

## CHAPTER 13

# Scaling the TIMSS 2015 Achievement Data

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### Overview

The TIMSS assessments cover a wide range of topics in mathematics and science across two grade levels. Given this broad coverage, a matrix-sampling booklet design is used such that each student is administered only a subset of the entire TIMSS mathematics and science item pools (see Chapter 4 of [TIMSS 2015 Assessment Frameworks](#)). Given the complexities of the data collection and the need to have student scores on the entirety of each assessment for analysis and reporting purposes, TIMSS relies on item response theory (IRT) scaling to describe student achievement and to provide accurate measures of trends. As each student responded to only a part of the assessment item pool, the TIMSS scaling approach uses multiple imputation—or plausible values—methodology to obtain proficiency scores in mathematics and science for all students. To enhance the reliability of the student scores, the TIMSS scaling approach uses conditioning, a process in which student responses to the items are combined with information about students' backgrounds.

This scaling chapter begins with a general description of the scaling approach and its use of plausible values. It then describes the concurrent calibration method used specifically to measure trends. Next, it explains how the proficiency scores are generated through the use of conditioning and describes the process of transforming the proficiency scores to place them on the metrics used to measure trends. A special section describes how the TIMSS Numeracy 2015 achievement data were scaled and placed on the TIMSS fourth grade mathematics reporting scale. A description of the technical details involved in the scaling can be found in [Chapter 12: TIMSS 2015 Achievement Scaling Methodology](#).

## Implementing the TIMSS Scaling Procedures

The application of IRT scaling and plausible values methodology to the data from the TIMSS assessments involves four major tasks: calibrating the achievement items (estimating model parameters for each item), creating principal components from the student questionnaire data for use in conditioning, generating proficiency scores for mathematics and science, and placing these proficiency scores on the metrics used to report trend results from previous assessments. TIMSS has separate scales for mathematics and science at both fourth and eighth grades. New for TIMSS 2015, the TIMSS Numeracy achievement results will be reported on the TIMSS fourth grade mathematics scale. The scaling procedures also generate proficiency scores for the domains of the overall subjects: the content and cognitive domains of mathematics and science.

## Linking Assessments Cycles with Concurrent Calibration

The metric of the TIMSS reporting scales for overall mathematics and science at each grade level were originally established in TIMSS 1995 by setting the mean of the national average scores for all countries that participated in TIMSS 1995 to 500 and the standard deviation to 100. To enable measurement of trends over time, achievement data from successive TIMSS assessments were transformed to these same metrics. This is done by concurrently scaling the data from each successive assessment with the data from the previous assessment—a process known as concurrent calibration—and applying linear transformations to place the results from each successive assessment on the same scale as the results from the previous assessment. This procedure enables TIMSS to measure trends across all six assessment cycles: 1995, 1999, 2003, 2007, 2011, and 2015.<sup>1</sup>

The first step in linking the assessments for trend scaling is to estimate (calibrate) the item parameters for the items in the current assessment through a concurrent calibration of the data from the current assessment and from the previous assessment. In 2015, the TIMSS concurrent calibration consisted of combining achievement data from the 2015 and 2011 assessments.

In linking successive assessments, concurrent calibration relies on having a large proportion of trend items, items that are retained from one assessment to the next. The TIMSS assessment consists of 14 mathematics item blocks and 14 science item blocks at each grade. In TIMSS 2015, 6 of the mathematics blocks and 6 of the science blocks consisted of newly developed items. The remaining 8 mathematics blocks and 8 science blocks were carried forward from the TIMSS 2011 assessment and are the basis for linking TIMSS 2015 to the TIMSS achievement scale and maintaining trends over time. Exhibits 13.1 through 13.4 list the number of items present for TIMSS concurrent calibration by item type and content and cognitive domain for both grades and subjects, respectively.

<sup>1</sup> See Mazzeo and von Davier (2014) for a discussion of the linking procedure used by TIMSS.

**Exhibit 13.1: TIMSS 2015 Mathematics Items for Concurrent Calibration at the Fourth Grade**

Item Type	Points	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
		Items	Points	Items	Points	Items	Points	Items	Points
Multiple-Choice	1	36	36	57	57	30	30	123	123
Constructed Response	1	31	31	42	42	31	31	104	104
	2	6	12	3	6	6	12	15	30
<b>Total</b>		<b>73</b>	<b>79</b>	<b>102</b>	<b>105</b>	<b>67</b>	<b>73</b>	<b>242</b>	<b>257</b>

**TIMSS 2015 Fourth Grade Mathematics Items for Concurrent Calibration by Content and Cognitive Domains**

Mathematics Content Domains	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
	Items	Points	Items	Points	Items	Points	Items	Points
Number	40	43	48	49	41	45	129	137
Geometric Shapes and Measures	24	27	37	38	19	21	80	86
Data Display	9	9	17	18	7	7	33	34

Mathematics Cognitive Domains	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
	Items	Points	Items	Points	Items	Points	Items	Points
Knowing	29	32	41	41	23	24	93	97
Applying	29	30	42	44	30	32	101	106
Reasoning	15	17	19	20	14	17	48	54
<b>Total</b>	<b>73</b>	<b>79</b>	<b>102</b>	<b>105</b>	<b>67</b>	<b>73</b>	<b>242</b>	<b>257</b>

**Exhibit 13.2: TIMSS 2015 Science Items for Concurrent Calibration at the Fourth Grade**

Item Type	Points	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
		Items	Points	Items	Points	Items	Points	Items	Points
Multiple-Choice	1	42	42	47	47	35	35	124	124
Constructed Response	1	25	25	40	40	34	34	99	99
	2	5	10	8	16	4	8	17	34
<b>Total</b>		<b>72</b>	<b>77</b>	<b>95</b>	<b>103</b>	<b>73</b>	<b>77</b>	<b>240</b>	<b>257</b>

**TIMSS 2015 Fourth Grade Science Items for Concurrent Calibration by Content and Cognitive Domains**

Science Content Domains	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
	Items	Points	Items	Points	Items	Points	Items	Points
Life Science	30	32	44	49	30	33	104	114
Physical Science	28	29	32	32	29	30	89	91
Earth Science	14	16	19	22	14	14	47	52

Science Cognitive Domains	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
	Items	Points	Items	Points	Items	Points	Items	Points
Knowing	30	34	38	41	29	32	97	107
Applying	31	32	39	42	27	28	97	102
Reasoning	11	11	18	20	17	17	46	48
<b>Total</b>	<b>72</b>	<b>77</b>	<b>95</b>	<b>103</b>	<b>73</b>	<b>77</b>	<b>240</b>	<b>257</b>

**Exhibit 13.3: TIMSS 2015 Mathematics Items for Concurrent Calibration at the Eighth Grade**

Item Type	Points	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
		Items	Points	Items	Points	Items	Points	Items	Points
Multiple-Choice	1	48	48	70	70	41	41	159	159
Constructed Response	1	30	30	52	52	34	34	116	116
	2	10	20	5	10	7	14	22	44
<b>Total</b>		<b>88</b>	<b>98</b>	<b>127</b>	<b>132</b>	<b>82</b>	<b>89</b>	<b>297</b>	<b>319</b>

**TIMSS 2015 Eighth Grade Mathematics Items for Concurrent Calibration by Content and Cognitive Domains**

Mathematics Content Domains	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
	Items	Points	Items	Points	Items	Points	Items	Points
Number	20	21	40	44	24	25	84	90
Algebra	30	35	40	41	21	22	91	98
Geometry	20	22	22	22	21	25	63	69
Data and Chance	18	20	25	25	16	17	59	62

Mathematics Cognitive Domains	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
	Items	Points	Items	Points	Items	Points	Items	Points
Knowing	34	36	45	45	24	24	103	105
Applying	30	34	54	57	40	44	124	135
Reasoning	24	28	28	30	18	21	70	79
<b>Total</b>	<b>88</b>	<b>98</b>	<b>127</b>	<b>132</b>	<b>82</b>	<b>89</b>	<b>297</b>	<b>319</b>

**Exhibit 13.4: TIMSS 2015 Science Items for Concurrent Calibration at the Eighth Grade**

Item Type	Points	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
		Items	Points	Items	Points	Items	Points	Items	Points
Multiple-Choice	1	46	46	63	63	43	43	152	152
Constructed Response	1	33	33	57	57	34	34	124	124
	2	11	22	6	12	12	24	29	58
<b>Total</b>		<b>90</b>	<b>101</b>	<b>126</b>	<b>132</b>	<b>89</b>	<b>101</b>	<b>305</b>	<b>334</b>

**TIMSS 2015 Eighth Grade Science Items for Concurrent Calibration by Content and Cognitive Domains**

Science Content Domains	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
	Items	Points	Items	Points	Items	Points	Items	Points
Biology	32	36	47	51	28	36	107	123
Chemistry	18	20	25	26	18	19	61	65
Physics	24	27	31	31	22	22	77	80
Earth Science	16	18	23	24	21	24	60	66

