve a solid in water
S10_09B	Explains the importance of controlling a variable in an experiment
S12_07	Identifies a physical property of metal pot that makes it good for boiling water
S12_08A	Evaluates the best way to separate a mixture of solids of similar size
S12_08B	Evaluates the best way to separate a mixture of things that dissolve and things that do not dissolve
S13_06	Identifies that two objects of the same size and shape have the same volume and, from a diagram, that they have different masses
S14_06	Recognizes one property of a liquid
S14_07	Evaluates the best set-up to investigate whether temperature affects the rate at which a solid dissolves in water
S14_09	Recognizes a diagram that demonstrates motion due to gravity
Earth Science	
S01_10	Draws a conclusion from an investigation to explain why water does not fill a glass inverted in water, (referring to air in the glass) OR to explain why water does fill a glass when it is tilted (referring to air escaping) (1 of 2 points)

S07_12	Recognizes how long it takes for Earth to orbit the Sun
S07_13	States two things that make up Earth's crust (2 of 2 points)
S09_11	Identifies how fish fossils are formed
S10_10B	Synthesizes precipitation information from a graph and diagram to recognize the best area to plant a crop in a given climate
S11_10	Identifies that clouds are made of water droplets
S11_12	Interprets a diagram of the Earth and the Sun to describe how Earth turning on its axis causes day and night in a particular location
S12_01	Recognizes which place is likely to have weather that is hot and wet
S13_10	Identifies the diagram that shows relative amounts of water and land on the Earth's surface
S14_10	Relates two different environments and weathering effects on rocks

Items Above the Advanced International Benchmark (625)

Life Science	
S03_03	Explains that the same type of plants should be compared when investigating plant growth with or without fertilizer
S05_04	From a list of plants and animals, identifies all of those that make their own food (2 of 2 points)
S05_05	States one thing necessary to maintain good physical health with a supporting explanation (2 of 2 points)
S06_03	Explains why laying a large number of eggs helps frogs survive in their environment
S07_05	States two characteristics that a plant and an animal share, other than a need for water (2 of 2 points)
S08_03	Recognizes a living thing that produces its own food and describes the process (2 of 2 points)
S09_06	Identifies that more use of public transportation will decrease air pollution in a large city
S11_02	Recognizes the main function of leaves on a plant
Physical Science	
S01_05	Labels the freezing point of water on a diagram of a thermometer
S03_06	Explains that cooking causes a change that cannot be reversed
S04_10	States two forms of energy present in a model of an electric circuit (2 of 2 points)
S05_08	Explains which orientation of two batteries in series, depicted in two circuit diagrams, allows a bulb to light
S11_07	Explains why a metal spoon in hot soup feels hotter than a wooden spoon in hot soup

Earth Science	
S01_10	In the context of an investigation, explains why water does not fill a glass inverted in water, (referring to air in the glass) AND explains why water does fill a glass when it is tilted (referring to air escaping) (2 of 2 points)
S02_11	Recognizes how wind can cause weathering of rocks
S02_12	Explains why stars are not visible during the day
S08_09	States one source of energy other than sunlight that can be changed into electricity
S14_11	Recognizes four true statements about recycling metals

Appendix 14C: TIMSS 2015 Eighth Grade Mathematics Item Descriptions Developed During the TIMSS 2015 Benchmarking

Items at Low International Benchmark (400)	
Number	
M04_01	Recognizes a 7-digit number given in words
M07_01	Evaluates the power of a whole number
Data and Chance	
M01_13	Uses information in a table to complete a bar graph
M06_13	Identifies the table that matches the information shown in a pictograph

Items at Intermediate International Benchmark (475)	
Number	
M01_04	Identifies equivalent ratios
M02_01	Recognizes the commutative property
M03_01	Identifies the decimal number closest in size to a given fraction
M05_01	Identifies the divisor by moving the decimal point
M07_03	Uses knowledge of the whole being 100 percent to solve a simple word problem
M07_04A	Completes a table of equivalent proportions
M08_04	Shades a percent of a figure
M09_01	Evaluates an expression involving negative whole numbers and parentheses
M09_02	Solves a word problem involving subtraction of negative numbers
M10_01	Solves a word problem involving subtraction of negative numbers
M11_03	Solves a two-step word problem involving whole numbers
M11_04	Determines what fraction of a 10×10 grid is shaded
M13_02A	Solves a word problem involving addition of time

