

Mathematical Problems Stated and Solved

Nations Reporting Data: Australia, the Czech Republic, Hong Kong SAR, Japan, the Netherlands, and the United States

The Third International Mathematics and Science Study (TIMSS) 1999 Video Study examined classroom teaching practices through in-depth analysis of videotapes of eighth-grade mathematics and science lessons in Australia, the Czech Republic, Hong Kong SAR, Japan, the Netherlands, Switzerland,¹ and the United States. This study looks at all problems presented during the mathematics lessons (about 15,000 problems were analyzed in the study) and computes the percentage of given problems per lesson. The problem statements and mathematical processes identified in the study are defined in the *Definition and Methodology* section of this indicator.

In all reporting nations except Japan, at least 57 percent of the problem statements per eighth-grade mathematics lesson focused on using procedures (figure 1). Hong Kong SAR lessons contained a larger percentage of problem statements classified as using procedures (84 percent) than all the other nations except the Czech Republic. Although mathematics lessons in all the nations included problem statements that focused on making connections, the lessons from Japan contained a larger percentage of these problems (54 percent) than Australia, the Czech Republic, Hong Kong SAR, and the United States (range from 13 to 17 percent).

A key aspect of this analysis involved following each problem from its introduction through the problem statement to its conclusion as the solution was stated publicly. A key question was whether the same kinds of mathematical processes implied by the problem statement were made explicit when solving the problem or whether the nature of the processes changed as the problem was being solved and discussed publicly.

In Australia, the Czech Republic, and the United States, 33 to 36 percent of problems per eighth-grade mathematics lesson, on average, were completed by giving results only (meaning that the public work consisted solely of stating the answer to the problem without any discussion of how or why it was attained) (figure 2). These were larger percentages than those found in the other three nations. Giving results only occurred least frequently in Japanese lessons. Using procedures ranged from 27 to 55 percent of problems per lesson across all nations, and was found for a higher percentage of problems in the United States than in the Czech Republic, Japan, and the Netherlands. From 8 to 33 percent of problems per lesson were solved and discussed publicly by stating concepts, with the smallest percentage occurring in the United States. A higher percentage of problems per lesson were solved publicly through making connections in Japanese lessons (37 percent) than in Australia, the Czech Republic, Hong Kong SAR, and the United States (range from 1 to 12 percent). Australian and U.S. lessons contained the smallest percentages of problems implemented as making connections (2 percent and 1 percent of problems per lesson, respectively).

¹ Switzerland was not included in this analysis because English transcripts were not available for all lessons as some of the coding was conducted in Switzerland

Definition and Methodology

The three types of problem statements were defined as follows:

Using procedures: Problem statements that suggested the problem was typically solved by applying a procedure or set of procedures.

Stating concepts: Problem statements that called for a mathematical convention or an example of a mathematical concept.

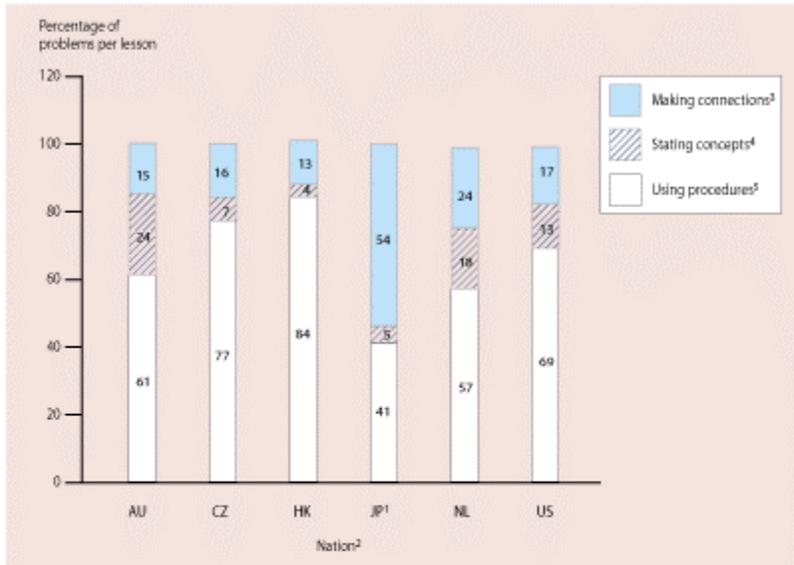
Making connections: Problem statements that implied the problem would focus on constructing relationships among mathematical ideas, facts, or procedures. Often, the problem statement suggested that students would engage in special forms of mathematical reasoning such as conjecturing, generalizing, and verifying.