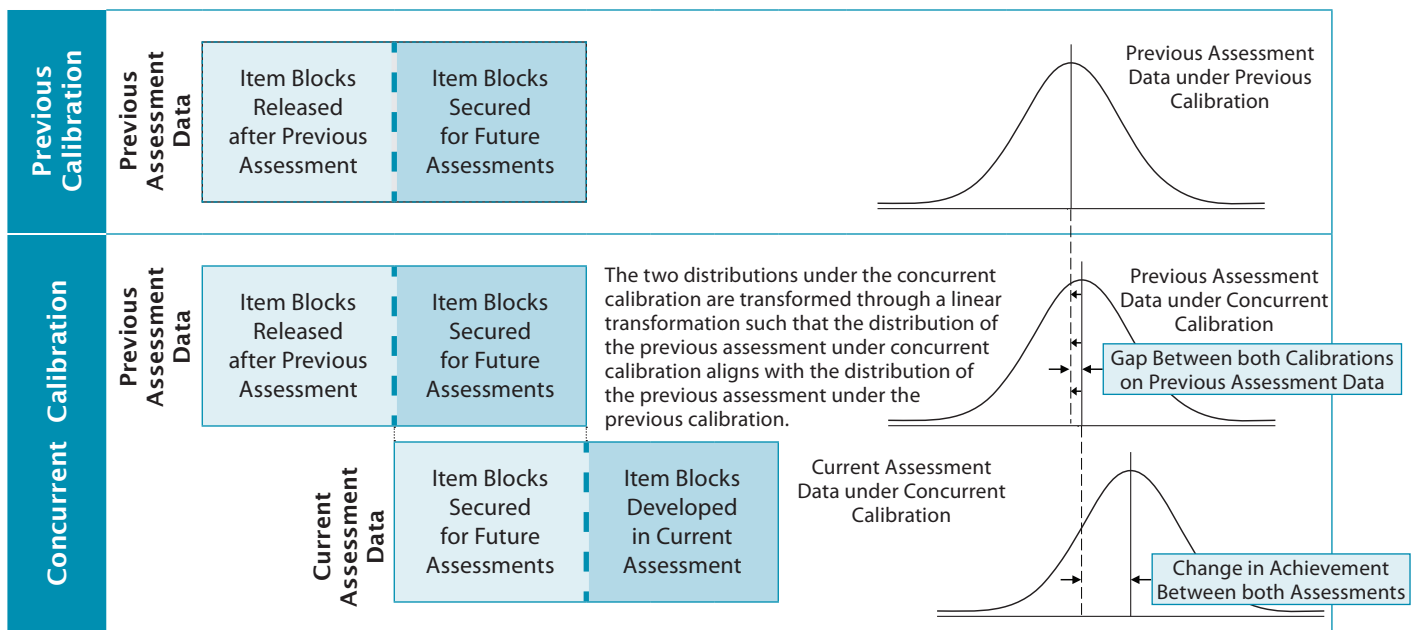
Science Cognitive Domains	Items Released in 2011		Items Common in 2011 and 2015		Items Introduced in 2015		Total	
	Items	Points	Items	Points	Items	Points	Items	Points
Knowing	33	35	40	41	35	42	108	118
Applying	35	43	56	59	32	35	123	137
Reasoning	22	23	30	32	22	24	74	79
<b>Total</b>	<b>90</b>	<b>101</b>	<b>126</b>	<b>132</b>	<b>89</b>	<b>101</b>	<b>305</b>	<b>334</b>

In concurrent calibration, item parameters for the current assessment are estimated based on the data from both the current and previous assessments, recognizing that some items (the trend items) are common to both. It is then possible to estimate the latent ability distributions of students in both assessments using the item parameters from the concurrent calibration. The difference between these two distributions is the change in achievement between the previous and current assessments.

After the calibration, the next step is to find a linear transformation that transforms the distribution of the previous assessment data under the concurrent calibration to match the distribution of these same data under the calibration that was done in the previous assessment. The final step entails applying this linear transformation to the current assessment data scaled using the concurrent calibration. This places the current assessment data on the trend scale.

Exhibit 13.5 illustrates how the concurrent calibration approach is applied in the context of TIMSS trend scaling. The gap between the distributions of the previous assessment data under the previous calibration and under the concurrent calibration is typically small and is the result of slight differences in the item parameter estimates from the two calibrations (Exhibit 13.5, second panel). The linear transformation removes this gap by shifting the two distributions from the concurrent calibration such that the distribution of the previous assessment data from the concurrent calibration aligns with the distribution of the previous assessment data from the previous calibration,<sup>2</sup> while preserving the gap between the previous and current assessment data under the concurrent calibration. This latter gap is the change in achievement between the previous and current assessments that TIMSS sets out to measure as trend.

**Exhibit 13.5: Concurrent Calibration Model Used for TIMSS**



## Calibrating the TIMSS 2015 Assessment Data

Item calibration was conducted by the TIMSS & PIRLS International Study Center using the commercially-available Parscale software (Muraki & Bock, 1991) and included data from the previous assessment (TIMSS 2011) and data from the 2015 assessment for countries that participated in both assessment cycles. The calibration used all available item response data from each country’s student samples and from both current and previous assessments. All student samples were weighted so that each country contributed equally to the item calibration. Exhibits 13.6 and 13.7 show the sample sizes for scaling the TIMSS 2015 data. A total of 41

<sup>2</sup> The difference between the ability distributions of the previous assessment data under the two calibrations is a measure of the linkage error in the trend scaling procedure.

countries from TIMSS 2015 contributed to the concurrent calibration at the fourth grade; 34 countries contributed at the eighth grade. Norway's data at the fourth and eighth grades were included in the concurrent calibrations.

**Exhibit 13.6: TIMSS 2015 Sample Sizes for Scaling the Fourth Grade Data**

Country	Concurrent Calibration		Proficiency Estimation	
	2015	2011	2015	2011
Australia	6,057	6,146	6,057	6,146
Bahrain	4,146	4,083	4,146	4,083
Belgium (Flemish)	5,404	4,849	5,404	4,849
Bulgaria	—	—	4,228	—
Canada	—	—	12,283	—
Chile	4,756	5,585	4,756	5,585
Chinese Taipei	4,291	4,284	4,291	4,284
Croatia	3,985	4,584	3,985	4,584
Cyprus	—	—	4,125	—
Czech Republic	5,202	4,578	5,202	4,578
Denmark	3,710	3,987	3,710	3,987
England	4,006	3,397	4,006	3,397
Finland	5,015	4,638	5,015	4,638
France	—	—	4,873	—
Georgia	3,919	4,799	3,919	4,799
Germany	3,948	3,995	3,948	3,995
Hong Kong SAR	3,600	3,957	3,600	3,957
Hungary	5,036	5,204	5,036	5,204
Indonesia	—	—	4,025	—
Iran, Islamic Rep. of	3,823	5,760	3,823	5,760
Ireland	4,344	4,560	4,344	4,560
Italy	4,373	4,200	4,373	4,200
Japan	4,383	4,411	4,383	4,411
Kazakhstan	4,702	4,382	4,702	4,382
Korea, Rep. of	4,669	4,334	4,669	4,334
Kuwait	2,397	4,142	3,593	4,142
Lithuania	2,837	4,688	4,529	4,688
Morocco	5,068	7,841	5,068	7,841
Netherlands	4,515	3,229	4,515	3,229
New Zealand	6,322	5,572	6,322	5,572



**Exhibit 13.6** TIMSS 2015 Sample Sizes for Scaling the Fourth Grade Data (Continued)

Country	Concurrent Calibration		Proficiency Estimation	
	2015	2011	2015	2011
Northern Ireland	3,116	3,571	3,116	3,571
Norway (5)	—	—	4,329	—
Oman	9,105	10,411	9,105	10,411
Poland	—	—	4,747	—
Portugal	4,693	4,042	4,693	4,042
Qatar	5,194	4,117	5,194	4,117
Russian Federation	4,921	4,467	4,921	4,467
Saudi Arabia	4,337	4,515	4,337	4,515
Serbia	4,036	4,379	4,036	4,379
Singapore	6,517	6,368	6,517	6,368
Slovak Republic	5,773	5,616	5,773	5,616
Slovenia	4,445	4,492	4,445	4,492
Spain	7,764	4,183	7,764	4,183
Sweden	4,142	4,663	4,142	4,663
Turkey	6,456	7,479	6,456	7,479
United Arab Emirates	21,177	14,720	21,177	14,720
United States	10,029	12,569	10,029	12,569
<b>Benchmarking Participants</b>				
Buenos Aires, Argentina	—	—	3,104	—
Ontario, Canada	—	—	4,574	—
Quebec, Canada	—	—	2,798	—
Norway (4)	4,164	3,121	4,164	3,121
Abu Dhabi, UAE	—	—	5,001	—
Dubai, UAE	—	—	7,453	—
Florida, US	—	—	2,025	—
<b>Total</b>	<b>216,377</b>	<b>215,918</b>	<b>288,305</b>	<b>215,918</b>

**Exhibit 13.7: TIMSS 2015 Sample Sizes for Scaling the Eighth Grade Data**

Country	Concurrent Calibration		Proficiency Estimation	
	2015	2011	2015	2011
Australia	10,338	7,556	10,338	7,556
Bahrain	4,918	4,640	4,918	4,640
Botswana (9)	5,964	5,400	5,964	5,400
Canada	—	—	8,757	—
Chile	4,849	5,835	4,849	5,835
Chinese Taipei	5,711	5,042	5,711	5,042
Egypt	—	—	7,822	—
England	4,814	3,842	4,814	3,842
Georgia	4,035	4,563	4,035	4,563
Hong Kong SAR	4,155	4,015	4,155	4,015
Hungary	4,893	5,178	4,893	5,178
Iran, Islamic Rep. of	6,130	6,029	6,130	6,029
Ireland	—	—	4,704	—
Israel	5,512	4,699	5,512	4,699
Italy	4,481	3,979	4,481	3,979
Japan	4,745	4,414	4,745	4,414
Jordan	7,865	7,694	7,865	7,694
Kazakhstan	4,887	4,390	4,887	4,390
Korea, Rep. of	5,309	5,166	5,309	5,166
Kuwait	—	—	4,503	—
Lebanon	3,873	3,974	3,873	3,974
Lithuania	2,933	4,747	4,347	4,747
Malaysia	9,726	5,733	9,726	5,733
Malta	—	—	3,817	—
Morocco	13,035	8,986	13,035	8,986
New Zealand	8,142	5,336	8,142	5,336
Norway (9)	—	—	4,697	—
Oman	8,883	9,542	8,883	9,542
Qatar	5,403	4,422	5,403	4,422
Russian Federation	4,780	4,893	4,780	4,893
Saudi Arabia	3,759	4,344	3,759	4,344
Singapore	6,116	5,927	6,116	5,927
Slovenia	4,257	4,415	4,257	4,415
South Africa (9)	12,514	11,969	12,514	11,969
Sweden	4,090	5,573	4,090	5,573