Algebra	
M11_06	Evaluates the power of an expression given its value
M12_08	Uses values for a linear function to determine an extrapolated value
M14_05	Solves a linear equation in two-variables given the value of one variable
Geometry	
M02_08	Identifies opposite faces of a cube given its net
M04_09	Recognizes congruent quadrilaterals
M05_12	Identifies a true statement based on the properties of parallel and perpendicular lines
M12_09	Identifies the reflection of a partly shaded shape
M12_11	Determines the total number of stacked unit cubes
Data and Chance	
M05_15	Given a table of percentages, selects the pie chart that could represent the given data
M06_12A	Compares the chances of two outcomes shown pictorially
M07_12	Reads values from two line graphs to solve a problem
M07_14	Given a situation, judges the chance of an outcome as unlikely
M08_14A	Estimates an expected value given an observed sample
M09_12	Finds and compares the unit prices of four objects
M09_14	Identifies the bar graph that matches the information shown in a table
M11_12A	Reads data from a line graph
M11_12B	Compares data from two line graphs to solve a problem
M13_12	Solves a problem given the chance of an outcome

Items at High International Benchmark (550)

Number	
M01_01	Solves a word problem involving multiplication of a fraction and a decimal
M01_06B	Selects and combines information from two sources to solve a multi-step word problem (2 of 2 points)
M02_02	Solves a two-step word problem involving subtraction of whole numbers and multiplication of a fraction

M02_03A	Determines the percentage for a section of a pie chart
M03_04	Orders decimals with different numbers of decimal places
M03_05	Solves a proportion problem involving decimals
M05_02	Recognizes the fraction equivalent to a percentage
M05_03	Approximates the sum of five three-digit numbers to the nearest hundred
M05_04	Identifies the larger of two fractions with different numerators and different denominators and explains why it is larger
M06_01	Uses the distributive law to identify an expression equivalent to a given one
M06_04	Determines fractions equivalent to a given fraction
M07_04B	Finds the unknown term in a proportion in a given situation
M08_01	Identifies an expression equivalent to a given division expression
M08_03	Finds the missing value in an addition problem with both fractions and decimals
M09_04	Given the two parts of a whole in a word problem, identifies the fraction which represents one part
M09_05A	Solves a word problem involving multiplication and addition of whole numbers
M10_02	Identifies equivalent ratios
M10_04	Uses four different digits to write two two-digit numbers with the smallest product
M11_01	Solves a word problem involving ratios
M11_02	Identifies a prime number
M12_01	Solves a word problem involving a fraction of a whole
M12_02	Solves a word problem involving division of whole numbers with a remainder
M13_01	Identifies the representation of a fraction equivalent to a given representation of a fraction
M13_03	Understands a property of adding multiples
M13_04	Writes a decimal with three places as a fraction
M14_01	Identifies an expression equivalent to a given multiplicative expression
M14_02	Solves a two-step word problem involving subtraction of whole numbers and multiplication of a fraction
M14_04	Solves a word problem involving ratios and decimals

Algebra	
M01_03	Recognizes the distributive property in evaluating an algebraic expression
M01_05	Identifies the algebraic expression that represents a fraction of a variable
M01_07	Identifies the ordered pair of numbers that satisfies a given linear equation
M01_08	Identifies the equation that models a situation given in a word problem
M01_09	Identifies values of two variables, each satisfying a simple inequality
M03_06	Evaluates an algebraic expression involving a fraction
M03_08	Identifies the solution to an equation involving a square root
M03_09	Identifies the formula that represents a situation involving area
M05_06	Solves a simple linear equation in one variable with a mixed number solution
M05_07	Finds a missing term in a non-arithmetic and non-geometric number sequence
M05_08	Identifies the linear equation satisfied by two given values
M05_11A	Adds two algebraic expressions and simplifies
M06_08A	Extends a pattern to find the area of a square
M07_07	Finds the value of an algebraic expression involving parentheses and negative terms
M08_07	Identifies an algebraic expression that represents the perimeter of an irregular shape
M08_08	Determines a missing coordinate for a linear relationship given in a table
M09_07	Evaluates an algebraic expression involving fractions and integers
M09_08	Uses a given formula involving fractions to solve a word problem
M10_05	Identifies an expression that represents a situation
M12_06	Identifies an equation that models a situation
M12_07	Identifies an expression for the area of part of a geometric figure
M13_06	Identifies the equivalent algebraic expression involving exponents and multiplication
M13_07A	Extends a given geometric pattern to find the value of the 10th term
M14_07	Identifies the true statement about a linear relationship given in a graph