Categories of mathematical processes for solving problems were the three types of processes defined for problem statements plus an additional category defined as follows:

Giving results only: The public work consisted solely of stating an answer to the problem without any discussion of how or why it was attained.

For convenience, Hong Kong SAR is referred to as a nation. Hong Kong is a Special Administrative Region (SAR) of the People's Republic of China.

Figure 1. Average percentage of problems per eighth-grade mathematics lesson of each problem statement type, by nation: 1999



¹Japanese mathematics data were collected in 1995.

²AU=Australia; CZ=Czech Republic; HK=Hong Kong SAR; JP=Japan; NL=Netherlands; and US=United States.

³Making connections: JP>AU, CZ, HK, US.

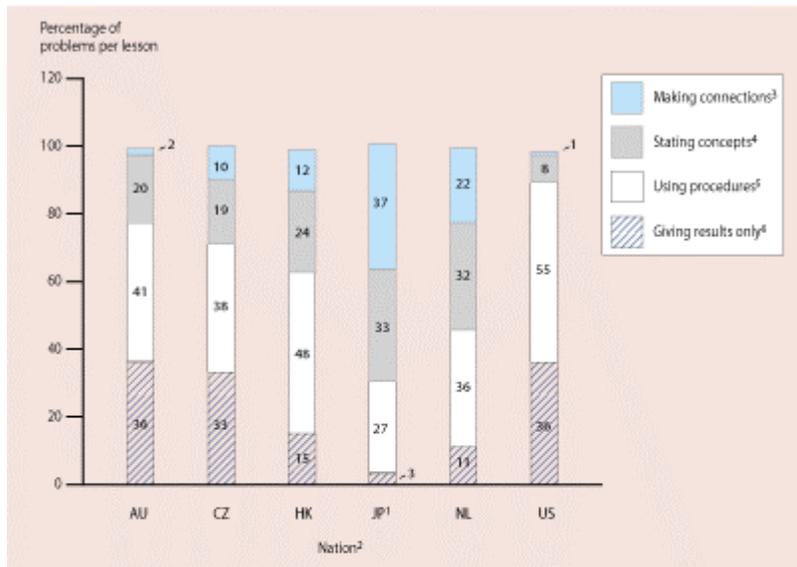
⁴Stating concepts: AU>CZ, HK, JP, NL, US>HK, JP.

⁵Using procedures: CZ>JP, NL; HK>AU, JP, NL, US; US>JP.

NOTE: Analyses do not include answered-only problems (i.e., problems that were completed prior to the videotaped lesson and only their answers were shared). For each nation, average percentage was calculated as the sum of the percentage within each lesson, divided by the number of lessons. English transcriptions of Swiss lessons were not available for mathematical processes analyses. Significance tests adjusted for multiple comparisons. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study (TIMSS), Video Study, 1999.

Figure 2. Average percentage of problems per eighth-grade mathematics lesson solved by explicitly using processes of each type, by nation: 1999



¹Japanese mathematics data were collected in 1995.

²AU=Australia; CZ=Czech Republic; HK=Hong Kong SAR; JP=Japan; NL=Netherlands; and US=United States.

³Making connections: CZ, HK, NL>AU, US; JP>AU, CZ, HK, US.

⁴Stating concepts: AU, CZ, HK, JP>US; NL>CZ, US.