**Exhibit 13.7: TIMSS 2015 Sample Sizes for Scaling the Eighth Grade Data (Continued)**

Country	Concurrent Calibration		Proficiency Estimation	
	2015	2011	2015	2011
Thailand	6,482	6,124	6,482	6,124
Turkey	6,079	6,928	6,079	6,928
United Arab Emirates	18,012	14,089	18,012	14,089
United States	10,221	10,477	10,221	10,477
<b>Benchmarking Participants</b>				
Buenos Aires, Argentina	—	—	3,253	—
Ontario, Canada	—	—	4,520	—
Quebec, Canada	—	—	3,950	—
Norway (8)	4,795	3,862	4,795	3,862
Abu Dhabi, UAE	—	—	4,838	—
Dubai, UAE	—	—	6,149	—
Florida, US	—	—	2,074	—
<b>Total</b>	<b>221,706</b>	<b>203,783</b>	<b>282,204</b>	<b>203,783</b>

The item parameters estimated from these concurrent calibrations, based on the countries that have participated in both the previous and current assessments, were used to estimate student proficiency for all countries and benchmarking entities participating in the TIMSS 2015 assessments. These item parameters were also used to estimate student proficiency in the mathematics and science content and cognitive domains. At the fourth grade, student proficiency was estimated for a total of 47 countries and seven benchmarking participants, as shown in Exhibit 13.6. At the eighth grade, it was estimated for 39 countries and seven benchmarking participants. The item parameters estimated from the TIMSS concurrent calibrations at the fourth and eighth grades and for mathematics and science are presented in Appendix 13A-13D.

## Treatment of Omitted and Not–Reached Responses

Given the matrix-sampling design used by TIMSS, whereby a student is administered only a sample of the assessment blocks (two mathematics and two science blocks) most items are missing by design for each student. However, missing data can also result from a student not answering an item, which can occur when the student does not know the answer, omits the item by mistake, or does not have sufficient time to attempt the item. An item is considered “not reached” when—within part 1 or part 2 of a booklet<sup>3</sup>—the item itself and the item immediately preceding it are not answered, and there are no other items completed in the remainder of that part of the booklet.

3 The TIMSS assessment booklets consist of two parts, with a break in between.

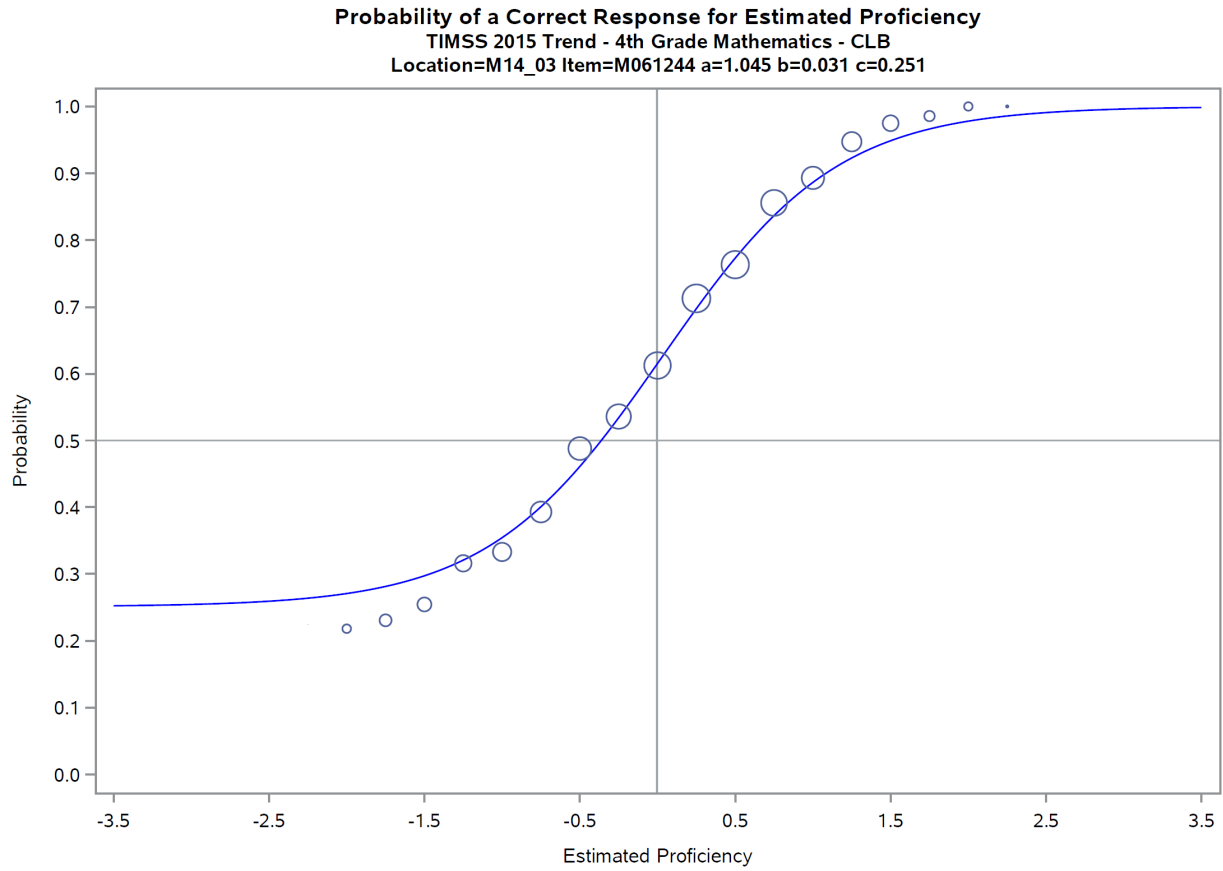
Not-reached items are treated differently in estimating item parameters and in generating student proficiency scores. In estimating the values of the item parameters, items in the assessment booklets that are considered not to have been reached by students are treated as if they have not been administered. This approach is considered optimal for parameter estimation. However, not-reached items are always considered as incorrect responses when student proficiency scores are generated.

## Evaluating Fit of IRT Models to the TIMSS Assessment Data

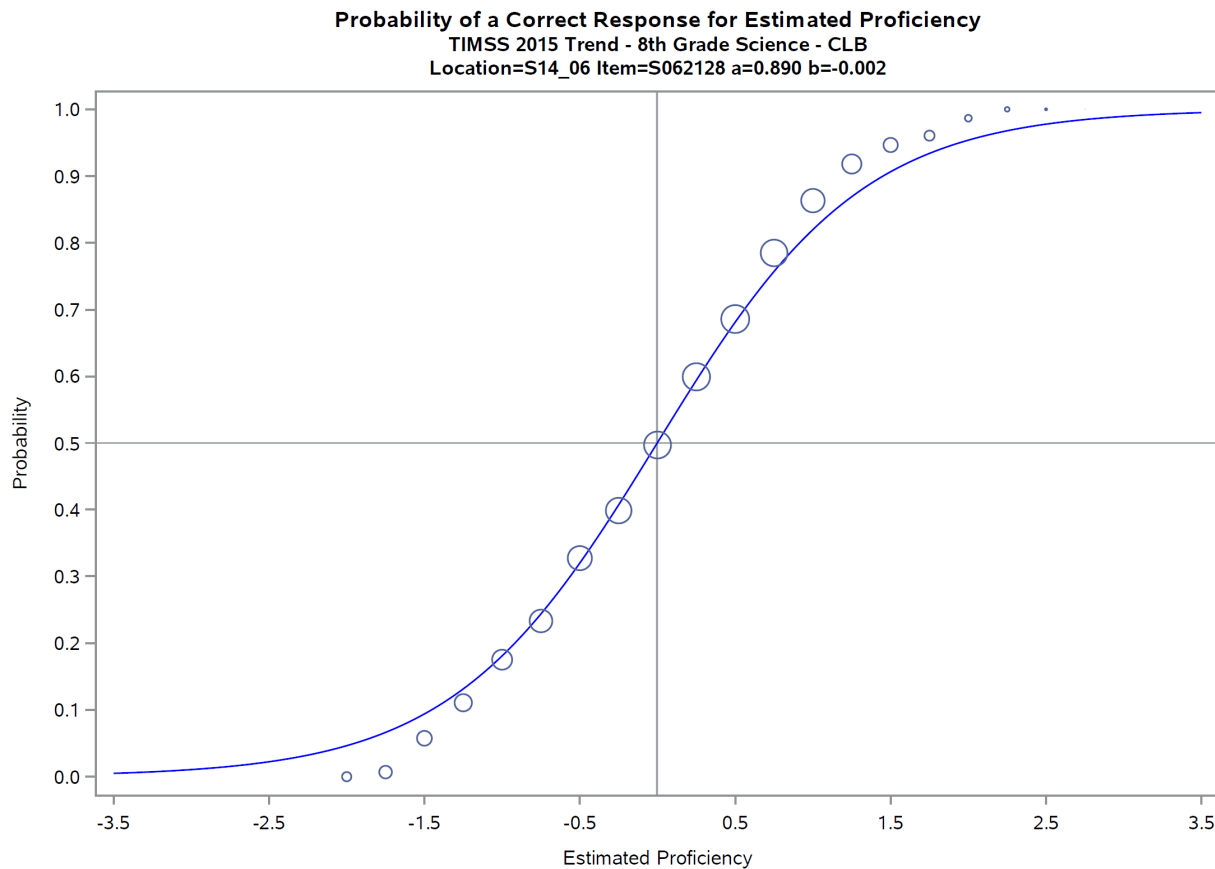
After the item calibrations were completed, checks were performed to verify that the item parameters obtained from Parscale adequately reproduce the observed distribution of student responses across the proficiency continuum. The fit of the IRT models to the TIMSS assessment data is examined by comparing the item response function curves generated using the item parameters estimated from the data with the empirical item response functions calculated from the latent abilities estimated for each student that responded to the item. When the empirical results for an item fall near the fitted curves, the IRT model fits the data well and provides an accurate and reliable measurement of the underlying proficiency scale. Graphical plots of these response function curves are called item characteristic curves (ICC).

