TIMSS 2023 Mathematics Framework

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Overview

- Improved assessment of the reasoning cognitive processes by relegating some procedural and secondary calculation tasks to the computer, allowing students to focus on strategy and mathematical thinking.
- Process data associated with students' response patterns that can be used to learn more about students' problem solving strategies, misconceptions, and approaches to test taking.
- Enrichment of the overall testing display and response formats, helping to improve students' engagement and motivation to participate in TIMSS.

Expectations for a Range of Problem Solving Contexts

Previous TIMSS Mathematics frameworks have not been clear about the degree of emphasis that should

Number	50%
Measurement and Geometry	30%
Data	20%

Number	30%
Algebra	30%
Geometry and Measurement	20%
Data and Probability	20%

Knowing	40%	35%
Applying	40%	40%
Reasoning	20%	25%

The content domains differ for the fourth and eighth grades, reflecting the mathematics widely taught at each grade. There is more emphasis on number at the fourth grade than at the eighth grade. Algebra becomes a topic of its own in eighth grade, whereas the introductory algebraic topics assessed at the fourth grade are included in the number topic area. The eighth grade geometry domain includes measurement but also a deeper inclusion of purely geometric topics. The fourth grade data domain focuses on reading, representing, and interpreting data, whereas at the eighth grade it includes more

Mathematics Content Domains—Fourth Grade

Exhibit 1.2 shows the TIMSS 2023 Mathematics—Fourth Grade content domains and the target percentages of assessment score points devoted to each. Each content domain consists of topic areas, and each topic area in turn includes several topics. Across the fourth grade mathematics assessment, each topic receives approximately equal weight.

3. Multiply (up to 3-digit by 1-digit and 2-digit by 2-digit numbers) and divide (up to 3-digit by 1-digit numbers).

4. Solve problems involving odd and even numbers, multiples and factors of numbers, rounding numbers (up to the nearest powers of 10), and making estimates.

5. Combine two or more properties of numbers or oper 620.415iervi37tve probles.

1. Measure, estimate, add, and subtract lengths (millimeters, centimeters, meters, kilometers).
2. Add and subtract mass (gram and kilogram), volume (milliliter and liter), and time (minutes and hours); select appropriate types and sizes of units and read scales.
3. Determine perimeters of polygons, areas of rectangles, areas of shapes covered with squares or

Mathematics Content Domains—Eighth Grade

Exhibit 1.3 shows the TIMSS 2023 Mathematics—Eighth Grade content domains and the target percentages of assessment score points devoted to each. Each content domain consists of topic areas, and each topic area in turn includes several topics. Across the eighth grade mathematics assessment, each topic receives approximately equal weight.

Number	30%
Algebra	30%
Geometry and Measurement	20%
Data and Probability	20%

As with fourth grade mathematics, each of the following topics within each content area at the eighth grade can be assessed by items measuring the knowing, applying, or reasoning cognitive domains as appropriate. Also, the items covering the topics in a content domain are expected to be situated in a range of contexts. At least 15 percent should be presented without context, and the remaining should range from straightforward problem solving situations to the complex extended scenarios in the PSIs.

Number

At the eighth grade, the 30 percent of the assessment devoted to number consists of three topic areas:

- Integers (10%)
- Fractions and decimals (10%)
- Proportions, ratios, and percentages (10%)

Building on the number content domain at the fourth grade, eighth grade students should have developed proficiency with more advanced whole number concepts and procedures as well as extended their mathematical understanding of rational numbers (integers, fractions, and decimals). Students also should understand and be able to compute with integers. Fractions and decimals are an important part of dail ann(um)9.9TETEMC /P ksn30um

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2. Interpret, relate, and generate representations of simple non-linear functions (e.g., quadratic) in tables, graphs, or words; generalize linear and non-linear pattern relationships or sequences, using words, or algebraic expressions.

Geometry and Measurement

The geometry and measurement content domain at the eighth grade consists of one topic area:

- Geometry and Measurement (20%)

Extending the understanding of shapes and measures assessed at the fourth grade, eighth grade

1. Interpret data from one or more sources (e.g., interpolate and extrapolate, make comparisons, draw conclusions).
2. Organize and represent data to help answer questions. Representations include all those at fourth grade (tables, pictographs, bar graphs, line graphs, and pie charts) and in addition, histograms, dot plots, scatter plots, clustered and stacked bar charts, and infographics.
3. Summarize data distributions; calculate, use, or interpret mean and median; recognize the effect of spread and outliers.

1. For simple and compound events: determine theoretical probability (based on proportions of favorable outcomes, e.g., rolling a fair die or drawing marbles of a particular color from a bag); estimate empirical probability (based on experimental outcomes).

Calculator Use at the Eighth Grade

At the eighth grade, students will be permitted to use the TIMSS on-screen calculator. This calculator has the four basic functions (+, −, ×, ÷), a square root key, and the negative sign. Students will not be permitted to bring their own calculators. On the whole the mathematics items are developed to be calculator neutral and do not advantage or disadvantage students whether or not they use calculators. A notable exception is the (very few) items that require the taking of a square root.

Mathematics Cognitive Domains—Fourth and Eighth Grades

In order to respond correctly to TIMSS test items, students need to be familiar with the mathematics content being assessed, but they also need to draw on a range of cognitive skills. These include the ability to select and carry out procedures, apply knowledge to solve problems, make logical deductions, and give reasons for an assertion. Describing these skills plays a crucial role in the development of an assessment like TIMSS 2023, ensuring that the survey covers the appropriate range of cognitive skills across the content domains already outlined.

The first domain, *knowing*, covers the facts, concepts, and procedures students need to know, while the second, *applying*, focuses on the ability of students to apply knowledge and conceptual understanding in a range of situations. The third domain, *reasoning*, involves the logical, systematic thinking that students need to use to generate and justify solutions to problems, make inferences, and deal with complex relationships between mathematical objects.

Knowing, applying, and reasoning are exercised in varying degrees when students display their mathematical competency, which goes beyond content knowledge. These TIMSS cognitive domains encompass the competencies of providing a mathematical argument to support a strategy or solution,

representing a situation mathematically (e.g., using symbols and graphs), creating mathematical models of a problem situation, and using tools such as a ruler or a calculator.

The three cognitive domains are used for both grades, with each item categorized into one of the three domains. Reflecting the diffeciuma5( )ʝ

	Recall definitions, terminology, number properties, units of measurement, geometric properties, and notation (e.g., a × b = ab, a + a + a = 3a).
	Identify numbers, expressions, quantities, and shapes. Recognize when

mathematics education, with the potential to influence learners' thinking more generally. For example, reasoning involves the ability to observe and make conjectures. It also involves making logical deductions based on specific assumptions and rules, and justifying results.

	Analyze, describe, or use relationships among numbers, expressions, quantities, and shapes.
	Link different elements of knowledge, related representations, and procedures.
	Make statements that represent relationships in more general and more widely applicable terms.
	Provide mathematical arguments to support a strategy or solution.

References

1   Kelly, D.L., Centurino, V., Martin, M.0., & Mullis, I.V. S. (Eds.) (2020). *TIMSS 2019 encyclopedia: Education policy and curriculum in mathematics and science*. Retrieved from Boston College, TIMSS & PIRLS International Student Center website: http://timssandpirls.bc.edu/timss2019/encyclopedia/