Geometry	
M01_11	Identifies the number of remaining unit cubes
M02_07	Draws the reflection of a shape over a diagonal line on a grid
M03_11	Identifies a net of a rectangular solid
M03_12	Solves a problem involving angles of a triangle and parallel lines
M05_13	Uses the angle properties of triangles and rectangles to find a missing angle
M06_09	Uses the Pythagorean theorem to solve a word problem
M06_10	Solves a problem involving angles of a triangle
M07_09	Draws a symmetrical shape given half of it and its line of symmetry
M08_10	Finds the coordinates of a midpoint given two points in the Cartesian plane
M09_10	Identifies the value of an angle involving properties of corresponding and supplementary angles
M09_11	Draws an angle of a given measure on a square grid
M11_10	Solves a problem involving similar triangles
M13_11	Solves a problem involving angles of a triangle
M14_08A	Solves a word problem involving the length around a hexagonal prism
Data and Chance	
M01_14	Explains why a conclusion drawn from a given bar graph is incorrect
M02_13	Identifies the probability of an event
M05_16	Interpolates from a line graph to provide an estimated value
M06_12B	Compares the chances of two outcomes
M07_02	Reads the value indicated by an unlabeled mark on a speedometer
M07_13	Identifies a possible description of a part of a time-speed graph
M10_13A	Computes the mean of four given values
M11_13	Interprets data in a pictograph to solve a multi-step problem
M11_14	Justifies a conclusion resulting from comparing two distributions

M12_13	Interprets a histogram to identify a proportion
M12_14	Draws a spinner that has given probabilities
M13_13B	Uses and interprets data sets in pie charts to solve a problem involving percentages
M14_11	Evaluates information given by a time/distance graph
M14_13	Identifies the probability of an event

Items at Advanced International Benchmark (625)

Number	
M01_02	Uses knowledge of place value to express a sum as a decimal
M01_06A	Selects and combines information from two sources to solve a multi-step word problem (2 of 2 points)
M02_03B	Determines the whole given the amount of a percentage
M03_02	Solves a non-routine problem involving whole numbers
M03_03	Reasons about divisibility in an algebraic expression
M04_02	Given the volume of a fraction of a container, determines the total volume for multiple containers of the same size
M04_03	Solves a word problem involving price per unit and explains reasoning
M04_04	Given four different containers, identifies the container with the greatest fraction filled
M06_02	Solves a word problem involving comparison of fractions and percentages and explains answer
M06_03	Solves a non-routine word problem involving reasoning with whole numbers (2 of 2 points)
M06_05	Reasons about fractional parts of a whole in a word problem and explains answer
M08_02	Solves a two-step word problem involving whole numbers
M09_03	Solves a two-step word problem involving percentages
M09_05B	Solves a non-routine word problem involving whole numbers
M10_03	Determines the dimensions of a rectangle that is similar to a given rectangle
M11_05	Identifies a true statements about percentages of given numbers
M12_03	Completes a table of equivalent proportions and percentages (2 of 2 points)
M12_04	Solves a word problem involving ratios

M13_02B	Solves a word problem involving percentages and elapsed time
M14_03	Identifies a percentage using a given ratio
Algebra	
M01_10	Uses a given formula to solve a word problem
M02_04	Solves a pair of simultaneous linear equations in two variables
M02_05	Computes values of a function given values of the variable
M02_06	Identifies a linear equation given the y-intercept
M04_05	Simplifies an algebraic expression
M04_06	Retrieves coordinate points from a graph of a function
M04_08	Constructs a linear equation for the perimeter of a triangle and solves for the length of one side
M05_05	Writes a rule for a multiplicative number pattern involving negative numbers
M05_09	Solves a proportion expressed algebraically
M05_10	Constructs and uses the solution of a linear equation to solve a word problem (2 of 2 points)
M05_11B	Subtracts one algebraic expression from another and simplifies
M06_06	Identifies an equivalent equation
M06_07	Identifies a pair of simultaneous linear equations that model a given situation
M07_05	Identifies the equation of a line that passes through points shown on a graph
M07_06	Identifies the equation that models a situation involving distance, speed, and time
M07_08A	Finds a specific term in a pattern presented numerically and geometrically
M07_08B	Explains how to find a specific term in a pattern presented numerically and geometrically
M07_08C	Expresses the general term algebraically in a pattern presented numerically and geometrically
M08_06	Identifies a line with positive slope
M09_06	Identifies an equivalent algebraic expression
M09_09	Demonstrates an understanding of slope by relating graphs and their equations
M10_06	Constructs a linear equation to represent a situation