The plots in the Exhibits 13.8 and 13.9 show examples of the empirical and fitted item response functions for dichotomously scored (right/wrong) multiple-choice and constructed response items, respectively. In each plot, the horizontal axis represents the proficiency scale, and the vertical axis represents the probability of a correct response. The fitted curve based on the estimated item parameters is shown as a solid line. Empirical results are represented by circles. The empirical results are obtained by first dividing the proficiency scale into intervals of equal size and then counting the number of students responding to the item whose estimated latent abilities (EAP scores) from Parscale fall in each interval. Then the proportion of students in each interval that responded correctly to the item is calculated. In the exhibits, the center of each circle represents this empirical proportion of correct responses. The size of each circle is proportional to the number of students contributing to the estimation of the empirical proportion correct.

**Exhibit 13.8:** Example of Item Response Function for a Dichotomous Multiple-Choice Item from the TIMSS 2015 Fourth Grade Mathematics Assessment

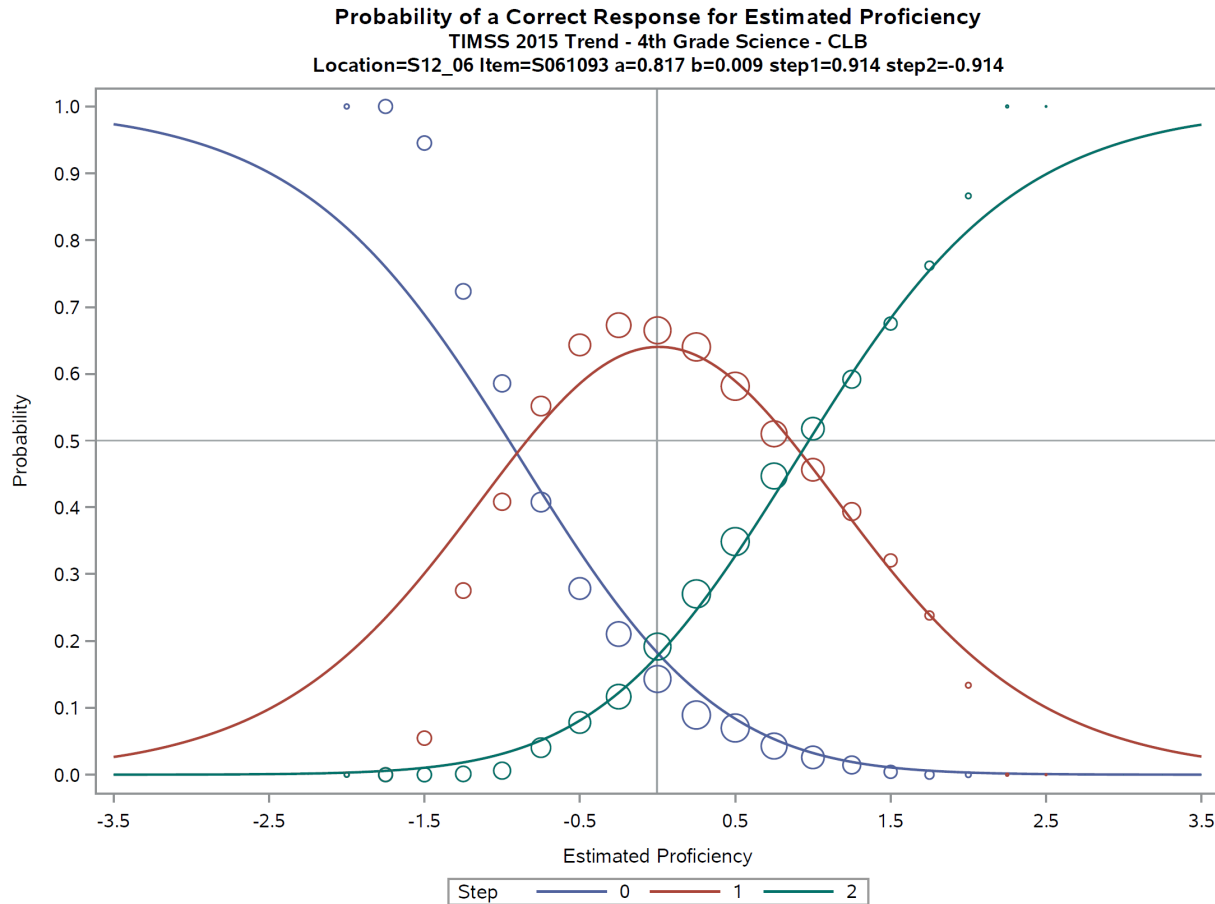


**Exhibit 13.9:** Example of Item Response Function for a Dichotomous Constructed Response Item from the TIMSS 2015 Eighth Grade Science Assessment



The plot in Exhibit 13.10 shows the empirical and fitted item response functions for a polytomous item (scored 0, 1, or 2). As for the dichotomous item plots, the horizontal axis represents the proficiency scale, but in this example the vertical axis represents the probability of having a response in a given response category. The fitted curves based on the estimated item parameters are shown as solid lines and again the empirical results are represented by circles. The interpretation of the circles is the same as in Exhibits 13.8 and 13.9. The curve starting at the top left of the chart plots the probability of a score of zero on the item. This probability decreases as proficiency increases. The bell-shaped curve shows the probability of a score of one point—partial credit, starting low for low-ability students, reaching a maximum for medium-ability students, and decreasing for high-ability students. The curve ending at the top right corner of the chart shows the probability of a score of two points—full credit, starting low for low-ability students and increasing as proficiency increases.

**Exhibit 13.10: Example of Item Response Function for a Polytomous Constructed Response Item from the TIMSS 2015 Fourth Grade Science Assessment**



## Variables for Conditioning the TIMSS Assessment Data

Conditioning is the practice of using all available students’ background information to improve the reliability of the estimated student proficiency scores. Ideally all background data would be included in the conditioning model, but because TIMSS has so many student background variables that could be used in conditioning, the TIMSS & PIRLS International Study Center follows the practice established by NAEP and followed by other large-scale studies of using principal components analysis to reduce the number of variables while explaining most of their common variance. Principal components for the TIMSS student background variables (including parent background variables at the fourth grade) were constructed as follows:

- For categorical variables (questions with a small number of fixed response options), a dummy coded variable was created for each response option, with a value of one if the option is chosen and zero otherwise. If a student omitted or was not administered

a particular question, all dummy coded variables associated with that question were assigned the value zero.

- Background variables with numerous response options (such as year of birth) were recoded using criterion scaling.<sup>4</sup> This was done by replacing the response option with the mean interim achievement score of all students choosing that option. Criterion scaling maximizes the correlation between the scaled variable and achievement. For TIMSS, the interim achievement score was the average of the mathematics and science EAP scores produced from the item calibrations.
- Separately for each country, all the dummy-coded and criterion-scaled variables were included in a principal components analysis. Those principal components accounting for 90 percent of the variance of the background variables were retained for use as conditioning variables.<sup>5</sup> Because the principal components analysis was performed separately for each country, different numbers of principal components were required to account for 90% of the common variance in each country's background variables.

In addition to the principal components, student gender (dummy coded), the language of the test (dummy coded), an indicator of the classroom in the school to which a student belongs (criterion scaled), and an optional country-specific variable (dummy coded) were included as primary conditioning variables, thereby accounting for most of the variance between students and preserving the between-classroom and within-classroom variance structure in the scaling model. For information on principal components conditioning, readers are referred to Exhibits 13.11 and 13.12, which provide details on the conditioning models used for proficiency estimation at the fourth and eighth grades, respectively.

4 The process of generating criterion-scaled variables is described in Beaton (1969).

5 The number of principal components retained is limited to no more than 5% of a country's student sample size, thereby possibly reducing the percentage of variance accounted for, to avoid over-specification of the conditioning model.