⁵Using procedures: HK>JP; US>CZ, JP, NL.

⁶Giving results only: AU, CZ, US>HK, JP, NL; HK, NL>JP.

NOTE: Analyses only include problems with a publicly presented solution. Analyses do not include answered-only problems (i.e., problems that were completed prior to the videotaped lesson and only their answers were shared). For each nation, average percentage was calculated as the sum of the percentage within each lesson, divided by the number of lessons. English transcriptions of Swiss lessons were not available for mathematical processes analyses. Significance tests adjusted for multiple comparisons. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study (TIMSS), Video Study, 1999.

Table A-1. Average percentage of problems per eighth-grade mathematics lesson of each problem statement type, by nation: 1999

Nation ²	Making connections ³		Stating concepts ⁴		Using procedures ⁵	
	Percentage	S.e.	Percentage	S.e.	Percentage	S.e.
Australia	15	2.7	24	4.1	61	5.3
Czech Republic	16	2.5	7	1.8	77	3.1
Hong Kong	13	2.6	4	0.8	84	2.7
Japan ¹	54	8.3	5	1.6	41	8.3
Netherlands	24	5.1	18	3.7	57	5.7
United States	17	2.9	13	2.1	69	3.3

¹Japanese mathematics data were collected in 1995.

²AU=Australia; CZ=Czech Republic; HK=Hong Kong SAR; JP=Japan; NL=Netherlands; and US=United States.

³Making connections: JP>AU, CZ, HK, US.

⁴Stating concepts: AU>CZ, HK, JP; NL, US>HK, JP.

⁵Using procedures: CZ>JP, NL; HK>AU, JP, NL, US; US>JP.

NOTE: Analyses do not include answered-only problems (i.e., problems that were completed prior to the videotaped lesson and only their answers were shared). For each nation, average percentage was calculated as the sum of the percentage within each lesson, divided by the number of lessons. English transcriptions of Swiss lessons were not available for mathematical processes analyses. Significance tests adjusted for multiple comparisons. Detail may not sum to totals because of rounding. S.e. means standard error.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study (TIMSS), Video Study, 1999.

Table A-2. Average percentage of problems per eighth-grade mathematics lesson solved by explicitly using processes of each type, by nation: 1999

Nation ²	Making connections ³		Stating concepts ⁴		Using procedures ⁵		Giving results only ⁶	
	Percentage	S.e.	Percentage	S.e.	Percentage	Se	Percentage	S.e.
Australia	2	0.8	20	3.1	41	5.0	38	5.6
Czech Republic	10	1.4	19	1.9	38	2.2	33	2.4
Hong Kong	12	2.0	24	1.8	48	2.9	15	2.3
Japan ¹	37	3.4	33	4.8	27	3.9	3	1.3
Netherlands	22	4.8	32	4.0	38	4.2	11	2.0
United States	1	0.5	8	1.1	55	3.1	38	3.1

¹Japanese mathematics data were collected in 1995.

²AU=Australia; CZ=Czech Republic; HK=Hong Kong SAR; JP=Japan; NL=Netherlands; and US=United States.

³Making connections: CZ, HK, NL>AU, US; JP>AU, CZ, HK, US.

⁴Stating concepts: AU, CZ, HK, JP>US; NL>CZ, US.

⁵Using procedures: HK>JP; US>CZ, JP, NL.

⁶Giving results only: AU, CZ, US>HK, JP, NL; HK, NL>JP.

NOTE: Analyses only include problems with a publicly presented solution. Analyses do not include -answered only problems (i.e., problems that were completed prior to the videotaped lesson and only their answers were shared). For each nation, average percentage was calculated as the sum of the percentage within each lesson, divided by the number of lessons. English transcriptions of Swiss lessons were not available for mathematical processes analyses. Significance tests adjusted for multiple comparisons. Detail may not sum to totals because of rounding. S.e. means standard error.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study (TIMSS), Video Study, 1999.