M10_08	Constructs a linear equation for the perimeter of a rectangle and finds the area (2 of 2 points)
M11_08	Solves a pair of simultaneous linear equations
M13_05	Identifies an algebraic expression that represents the area of a given rectangle
M13_07B	Gives a rule for the nth term of a geometric pattern
M13_08	Identifies the graph of a linear equation
M14_06	Identifies the slope of a line given its equation
Geometry	
M01_12	Uses the Pythagorean theorem in finding the area of a triangle
M02_09	Identifies two different arrangements of trapezoids with the same perimeter
M04_10	Finds the coordinates of a vertex of a rectangle given the other three vertices
M05_14	Uses properties of similar triangles to identify equal angles
M06_11	Identifies the point equidistant from two given points in the Cartesian plane
M07_10	Uses the Pythagorean theorem in finding the perimeter of a trapezoid
M07_11	Identifies two shapes that make a square
M08_09	Uses properties of triangles and quadrilaterals to solve for an angle
M08_12	Draws a rectangle on square grid given area and perimeter (2 of 2 points)
M10_09	Estimates area of an irregular shape on a square grid
M10_10	Finds vertices of triangles created from trapezoids in the Cartesian plane (2 of 2 points)
M10_11	Uses properties of supplementary angles to solve for an angle
M12_10	Determines the number of faces of a regular solid with unit cubes removed
M13_10	Determines the surface area of a prism given its net
M14_08B	Solves a word problem involving the lateral surface area of a hexagonal prism
Data and Chance	
M01_15	Uses understanding of average to solve a problem
M02_11	Identifies the statement that best describes a data set given in a table

M02_12	Estimates probability given an observed sample
M03_13	Explains why a data representation could be misleading
M03_14	Interprets data in a pie chart to solve a word problem
M03_15	Uses understanding of mean and range to solve a problem
M04_12A	Calculates mean and median for two ordered lists of data (2 of 2 points)
M08_14B	Compares observed and expected values
M10_12	Estimates the number of objects in a given probability sample
M10_13B	Determines the change in a mean given changes in individual scores
M12_12	Solves a word problem involving averages
M13_13A	Uses and interprets data sets in pie charts to solve a problem involving percentages

Items Above the Advanced International Benchmark (625)

Number	
M01_06C	Compares results derived from two sources and provides a justification for the conclusion (2 of 2 points)
Algebra	
M03_07	Writes an expression for the area of part of a geometric figure
M04_07	Determines a collinear point given another point on the line and the slope
M06_08B	Writes the algebraic expression for the nth term in a series
M08_05	Identifies the equivalent form of a linear inequality in one variable
M11_07	Identifies an algebraic expression involving parentheses and negative terms
M12_05	Identifies equivalent rational expressions
Geometry	
M02_10	Explains how to find the area of an irregular shape on a grid (2 of 2 points)
M03_10	Solves a word problem using properties of similar triangles
M04_11	Explains why two shaded areas of overlapping congruent triangles are equal
M08_11	Solves for a missing side length given two similar triangles
M11_09	Draws all lines of symmetry on a regular polygon

M11_11	Solves a multi-step word problem involving ratios between volumes
M13_09	Identifies the image of a shape after rotation and reflection
M14_09	Determines the number of exposed faces for unit-cubes that make up a larger cube (2 of 2 points)
M14_10	Solves a word problem involving the Pythagorean theorem
Data and Chance	
M04_13	Solves a multi-step problem involving probability
M08_13	Compares characteristics of two dot plots to justify a conclusion
M09_13	Explains why a data representation could be misleading

Appendix 14D: TIMSS 2015 Eighth Grade Science Item Descriptions Developed During the TIMSS 2015 Benchmarking

Items at Low International Benchmark (400)

Biology	
S13_01	States one reason why male penguins' incubation behavior helps their eggs survive (1 of 2 points)
S14_01A	Uses a food web to identify which organisms are producers
S14_01B	Uses a food web to identify which organisms eat only plants
Chemistry	
S07_06	Recognizes a material that best conducts both heat and electricity
Physics	
S12_15	Recognizes whether an electromagnet would attract objects made of various materials (1 of 2 points)
Earth Science	
S03_12A	Using a diagram, identifies what moves water from an artesian basin to the surface

Items at Intermediate International Benchmark (475)

Biology	
S02_03	Explains the advantage for a species of mice to have color matching its environment
S03_02	Matches 2 of 4 animal groups to their characteristic features (1 of 2 points)
S04_03	Recognizes characteristics inherited by rabbits in a given context
S04_04	Justifies an advantage of hollow bones for birds
S05_01	Identifies how vaccination helps prevent illnesses
S05_05A	Interprets information in a table to describe how the populations of two organisms changed over time
S06_01	Recognizes a living thing that has growth rings
S06_04	Recognizes from a list of foods which is the best source of calcium
S06_05A	Identifies why fish eat mosquito larvae but not adult mosquitos
S07_01	Recognizes an organism that is a producer