**Exhibit 13.11: TIMSS 2015 Conditioning Models for Proficiency Estimation at the Fourth Grade**

Country	2015				2011			
	Number of Primary Conditioning Variables	Number of Principal Components Available	Number of Principal Components Retained	Percentage of Variance Explained	Number of Primary Conditioning Variables	Number of Principal Components Available	Number of Principal Components Retained	Percentage of Variance Explained
Australia	2	633	302	89	2	233	129	90
Bahrain	3	637	207	75	3	239	139	90
Belgium (Flemish)	2	629	270	84	2	235	129	90
Bulgaria	2	617	211	78	—	—	—	—
Canada	5	619	321	90	—	—	—	—
Chile	2	610	237	80	2	239	138	90
Chinese Taipei	2	636	214	78	2	237	128	90
Croatia	3	637	199	76	2	235	128	90
Cyprus	2	637	206	74	—	—	—	—
Czech Republic	2	636	260	84	2	239	129	90
Denmark	2	628	185	73	2	239	132	90
England	2	336	179	90	2	239	131	90
Finland	3	634	250	83	3	237	125	90
France	2	637	243	81	—	—	—	—
Georgia	2	637	195	74	2	235	137	90
Germany	2	637	197	76	2	239	130	90
Hong Kong SAR	3	637	180	73	3	239	128	90
Hungary	2	613	251	82	2	239	131	90
Indonesia	2	617	201	75	—	—	—	—
Iran, Islamic Rep. of	2	637	191	73	2	239	139	90
Ireland	3	637	217	78	3	237	129	90
Italy	2	631	218	77	3	239	132	90
Japan	2	635	219	79	2	239	129	90
Kazakhstan	3	608	235	81	3	239	133	90
Korea, Rep. of	2	636	233	81	2	239	127	90
Kuwait	3	629	179	71	2	239	148	90
Lithuania	4	630	226	79	2	239	131	90
Morocco	2	637	253	80	2	239	146	90
Netherlands	2	619	225	82	2	227	129	90
New Zealand	8	633	314	90	7	239	134	90
Northern Ireland	3	589	155	71	3	239	129	90
Norway (5)	3	636	216	80	—	—	—	—
Oman	3	637	353	90	3	239	142	90
Poland	2	616	237	81	—	—	—	—

**Exhibit 13.11: TIMSS 2015 Conditioning Models for Proficiency Estimation at the Fourth Grade (Continued)**

Country	2015				2011			
	Number of Primary Conditioning Variables	Number of Principal Components Available	Number of Principal Components Retained	Percentage of Variance Explained	Number of Primary Conditioning Variables	Number of Principal Components Available	Number of Principal Components Retained	Percentage of Variance Explained
Portugal	2	636	234	79	2	235	127	90
Qatar	3	632	259	83	3	231	136	90
Russian Federation	2	613	246	81	2	239	132	90
Saudi Arabia	3	637	216	75	3	239	138	90
Serbia	2	628	201	76	2	227	125	90
Singapore	2	637	322	90	2	239	129	90
Slovak Republic	3	633	288	86	3	235	129	90
Slovenia	2	636	222	81	2	236	129	90
Spain	5	628	319	90	5	229	130	90
Sweden	2	611	207	78	2	237	128	90
Turkey	2	612	322	89	2	237	139	90
United Arab Emirates	5	637	346	90	5	235	138	90
United States	10	330	184	90	9	233	133	90
<b>Benchmarking Participants</b>								
Buenos Aires, Argentina	2	630	155	77	—	—	—	—
Ontario, Canada	3	619	228	80	3	239	133	90
Quebec, Canada	3	619	139	68	3	239	130	90
Norway (4)	3	636	208	79	3	239	129	90
Abu Dhabi, UAE	3	637	250	81	3	235	136	90
Dubai, UAE	3	637	333	90	3	235	134	90
Florida, US	10	330	101	72	—	233	130	90

**Exhibit 13.12: TIMSS 2015 Conditioning Models for Proficiency Estimation at the Eighth Grade**

Country	2015				2011			
	Number of Primary Conditioning Variables	Number of Principal Components Available	Number of Principal Components Retained	Percentage of Variance Explained	Number of Primary Conditioning Variables	Number of Principal Components Available	Number of Principal Components Retained	Percentage of Variance Explained
Australia	2	478	245	90	2	363	187	90
Bahrain	3	482	245	89	3	366	197	90
Botswana (9)	2	480	275	90	2	369	212	90
Canada	5	480	247	90	—	—	—	—
Chile	2	481	242	89	2	369	202	90
Chinese Taipei	2	481	231	90	2	369	184	90
Egypt	2	482	276	90	—	—	—	—
England	2	482	240	89	2	368	189	90
Georgia	2	850	201	72	2	825	228	76
Hong Kong SAR	2	482	207	87	2	369	185	90
Hungary	2	850	244	75	2	829	258	78
Iran, Islamic Rep. of	2	482	261	90	2	369	204	90
Ireland	3	482	235	88	—	—	—	—
Israel	3	436	230	90	3	339	181	90
Italy	2	482	224	87	3	369	190	90
Japan	2	480	234	90	2	366	184	90
Jordan	2	482	263	90	2	369	207	90
Kazakhstan	3	849	244	80	3	826	219	77
Korea, Rep. of	2	481	227	90	2	366	182	90
Kuwait	3	474	225	85	—	—	—	—
Lebanon	3	724	193	71	3	677	198	75
Lithuania	4	845	217	73	2	829	237	76
Malaysia	2	473	248	90	2	365	196	90
Malta	2	850	190	70	—	—	—	—
Morocco	2	850	463	90	2	823	412	90
New Zealand	8	478	245	90	7	369	192	90
Norway (9)	3	482	234	89	—	—	—	—
Oman	3	482	271	90	3	366	208	90
Qatar	3	477	244	90	3	358	190	90
Russian Federation	2	849	239	76	2	826	244	77
Saudi Arabia	3	482	187	79	3	365	200	90
Singapore	2	482	246	90	2	369	188	90
Slovenia	2	850	212	74	2	829	220	76
South Africa (9)	3	482	276	90	3	369	214	90

**Exhibit 13.12: TIMSS 2015 Conditioning Models for Proficiency Estimation at the Eighth Grade (Continued)**

Country	2015				2011			
	Number of Primary Conditioning Variables	Number of Principal Components Available	Number of Principal Components Retained	Percentage of Variance Explained	Number of Primary Conditioning Variables	Number of Principal Components Available	Number of Principal Components Retained	Percentage of Variance Explained
Sweden	2	726	204	77	2	827	278	84
Thailand	2	481	252	90	2	366	198	90
Turkey	2	481	257	90	2	364	200	90
United Arab Emirates	5	482	258	90	5	365	202	90
United States	10	475	248	90	9	363	195	90
<b>Benchmarking Participants</b>								
Buenos Aires, Argentina	2	481	162	75	—	—	—	—
Ontario, Canada	3	480	226	88	3	369	188	90
Quebec, Canada	3	480	197	85	3	369	193	90
Norway (8)	3	482	239	90	3	369	189	90
Abu Dhabi, UAE	3	482	241	89	3	365	197	90
Dubai, UAE	3	482	252	90	3	365	196	90
Florida, US	10	475	103	66	9	363	85	65

## Generating IRT Proficiency Scores for the TIMSS Assessment Data

Educational Testing Service’s MGROUP program (Sheehan, 1985) was used to generate the IRT proficiency scores. This program takes as input the students’ responses to the items they were given, the item parameters estimated at the calibration stage, and the conditioning variables, and generates as output the plausible values that represent student proficiency. A useful feature of MGROUP is its ability to perform multi-dimensional scaling using the responses to all items across the proficiency scales and the correlations among the scales to improve the reliability of each individual scale. TIMSS capitalizes on this feature to simultaneously estimate overall mathematics and overall science proficiency using a two-dimensional MGROUP run.

The multi-dimensional scaling feature of MGROUP also was used to generate proficiency scores for the TIMSS 2015 content and cognitive domains. The estimation of proficiency scores for the mathematics and science content and cognitive domains relied on multidimensional IRT models using the item parameters estimated for the overall mathematics and overall science scales as well the same conditioning variables. At the fourth grade, the content domain scaling used two three-dimensional models, one to estimate proficiency scores for the three content domains in mathematics and a second for the three science content domains. At the eighth grade, the content

domain scaling required two four-dimensional models because of the four content domains in each subject. The cognitive domain scaling relied on four three-dimensional models to estimate the three cognitive domains in mathematics and science at both fourth and eighth grades.

In addition to generating plausible values on the overall mathematics and science scales for the 2015 assessment data, the item parameters estimated at the calibration stage also were used to generate plausible values for the TIMSS 2011 assessment for the countries included in the concurrent calibration at the fourth and eighth grades. These additional plausible values were used to establish the linear transformation necessary to place the 2015 assessment data on the appropriate trend scales.

## Transforming the Overall Scores to Measure Trends

To provide results for the TIMSS 2015 assessments on the existing TIMSS achievement scales, the 2015 proficiency scores (plausible values) for overall mathematics and overall science had to be transformed to the TIMSS reporting metric. This was accomplished through a set of linear transformations as part of the concurrent calibration approach. These linear transformations were given by:

$$PV_{k,i}^* = A_{k,i} + B_{k,i} \times PV_{k,i}$$

where

$PV_{k,i}$  is the TIMSS 2015 plausible value  $i$  of scale  $k$  prior to transformation;

$PV_{k,i}^*$  is the TIMSS 2015 plausible value  $i$  of scale  $k$  after transformation; and

$A_{k,i}$  and  $B_{k,i}$  are the linear transformation constants.

The linear transformation constants were obtained by first computing the international means and standard deviations of the proficiency scores for the overall mathematics and science scales using the plausible values produced in 2011 based on the 2011 item calibrations for the trend countries. These were the plausible values published in 2011. Next, the same calculations were done using the plausible values from the re-scaled TIMSS 2011 assessment data based on the 2015 concurrent item calibrations for the same set of countries. From these calculations, the linear transformation constants were defined as:

$$B_{k,i} = \sigma_{k,i} / \sigma_{k,i}^*$$

$$A_{k,i} = \mu_{k,i} - B_{k,i} \cdot \mu_{k,i}^*$$

where

$\mu_{k,i}$  is the international mean of scale  $k$  based on plausible value  $i$  published in 2011;

$\mu_{k,i}^*$  is the international mean of scale  $k$  based on plausible value  $i$  from the 2011 assessment based on the 2015 concurrent calibration;

$\sigma_{k,i}$  is the international standard deviation of scale  $k$  based on plausible value  $i$  published in 2011;

$\sigma_{k,i}^*$  is the international standard deviation of scale  $k$  based on plausible value  $i$  from the 2011 assessment based on the 2015 concurrent calibration.