S07_05C	Identifies an advantage for a species of butterfly to resemble another species that is toxic to birds
S09_02	Analyzes information about an ecosystem and explains the effect of introducing a new population
S09_03B	Reasons how a crocodile's angle of vision helps it to survive in the environment
S10_01	Recognizes the process in the water cycle indicated in a diagram of an ecosystem
S10_02	States one substance plants obtain from their environment and use in photosynthesis (1 of 2 points)
S11_01A	Recognizes the agent that causes influenza
S12_04	Describes one characteristic of mammals that is advantageous for survival in cold weather (1 of 2 points)
S13_05	For pairs of animals, distinguishes between predatory and competitive relationships
S14_04	Recognizes the functions of 2 of 4 tissues found in the human stomach (1 of 2 points)
Chemistry	
S07_04	Uses information from an investigation to recognize the condition under which nails would rust most
S08_01	Recognizes a chemical process that involves the absorption of light
S11_07	Recognizes an everyday occurrence that is an example of a chemical change
S13_07	Applies knowledge of concentration to explain why one solution is paler than another solution
Physics	
S01_10A	Given a diagram showing a ball being thrown upwards, states the force that causes the ball to fall
S02_11	Uses information in a graph to recognize the motion of an object at five time points
S03_11	Recognizes the placement of a fulcrum that requires the least amount of force to move an object
S05_06	Recognizes the form of energy in a compressed spring
S08_09	Recognizes the type of energy change that occurs as a child slides down a slide
S14_06	Relates knowledge of density to indicate the order in which three liquids will settle after being poured in a beaker
Earth Science	
S02_01	Recognizes whether 4 of 5 effects are a benefits of recycling paper (1 of 2 points)
S02_12	Recognizes a possible result of Earth's continents moving
S02_13	Describes one thing being done by car-makers to reduce air pollution (1 of 2 points)

S05_09	Recognizes a gas that is increasing in Earth's atmosphere
S06_14	Uses a diagram to state one advantage of a plant having roots that reach the subsoil (1 of 2 points)
S07_14	Recognizes an effect of Earth rotating on its axis
S13_11A	Uses information in a table with characteristics of planets to identify the planet with the shortest day length
S13_12	Recognizes the reason for cold temperatures outside an airplane in flight
S14_15	Synthesizes information in rainfall and temperature graphs to match 2 of 4 animals with the climate where they live (1 of 2 points)

Items at High International Benchmark (550)

Biology

S01_02	Classifies 6 of 7 animals into two groups, based on a stated physical or behavioral characteristic (1 of 2 points)
S01_04A	Indicates in a table which gas is released into the air and which gas is removed from the air during animal respiration
S01_04C	Indicates in a table which gas is released into the air and which gas is removed from the air during photosynthesis
S02_02	Recognizes the group to which an animal belongs given some of its features
S02_04A	Predicts the change in the amounts of two gases in the air as a result of an experiment on photosynthesis
S02_04B	Identifies 1 of 2 factors other than light intensity that could affect the rate of photosynthesis in an investigation (1 of 2 points)
S04_01	Recognizes what happens to an animal's cells as it grows
S04_02	Recognizes 2 of 3 major organs in a diagram (1 of 2 points)
S05_02	Explains why birds of prey cannot survive in an environment without plants
S05_05B	Draws a conclusion from population data in a table and gives a possible explanation for a change in population
S06_02	Identifies why birds puff up their feathers in cold weather
S06_06	Identifies parts of the human body as organ systems
S08_05	Selects and classifies 3 of 4 foods from a list that comprise a balanced diet (1 of 2 points)
S08_06A	Evaluates data from a table to draw a conclusion about the reason for a change in population of a species
S09_01	Recognizes which food is the best source of carbohydrates
S10_03	Recognizes why rabbits inherit traits that their parents do not have