There are five sets of transformation constants for each scale, one for each plausible value. The trend countries contributed equally in the calculation of these transformation constants. Exhibits 13.13 and 13.14 show the TIMSS 2015 transformation constants for both subjects at the fourth grade and eighth grade, respectively.

**Exhibit 13.13: TIMSS 2015 Linear Transformation Constants for Achievement Scores at the Fourth Grade**

Overall Mathematics	TIMSS 2011 Published Scores		TIMSS 2011 Re-Scaled Scores		$A_{k,i}$	$B_{k,i}$
	Mean	Standard Deviation	Mean	Standard Deviation		
PV1	501.91552	103.54133	-0.04936	1.00427	507.00466	103.10157
PV2	502.00544	103.94119	-0.04786	1.00299	506.96561	103.63170
PV3	502.35389	102.68220	-0.04820	1.00351	507.28627	102.32346
PV4	501.84105	103.49324	-0.04773	1.00347	506.76322	103.13524
PV5	501.65257	103.64052	-0.04757	1.00426	506.56219	103.20051

Overall Science	TIMSS 2011 Published Scores		TIMSS 2011 Re-Scaled Scores		$A_{k,i}$	$B_{k,i}$
	Mean	Standard Deviation	Mean	Standard Deviation		
PV1	499.45160	105.78445	-0.04165	1.00373	503.84141	105.39178
PV2	497.56584	106.72416	-0.04269	1.00417	502.10293	106.28087
PV3	498.16387	106.63119	-0.04116	1.00347	502.53750	106.26254
PV4	497.34909	106.68599	-0.04078	1.00064	501.69694	106.61724
PV5	499.15420	106.17634	-0.04151	1.00259	503.54985	105.90178

**Exhibit 13.14: TIMSS 2015 Linear Transformation Constants for Achievement Scores at the Eighth Grade**

Overall Mathematics	TIMSS 2011 Published Scores		TIMSS 2011 Re-Scaled Scores		$A_{k,i}$	$B_{k,i}$
	Mean	Standard Deviation	Mean	Standard Deviation		
PV1	473.42229	111.72611	-0.03549	0.99024	477.42708	112.82747
PV2	473.75171	112.62466	-0.03610	0.99166	477.85132	113.57130
PV3	473.63844	113.27223	-0.03601	0.99136	477.75261	114.25951
PV4	473.10247	113.46924	-0.03444	0.99066	477.04681	114.53935
PV5	473.67012	113.04213	-0.03540	0.99170	477.70540	113.98864

Overall Science	TIMSS 2011 Published Scores		TIMSS 2011 Re-Scaled Scores		$A_{k,i}$	$B_{k,i}$
	Mean	Standard Deviation	Mean	Standard Deviation		
PV1	482.10953	107.52913	-0.00234	0.92492	482.38202	116.25820
PV2	482.14011	107.21152	-0.00113	0.92745	482.27044	115.59787
PV3	483.14479	106.44266	-0.00367	0.92707	483.56607	114.81597
PV4	481.87213	107.83798	-0.00133	0.92584	482.02702	116.47632
PV5	482.89696	107.25956	-0.00132	0.92636	483.04972	115.78622

These linear transformation constants were applied to the overall proficiency scores—mathematics and science—at both grades and for all participating countries and benchmarking participants. This provided student achievement scores for the TIMSS 2015 assessments that are directly comparable to the scores from all previous assessments.

The linear transformation constants for the overall scales also were applied to the scales for the content and cognitive domains. The transformation constants for mathematics were applied to the proficiency scores of the mathematics content domains and cognitive domains, and the transformation constants for science were applied to the proficiency scores of the science content domains and cognitive domains. In this approach to measuring trends in content and cognitive domains, achievement changes over time are established in the context of achievement in each subject overall. Trends are not established separately for each content or cognitive domain; rather differential changes in performance in the domains are considered in the light of trends in the subject overall.

## Scaling the TIMSS Numeracy 2015 Achievement Data

TIMSS Numeracy was introduced in 2015 to assess the fundamental mathematical knowledge, procedures, and problem-solving strategies that are prerequisites for success on TIMSS mathematics at the fourth grade. TIMSS Numeracy asks students to answer questions and work problems similar to TIMSS mathematics at the fourth grade, with easier numbers and more straightforward procedures.

The TIMSS Numeracy assessment was designed to allow the mathematics achievement of participating countries to be reported on the TIMSS fourth grade mathematics trend scale. To that end, two of the TIMSS fourth grade item blocks were included in the TIMSS Numeracy assessment, along with eight mathematics item blocks dedicated to TIMSS Numeracy. The two shared TIMSS item blocks provided the link to place TIMSS Numeracy achievement on the TIMSS fourth grade mathematics scale. Exhibit 13.15 shows the number of items present in the TIMSS Numeracy 2015 assessment by item type and domain. There was a total of 124 items in the Numeracy assessment, 22 of them from the TIMSS fourth grade mathematics assessment.

**Exhibit 13.15: TIMSS Numeracy 2015 Items for Calibration**

Item Type	Points	TIMSS Items		Numeracy Items		Total	
		Items	Points	Items	Points	Items	Points
Multiple-Choice	1	11	11	45	45	56	56
Constructed Response	1	9	9	53	53	62	62
	2	2	4	4	8	6	12
<b>Total</b>		<b>22</b>	<b>24</b>	<b>102</b>	<b>106</b>	<b>124</b>	<b>130</b>

**TIMSS Numeracy 2015 Mathematics Items for Calibration by Content and Cognitive Domains**

Mathematics Content Domains	TIMSS Items		Numeracy Items		Total	
	Items	Points	Items	Points	Items	Points
Number	13	15	68	69	81	84
Geometric Shapes and Measures	7	7	24	9	31	16
Data Display	2	2	10	3	12	5

Mathematics Cognitive Domains	TIMSS Items		Numeracy Items		Total	
	Items	Points	Items	Points	Items	Points
Knowing	7	8	55	55	62	63
Applying	10	10	35	36	45	46
Reasoning	5	6	12	15	17	21
<b>Total</b>	<b>22</b>	<b>24</b>	<b>102</b>	<b>106</b>	<b>124</b>	<b>130</b>



Much like the normal TIMSS scaling procedure, the TIMSS Numeracy scaling approach involved the same four tasks of calibrating the achievement items, creating principal components for conditioning, generating proficiency scores, and placing these proficiency scores on the TIMSS fourth grade mathematics reporting scale. Exhibit 13.16 shows the sample sizes for scaling the TIMSS Numeracy data. A total of seven countries participated, as well as one benchmarking participant.

**Exhibit 13.16: TIMSS Numeracy 2015 Sample Sizes for Scaling**

Country	Item Calibration	Proficiency Estimation
Bahrain	4,429	4,429
Indonesia	4,294	4,294
Iran, Islamic Rep. of	4,105	4,105
Jordan	7,861	7,861
Kuwait	3,703	3,703
Morocco	5,360	5,360
South Africa (5)	10,932	10,932
<b>Benchmarking Participants</b>		
Buenos Aires, Argentina	—	3,331
<b>Total</b>	<b>40,684</b>	<b>44,015</b>

The item calibration step was based on a straightforward calibration of the TIMSS Numeracy 2015 achievement items from the seven participating countries. The item parameters for the TIMSS Numeracy items were placed on the TIMSS fourth grade mathematics metric by fixing the parameters of the items in the two shared TIMSS 2015 item blocks to the values estimated from the TIMSS 2015 concurrent calibration. The two shared item blocks consisted of 22 items, 21 of which were used for linking the TIMSS Numeracy assessment to the TIMSS fourth grade mathematics assessment. One item—N04\_08A (M061265A)—did not behave the same across both assessments and had its item parameters re-estimated as part of the TIMSS Numeracy item calibration. The item parameters estimated from the TIMSS Numeracy item calibration are presented in Appendix 13E. The 21 link items, whose item parameters were fixed, are marked with asterisks.

The conditioning for TIMSS Numeracy was done in exactly the same way as for TIMSS, as was the estimation of proficiency scores using the MGROUP software. This included overall mathematics scores for the TIMSS Numeracy countries and scores for the TIMSS fourth grade mathematics content and cognitive domains. Exhibit 13.17 provides details on the conditioning models used for the TIMSS Numeracy proficiency estimation.

**Exhibit 13.17: TIMSS Numeracy 2015 Mathematics Conditioning Models for Proficiency Estimation**

Country	2015			
	Number of Primary Conditioning Variables	Number of Principal Components Available	Number of Principal Components Retained	Percentage of Variance Explained
Bahrain	3	637	221	77
Indonesia	2	617	214	76
Iran, Islamic Rep. of	2	637	205	75
Jordan	2	637	334	90
Kuwait	3	629	185	72
Morocco	2	637	268	82
South Africa (5)	3	533	301	90
<b>Benchmarking Participants</b>				
Buenos Aires, Argentina	2	620	166	78

The final step in the process consisted of placing students' performance on the TIMSS Numeracy 2015 assessment on the TIMSS fourth grade mathematics reporting scale. This was done by applying the appropriate linear transformation to the estimated proficiency scores. The TIMSS Numeracy item calibration resulted in item parameters on the same metric as the TIMSS fourth grade mathematics metric—by fixing the parameters of the 21 link items. Thus, placing the TIMSS Numeracy achievement scores on the TIMSS fourth grade mathematics scale was accomplished by using the TIMSS fourth grade mathematics linear transformation constants, as presented in Exhibit 13.13. These linear transformation constants were applied to the overall mathematics achievement scores, as well as the achievement scores on the content and cognitive domains.

## References

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## Appendix 13A: TIMSS 2015 Fourth Grade Mathematics Item Parameters from Concurrent Calibration

**TIMSS 2015 Fourth Grade Mathematics Item Parameters from Concurrent Calibration**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
<b>Items Released in 2011:</b>						
M01_01A	M031346A	1.675 (0.064)	-0.334 (0.020)			
M01_01B	M031346B	1.818 (0.072)	0.494 (0.018)			
M01_01C	M031346C	1.465 (0.049)	0.260 (0.014)		0.408 (0.022)	-0.408 (0.023)
M01_02	M031379	1.113 (0.050)	0.834 (0.031)			
M01_03	M031380	1.165 (0.055)	1.091 (0.037)			
M01_05	M031313	0.653 (0.033)	-1.187 (0.060)			
M01_06	M031083	0.969 (0.068)	-0.496 (0.082)	0.210 (0.036)		
M01_07	M031071	1.003 (0.089)	0.647 (0.055)	0.206 (0.022)		
M01_08	M031185	1.720 (0.119)	0.199 (0.035)	0.235 (0.019)		
M02_01	M051305	0.957 (0.067)	-0.162 (0.068)	0.183 (0.029)		
M02_02	M051091	1.508 (0.107)	0.514 (0.034)	0.188 (0.016)		
M02_03	M051001	1.055 (0.046)	0.702 (0.030)			
M02_04	M051007	1.153 (0.144)	1.275 (0.063)	0.266 (0.016)		
M02_05	M051203	0.561 (0.030)	0.413 (0.045)			
M02_06	M051601	1.002 (0.040)	-0.261 (0.028)			
M02_07A	M051064A	0.856 (0.036)	-0.155 (0.031)			
M02_07B	M051064B	0.902 (0.038)	-0.719 (0.036)			
M02_08	M051015	0.671 (0.032)	0.221 (0.037)			
M02_09	M051123	0.567 (0.074)	0.854 (0.115)	0.190 (0.036)		
M02_10	M051109	1.127 (0.044)	-0.229 (0.025)			
M02_11	M051117	0.987 (0.087)	0.305 (0.067)	0.271 (0.026)		
M03_01	M041010	0.921 (0.071)	-0.452 (0.095)	0.267 (0.038)		
M03_02	M041098	1.839 (0.143)	0.596 (0.032)	0.250 (0.015)		
M03_03	M041064	0.712 (0.032)	-0.538 (0.040)			
M03_04	M041003	0.828 (0.036)	-0.018 (0.031)			
M03_05	M041104	1.071 (0.043)	-0.074 (0.026)			
M03_06	M041299	1.303 (0.056)	0.784 (0.027)			
M03_07	M041329	1.055 (0.093)	0.069 (0.075)	0.343 (0.029)		
M03_08	M041143	0.331 (0.011)	-0.632 (0.045)		-1.833 (0.111)	1.833 (0.103)
M03_09	M041158	0.853 (0.063)	-0.314 (0.086)	0.189 (0.035)		
M03_10	M041328	0.905 (0.038)	-0.274 (0.030)			
M03_11	M041155	0.986 (0.070)	0.244 (0.052)	0.139 (0.022)		
M03_12	M041284	0.741 (0.029)	0.678 (0.027)		0.420 (0.037)	-0.420 (0.047)

**TIMSS 2015 Fourth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M03_13	M041335	0.769 (0.052)	-1.179 (0.120)	0.154 (0.048)	
M03_14	M041184	0.899 (0.066)	-0.726 (0.101)	0.222 (0.042)	
M05_01	M031128	0.534 (0.029)	-1.247 (0.071)		
M05_02	M031016	1.295 (0.055)	0.719 (0.026)		
M05_03	M031183	0.864 (0.030)	0.147 (0.022)	0.656 (0.034)	-0.656 (0.035)
M05_05	M031187	0.749 (0.058)	-0.776 (0.129)	0.213 (0.048)	
M05_06	M031251	1.473 (0.112)	0.501 (0.038)	0.237 (0.017)	
M05_07	M031294	1.355 (0.080)	-0.035 (0.039)	0.138 (0.020)	
M05_08	M031297	0.824 (0.039)	0.735 (0.037)		
M05_09	M031218	1.402 (0.087)	0.069 (0.039)	0.162 (0.019)	
M05_10	M031109	0.674 (0.060)	-0.319 (0.129)	0.208 (0.044)	
M05_11	M031159	1.059 (0.076)	-0.263 (0.070)	0.236 (0.031)	
M05_12	M031133	0.854 (0.039)	-1.289 (0.051)		
M06_01	M041107	0.991 (0.062)	-1.006 (0.083)	0.150 (0.037)	
M06_02	M041011	1.301 (0.085)	-0.199 (0.052)	0.228 (0.026)	
M06_03	M041122	0.483 (0.016)	0.576 (0.032)	-0.778 (0.065)	0.778 (0.071)
M06_04	M041041	1.151 (0.104)	0.345 (0.063)	0.353 (0.025)	
M06_05	M041320	1.694 (0.111)	0.408 (0.030)	0.179 (0.016)	
M06_06A	M041115A	0.871 (0.037)	-0.377 (0.033)		
M06_06B	M041115B	1.173 (0.047)	0.142 (0.023)		
M06_07A	M041160A	1.087 (0.047)	-1.133 (0.041)		
M06_07B	M041160B	1.345 (0.059)	-1.159 (0.036)		
M06_08	M041327	0.533 (0.029)	0.001 (0.045)		
M06_09	M041148	0.374 (0.019)	-0.059 (0.041)	0.354 (0.076)	-0.354 (0.073)
M06_10	M041265	0.886 (0.076)	0.816 (0.053)	0.123 (0.019)	
M06_11	M041175	0.881 (0.060)	-1.144 (0.111)	0.180 (0.047)	
M06_12	M041199	1.249 (0.083)	-0.614 (0.067)	0.243 (0.033)	
M07_01	M031210	1.599 (0.150)	0.813 (0.040)	0.310 (0.016)	
M07_02	M031009	1.016 (0.044)	0.525 (0.028)		
M07_03	M031252	1.099 (0.070)	-0.244 (0.058)	0.170 (0.027)	
M07_04	M031316	0.802 (0.038)	-1.574 (0.063)		
M07_05	M031317	1.479 (0.099)	0.600 (0.031)	0.131 (0.014)	
M07_06B	M031079B	1.269 (0.050)	-0.639 (0.028)		
M07_06C	M031079C	0.799 (0.037)	0.396 (0.032)		
M07_07	M031004	1.217 (0.099)	1.036 (0.040)	0.108 (0.013)	

**TIMSS 2015 Fourth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M07_08	M031043	1.456 (0.094)	0.263 (0.036)	0.175 (0.018)		
M07_09	M031325	0.907 (0.041)	0.637 (0.032)			
M07_10	M031088	0.925 (0.068)	-0.436 (0.089)	0.225 (0.037)		
M07_11	M031093	0.583 (0.109)	1.016 (0.159)	0.389 (0.040)		
M07_12	M031155	1.301 (0.105)	0.335 (0.050)	0.294 (0.022)		
<b>Items Common in 2011 and 2015:</b>						
M01_01	M041004	0.987 (0.050)	-1.314 (0.084)	0.210 (0.040)		
M01_02	M041023	1.650 (0.070)	-0.693 (0.033)	0.182 (0.020)		
M01_03	M041034	0.949 (0.045)	-0.068 (0.045)	0.139 (0.020)		
M01_04	M041087	0.808 (0.025)	-0.072 (0.022)			
M01_05	M041124	0.964 (0.028)	-0.199 (0.020)			
M01_06A	M041302A	1.037 (0.047)	-0.604 (0.052)	0.165 (0.025)		
M01_06B	M041302B	0.628 (0.021)	-0.296 (0.029)			
M01_06C	M041302C	1.071 (0.030)	-0.312 (0.019)			
M01_07	M041254	0.775 (0.052)	0.306 (0.064)	0.223 (0.024)		
M01_08	M041153	1.100 (0.053)	0.224 (0.034)	0.148 (0.016)		
M01_09	M041132	0.460 (0.041)	0.800 (0.100)	0.111 (0.030)		
M01_10	M041165	0.375 (0.010)	0.411 (0.027)		-0.866 (0.057)	0.866 (0.060)
M01_11	M041174	1.136 (0.032)	-0.689 (0.022)			
M01_12	M041191	1.025 (0.059)	-1.045 (0.089)	0.337 (0.038)		
M03_01	M051205	0.691 (0.023)	-0.325 (0.027)			
M03_02	M051039	1.186 (0.033)	-0.094 (0.017)			
M03_03	M051055	1.166 (0.037)	0.889 (0.022)			
M03_04	M051006	0.539 (0.014)	1.070 (0.028)		-0.560 (0.042)	0.560 (0.051)
M03_05	M051070	1.462 (0.088)	0.922 (0.026)	0.185 (0.010)		
M03_06	M051018	0.944 (0.063)	0.573 (0.046)	0.243 (0.018)		
M03_07	M051407	0.942 (0.053)	0.165 (0.049)	0.203 (0.020)		
M03_08	M051410	0.962 (0.058)	0.576 (0.040)	0.176 (0.016)		
M03_09	M051059	0.750 (0.025)	-1.128 (0.037)			
M03_10	M051093	0.814 (0.056)	0.720 (0.048)	0.169 (0.018)		
M03_11	M051134	1.277 (0.036)	0.363 (0.016)			
M03_12	M051077	1.236 (0.052)	0.190 (0.026)	0.090 (0.012)		
M05_01	M041291	0.705 (0.023)	-0.727 (0.032)			
M05_02	M041289	1.156 (0.066)	0.200 (0.043)	0.292 (0.018)		
M05_03	M041068	1.261 (0.056)	0.574 (0.023)	0.081 (0.010)		