S10_04A	Identifies one way that plant and animal cells are similar (1 of 2 points)
S11_02	Interprets a diagram to identify what happens to biceps and triceps when an elbow bends
S11_03	Recognizes a human characteristic that is acquired
S11_04	Explains how flooding leads to a shortage of drinking water or the spread of disease (1 of 2 points)
S12_01	Recognizes a list of food that comprises a healthy, balanced meal
S12_02	Explains why it is unlikely for someone to get sick with the measles a second time
S12_03	Identifies the conclusion best supported by a diagram of rock layers with embedded fossils
S12_04	Describes two characteristics of mammals that are advantageous for survival in cold weather (2 of 2 points)
S13_02	Recognizes an organism that is made up of cells with cell walls
S13_03	Recognizes how decomposers get their energy
S13_04	Given a food chain, explains which organism competes most with humans in a farming community
S14_02	Explains how a fossil can be classified as plant or animal, based on its cellular structure
S14_03	Predicts how heart rate changes in response to exercise, based on a set of given conditions
Chemistry	
S03_05	Recognizes a property of most nonmetals
S05_08B	In the context of an investigation about the gold content of jewelry, selects information from a table of properties of gold alloys to complete a table relating the density of alloys to number of carats and percentage of gold in each piece of jewelry
S05_08C	In the context of an investigation about the gold content of jewelry, uses previously selected information and follows an example to calculate the mass of gold in jewelry
S06_07	From a table of melting and boiling points of three substances, identifies the state of each substance at a given temperature
S06_08	Given two proposed methods for separating a mixture of small pieces of two metals, identifies which method will work or why the other method will not work (1 of 2 points)
S06_09	Recognizes an everyday activity that is a chemical process that releases energy
S07_08	Identifies and explains which solution is more dilute than another in a given context
S08_02	Recognizes a model of a carbon dioxide molecule
S09_06	Recognizes and explains which substance will float on water using a table of densities
S09_08	Recognizes which process makes bronze dark and dull over time

S10_10	Recognizes which model best illustrates the results of a chemical reaction
S11_05	From a list of symbols and formulas, recognizes which are elements and which are compounds
S11_10	Explains the effect of temperature on diffusion in the context of an investigation
S12_06	Identifies the number of atoms of each element in nitric acid
S12_07	Use data in a table to order set-ups according to the rate at which a solute will dissolve in water
S14_11	Explains whether a reaction between two solutions in a given context can occur a second time
Physics	
S01_07	Recognizes the pathway of light required for an object to be seen
S01_08	Recognizes an everyday object most likely to be used as a lever
S02_09	Explains whether a conclusion can be made about the relative strengths of two magnets in a given context
S04_05	Relates knowledge of heat transfer to recognize a graph that shows how two substances eventually reach temperature equilibrium
S05_12	Explains that there are forces acting on students sitting on a wall
S06_10	Recognizes the orientation of a hidden mirror given rays of light reflecting
S07_07	Uses a table showing the speed of sound through different media and knowledge of the state of each medium to recognize a conclusion that may be drawn about the relative speed of sound
S07_09	Recognizes why a helium balloon rises into the air
S07_12	Explains why lightning is seen before thunder is heard during an electrical storm
S09_10	Given the densities of two objects and three liquids, and diagrams showing the objects floating or sinking in the liquids, identifies each liquid
S10_07	Recognizes which graph represents a musical note with given specifications for volume and pitch
S10_08	Recognizes a free-body diagram that has a total force acting towards the right
S11_09	Recognizes how to increase the strength of an electromagnet
S12_14	Recognizes the type of energy transformation that occurs when a car begins to move from rest
S13_09B	Explains that in a parallel arrangement of two bulbs, one bulb failing does not affect the other bulb
S13_10	Recognizes the best explanation of why two bar magnets repel each other
Earth Science	
S01_14	Recognizes a consequence of the gravitational pull of the Moon on Earth

S04_13	Identifies a disadvantage of using solar energy
S04_14A	Recognizes the process that forms rock layers
S05_13	Matches each of four processes that take place in the water cycle with the description of the process
S06_13	Recognizes a non-renewable energy source
S07_13	Describes a cause of earthquakes
S08_11	Recognizes a major source of water for desalinization plants
S08_13	Uses a diagram of a mountain range on the ocean and a given wind direction to recognize which location will have the greatest rainfall
S09_13	Uses a graph of average monthly temperature to identify the city most likely to be located at the equator
S10_12	Describes one geographic factor to consider when selecting a safe location for a nuclear power plant
S10_13A	Relates information in temperature graphs and maps to recognize climatic attributes of two cities
S11_12	Recognizes the source of energy for the water cycle
S12_11A	Interprets information in a climate graph to determine the warmest and driest month of the year
S14_13	Identifies how the melting of permafrost can affect the Earth's climate
S14_14	Recognizes sources of fresh and salt water in a diagram
S14_15	Synthesizes information in rainfall and temperature graphs to match 4 of 4 animals with the climates where they live (2 of 2 points)

Items at Advanced International Benchmark (625)

Biology	
S01_01	Identifies a function shared by lungs, skin, and kidneys
S01_02	Classifies 7 of 7 animals into two groups based on a stated physical or behavioral characteristics (2 of 2 points)
S01_03	Recognizes which organelle produces energy for the cell
S01_05	Designs an investigation to find out how fertilizer affects plant growth using equipment shown in a diagram
S03_01	Recognizes the function of shivering
S03_03B	In the context of an investigation about cellular respiration, identifies the gas produced and its source
S03_04	Explains why offspring are unlikely to have traits dissimilar to their parents

S05_03	Recognizes a function of the cell membrane
S05_04	Recognizes an explanation for a change over time in a physical characteristic of an organism
S06_03	Identifies the best conclusion supported by a diagram of limbs from different animals
S06_05B	Predicts the consequence for a prey population of increasing a predator population in a pond ecosystem
S07_02	Recognizes an example of asexual reproduction and describes the characteristics of asexual reproduction
S07_03	Identifies an organism in which gases are exchanged through the skin
S07_05B	Identifies and explains the stage of the life cycle during which a butterfly develops
S08_04	Applies knowledge about the theory of evolution to identify the best conclusion supported by a diagram of limbs from different animals
S08_05	Selects and classifies 4 of 4 foods from a list that comprise a balanced diet (2 of 2 points)
S08_06B	Selects and evaluates data from a table to draw a conclusion about the likely reason for a change in population of a species
S09_03A	Justifies a statement about crocodiles' adaptation to their environment, based on given facts
S09_04	States one similarity between the life cycles of a bird and a frog
S09_05	Identifies an explanation for disappearance of a trait over generations
S10_04A	Identifies two ways that plant and animal cells are similar (2 of 2 points)
S10_04B	States one way that plant and animal cells are different (1 of 2 points)
S12_05	Recognizes an example of a symbiotic relationship between two organisms
S13_01	States two reasons why male penguins' incubation behavior helps their eggs survive (2 of 2 points)
S14_04	Recognizes the functions of 4 of 4 tissues found in the human stomach (2 of 2 points)
Chemistry	
S01_06	Recognizes a mixture
S02_05	Recognizes whether characteristics of substances are physical or chemical properties
S02_06	Recognizes a statement that best describes chemical reactions
S02_07	Determines the color that results after a pH indicator is added to four solutions based on information provided about the indicator
S03_06	Recognizes the reason for the difference in taste between distilled and drinking water
S04_08	Recognizes whether 4 of 5 substances are elements, compounds, or mixtures (1 of 2 points)

S04_10	Identifies and explains whether a described change is physical or chemical
S04_11	Explains whether a reaction took place after a pH indicator is added to a solution based on information provided about the indicator
S05_08A	In the context of an investigation about the gold content of jewelry, describes the measurements to be taken using a graduated cylinder and water to find the volume of the jewelry
S07_10	Applies knowledge of conservation of mass during a neutralization reaction to explain what happens to mass when new substances are formed
S07_11	Applies knowledge of density to explain why oil floats on water
S08_03	Applies knowledge of density to identify and explain which liquid will leave a dropper first after a mixture separates
S09_07	Recognizes a property that is common to both acids and bases
S10_09	Explains the difference between a solid and air in terms of particle spacing in context
S10_11	Recognizes what happens to the atoms in an object pounded flat
S11_06	Identifies an element as a metal or a nonmetal, based on a list of physical properties and predicts one additional property
S13_06	Given their chemical formulas, recognizes a compound with the same number of atoms as another compound
S13_08	Recognizes an everyday process that is an example of a physical change
Physics	
S01_09	Applies knowledge of expansion of water during freezing to explain why a bottle full of water cracked when it was left in a freezer
S01_12	Applies knowledge of thermal conductivity to explain why ice will stay frozen in a wooden container longer than in a metal container
S02_10	Explains whether one person can see another person in a practical problem involving reflection of light from plane mirrors
S03_08	Given two unknown samples and using knowledge that only gases fill the available space, recognizes a statement about the spacing of particles in the samples
S03_09	Recognizes the relative temperatures of the outside surfaces of containers made of materials with different thermal properties
S04_06	Explains why a vehicle with tires is more likely to sink in the mud than a vehicle with treads
S04_07	Recognizes an explanation for why a ball appears a certain color in a given context
S05_07	Interprets a diagram to describe the direction of heat flow in metals
S05_11	Describes a way to distinguish between fresh water and salt water, using two hot plates and without using a thermometer
S06_12	Explains why one orientation of a rectangular block exerts the greatest pressure on the ground
S08_07	Recognizes which property of sound allows animals to navigate and find food

S08_10	Identifies and explains which of three methods will require the smallest force to move a heavy box onto a truck
S09_09	Recognizes why gases are easier to compress than solids and liquids
S10_06	Uses a diagram to explain one way to increase the strength of an electromagnet
S11_08	Recognizes the property of a gas in a dented ping pong ball that stays constant if the ball is heated
S11_11	Applies knowledge about the relationship between depth and water pressure to recognize a conclusion about the pressure at different depths
S12_13	Draws a conclusion about the states of substances in two pistons, based on the different amounts of compression that occurred
S13_09A	States one reason why a bulb in a diagram of an electrical circuit does not light
S13_09C	Recognizes a correct statement about battery life and bulb brightness in two given electrical circuits
S14_07	Recognizes whether a red object will absorb or reflect different colors of light
S14_08	Indicates whether parts of a light bulb are electrical conductors or insulators
Earth Science	
S02_01	Recognizes whether each of five effects is a benefit of recycling paper (2 of 2 points)
S02_14	From diagrams involving the Earth, Moon, and Sun, identifies the one that explains the changing seasons
S03_12B	Identifies the cause of decreasing water flow in an artesian well over time
S03_12C	Explains why water from an artesian well can be hot
S05_14	Recognizes what causes the moon to appear to change shape
S06_14	Uses a diagram to state two advantages of a plant having roots that reach into the subsoil (2 of 2 points)
S06_15	Explains whether an object's weight is less on the Moon than on the Earth
S07_15	Recognizes how a shadow changes throughout the day
S07_16	Draws an arrow on a map to show the direction a river flows and explains why it flows in this direction
S09_12	States one condition below Earth's crust that can be inferred from volcanic eruptions
S09_14	Identifies an explanation for why a constellation visible one night is no longer visible six months later
S11_13	Explains one way trees protect soil from erosion
S11_14	Justifies a claim that the Moon travels around the Sun
S12_09	Recognizes how oil is formed on Earth

S13_11B	Synthesizes information from tables about revolution times around and distances from the Sun to infer relative distances of planets from the Sun
S14_12	Recognizes a negative effect that fertilizer can have on the environment

Items Above the Advanced International Benchmark (625)

Biology	
S01_04B	Indicates in a table which gas is released into the air and which gas is removed from the air during plant respiration
S02_04B	Identifies two factors other than light intensity that could affect the rate of photosynthesis in an investigation (2 of 2 points)
S03_02	Matches 4 of 4 animal groups to their characteristic features (2 of 2 points)
S03_03A	In the context of an investigation about cellular respiration, interprets the role of parts of an experimental set-up to provide a controlled condition
S04_02	Recognizes 3 of 3 major organs in a diagram (2 of 2 points)
S07_05A	Identifies and explains the stage of the life cycle in which a butterfly grows
S08_06C	Predicts which species would best survive in a given environment, using information in a table, and provides a supporting explanation
S10_02	States two substances plants obtain from their environment and use in photosynthesis (2 of 2 points)
S10_04B	States two ways that plant and animal cells are different (2 of 2 points)
S11_01B	Explains how influenza can be spread rapidly around the world
S11_04	Explains how flooding leads to a shortage of drinking water and the spread of disease (2 of 2 points)
Chemistry	
S03_07	Recognizes whether everyday liquids will neutralize a base
S04_08	Recognizes whether each of five substances is an element, a compound, or a mixture (2 of 2 points)
S06_08	Given two proposed methods for separating a mixture of small pieces of two metals, identifies which method will work and explains why it will work and why the other method will not work (2 of 2 points)
S12_08	Recognizes a property of a basic solution
S14_09	Explains how painting a metal prevents rust from forming
S14_10	Recognizes a true statement about neutral atoms
Physics	
S01_10B	Recognizes that a falling ball will not bounce as high as the point from which it fell and explains why

S01_11	Calculates resistance from current and voltage
S02_08	Interprets a diagram showing heat transfer to recognize the relative temperatures of two blocks in water
S03_10	From a diagram of an object floating in different liquids, explains that the portion of the object which is submerged depends on the density of the liquid
S04_09	Explains how a substance can be in two different states in a container at one time in a given context
S05_10	Recognizes what happens to the mass and volume of water when it freezes
S06_11	Recognizes the correct statement about the relative motion of an object seen from two frames of reference
S08_08	Recognizes how the temperature of water changes over time when heated
S10_05	Recognizes how the mass of a metal ball will change as it cools down
Earth Science	
S02_13	Describes two things being done by car-makers to reduce air pollution (2 of 2 points)
S04_12	Recognizes the gas that makes up most of Earth's atmosphere
S04_14B	Given a diagram, explains a process that shaped a rock formation in the ocean
S10_13B	Synthesizes information in temperature graphs and maps to recognize an explanation for the difference in seasonal climates of two cities at similar latitudes
S12_10	Recognizes the relative composition of gases in Earth's atmosphere
S12_11B	Evaluates a conclusion about climate data, based on one week of weather observations