**TIMSS 2015 Fourth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M05_04A	M041065A	1.625 (0.081)	0.643 (0.022)	0.172 (0.010)	
M05_04B	M041065B	1.067 (0.035)	1.015 (0.025)		
M05_05	M041096	1.079 (0.052)	0.489 (0.029)	0.103 (0.013)	
M05_06	M041125	1.209 (0.072)	0.791 (0.031)	0.195 (0.012)	
M05_07	M041135	0.832 (0.060)	-0.466 (0.107)	0.422 (0.034)	
M05_08	M041257	0.772 (0.025)	0.331 (0.023)		
M05_09	M041268	2.022 (0.129)	1.008 (0.022)	0.232 (0.009)	
M05_10	M041151	0.519 (0.042)	-0.314 (0.158)	0.208 (0.046)	
M05_11	M041264	0.545 (0.052)	0.561 (0.110)	0.221 (0.033)	
M05_12	M041182	0.818 (0.028)	-1.611 (0.045)		
M05_13	M041200	0.472 (0.013)	-0.556 (0.027)	-0.209 (0.050)	0.209 (0.043)
M06_01	M051140	0.665 (0.044)	0.214 (0.074)	0.160 (0.026)	
M06_02	M051017	0.994 (0.071)	0.656 (0.046)	0.295 (0.017)	
M06_03	M051111	0.696 (0.026)	0.992 (0.035)		
M06_04	M051089	1.211 (0.036)	0.693 (0.018)		
M06_05	M051094	1.235 (0.068)	0.490 (0.032)	0.220 (0.014)	
M06_06	M051227	1.101 (0.037)	1.126 (0.027)		
M06_07	M051060	0.578 (0.046)	0.538 (0.083)	0.151 (0.028)	
M06_08Z	M051061Z	0.735 (0.025)	0.687 (0.028)		
M06_09	M051129	0.748 (0.049)	-0.060 (0.081)	0.241 (0.029)	
M06_10	M051236	0.897 (0.027)	0.077 (0.020)		
M06_11A	M051125A	0.825 (0.028)	-1.633 (0.046)		
M06_11B	M051125B	0.669 (0.050)	0.085 (0.096)	0.251 (0.032)	
M07_01	M041298	1.021 (0.055)	-0.537 (0.065)	0.285 (0.028)	
M07_02	M041007	0.877 (0.053)	0.425 (0.046)	0.182 (0.019)	
M07_03	M041280	0.877 (0.065)	0.801 (0.048)	0.238 (0.017)	
M07_04	M041059	0.699 (0.023)	-0.143 (0.025)		
M07_05	M041046	1.335 (0.058)	0.288 (0.025)	0.118 (0.012)	
M07_06	M041048	1.556 (0.092)	0.631 (0.028)	0.287 (0.012)	
M07_07	M041169	1.066 (0.058)	0.187 (0.042)	0.222 (0.018)	
M07_08	M041333	1.083 (0.058)	0.648 (0.031)	0.137 (0.013)	
M07_09	M041262	0.938 (0.070)	0.993 (0.043)	0.209 (0.015)	
M07_10	M041267	0.598 (0.023)	0.751 (0.035)		
M07_11	M041177	0.882 (0.044)	-0.432 (0.060)	0.152 (0.026)	
M07_12	M041271	0.935 (0.042)	-0.491 (0.051)	0.121 (0.023)	

**TIMSS 2015 Fourth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M07_13A	M041276A	1.032 (0.030)	0.119 (0.018)		
M07_13B	M041276B	0.911 (0.029)	0.674 (0.023)		
M09_01	M051206	0.646 (0.022)	-0.720 (0.034)		
M09_02	M051052	1.021 (0.066)	0.268 (0.053)	0.331 (0.020)	
M09_03	M051049	1.499 (0.064)	0.098 (0.025)	0.152 (0.013)	
M09_04	M051045	1.176 (0.033)	0.056 (0.017)		
M09_05	M051098	1.067 (0.059)	0.736 (0.031)	0.132 (0.013)	
M09_06	M051030	1.019 (0.035)	1.161 (0.029)		
M09_07	M051502	0.975 (0.068)	1.099 (0.039)	0.154 (0.013)	
M09_08	M051224	1.015 (0.060)	0.159 (0.051)	0.280 (0.021)	
M09_09	M051207	0.952 (0.085)	0.898 (0.056)	0.377 (0.017)	
M09_10	M051427	1.135 (0.064)	0.717 (0.031)	0.165 (0.013)	
M09_11	M051533	1.134 (0.032)	0.184 (0.017)		
M09_12	M051080	1.073 (0.031)	-0.066 (0.018)		
M11_01	M051401	0.865 (0.028)	0.566 (0.023)		
M11_02	M051075	1.597 (0.126)	1.075 (0.032)	0.342 (0.010)	
M11_03	M051402	1.061 (0.031)	0.401 (0.018)		
M11_04	M051226	1.361 (0.080)	0.595 (0.031)	0.264 (0.013)	
M11_05	M051131	0.777 (0.024)	-0.022 (0.023)		
M11_06	M051103	1.470 (0.081)	0.326 (0.031)	0.301 (0.015)	
M11_07	M051217	1.210 (0.036)	0.609 (0.018)		
M11_08	M051079	0.887 (0.027)	0.378 (0.021)		
M11_09	M051211	0.868 (0.052)	-0.044 (0.064)	0.246 (0.025)	
M11_10	M051102	1.223 (0.072)	0.723 (0.031)	0.203 (0.013)	
M11_11	M051009	0.881 (0.027)	0.049 (0.021)		
M11_12	M051100	0.724 (0.051)	0.317 (0.070)	0.208 (0.025)	
M13_01	M051043	0.544 (0.021)	-0.007 (0.031)		
M13_02	M051040	1.219 (0.079)	0.039 (0.054)	0.436 (0.020)	
M13_03	M051008	1.220 (0.038)	0.948 (0.022)		
M13_04A	M051031A	1.490 (0.040)	0.166 (0.014)		
M13_04B	M051031B	1.662 (0.045)	0.258 (0.013)		
M13_05	M051508	1.295 (0.036)	0.179 (0.015)		
M13_06A	M051216A	1.292 (0.070)	0.480 (0.031)	0.226 (0.014)	
M13_06B	M051216B	0.552 (0.041)	-1.034 (0.197)	0.250 (0.060)	
M13_07	M051221	0.649 (0.039)	-0.726 (0.114)	0.172 (0.041)	

**TIMSS 2015 Fourth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M13_08	M051115	0.612 (0.059)	1.641 (0.075)	0.100 (0.017)		
M13_09A	M051507A	0.748 (0.024)	-0.513 (0.028)			
M13_09B	M051507B	1.152 (0.036)	0.825 (0.021)			
<b>Items Introduced in 2015:</b>						
M02_01	M061272	0.910 (0.038)	0.121 (0.028)			
M02_02	M061243	0.477 (0.015)	-0.220 (0.031)		-0.923 (0.072)	0.923 (0.068)
M02_03	M061029	1.151 (0.072)	-0.226 (0.055)	0.139 (0.027)		
M02_04	M061031	1.497 (0.087)	0.563 (0.027)	0.066 (0.012)		
M02_05	M061050	1.427 (0.104)	0.596 (0.036)	0.184 (0.017)		
M02_06	M061167	0.730 (0.033)	-0.826 (0.047)			
M02_07	M061206	0.723 (0.069)	0.755 (0.070)	0.105 (0.027)		
M02_08A	M061265A	0.989 (0.042)	0.485 (0.028)			
M02_08B	M061265B	0.991 (0.103)	1.125 (0.057)	0.183 (0.019)		
M02_09	M061185	0.980 (0.063)	-0.503 (0.076)	0.114 (0.036)		
M02_10	M061239	1.408 (0.056)	-0.587 (0.026)			
M04_01	M061275	0.764 (0.065)	-0.479 (0.132)	0.192 (0.053)		
M04_02	M061027	0.941 (0.039)	-0.423 (0.032)			
M04_03	M061255	0.842 (0.027)	0.561 (0.021)		-0.210 (0.038)	0.210 (0.042)
M04_04	M061021	0.835 (0.039)	0.715 (0.035)			
M04_05	M061043	1.385 (0.054)	0.358 (0.021)			
M04_06	M061151	1.295 (0.080)	-0.012 (0.044)	0.143 (0.023)		
M04_07	M061172	1.556 (0.113)	0.830 (0.031)	0.135 (0.013)		
M04_08	M061223	0.739 (0.055)	-0.678 (0.122)	0.066 (0.053)		
M04_09	M061269	0.818 (0.058)	-0.439 (0.093)	0.085 (0.041)		
M04_10A	M061081A	1.115 (0.049)	0.742 (0.029)			
M04_10B	M061081B	0.801 (0.041)	1.002 (0.044)			
M08_01	M061026	0.920 (0.055)	-0.764 (0.079)	0.043 (0.038)		
M08_02	M061273	0.815 (0.065)	0.246 (0.073)	0.119 (0.031)		
M08_03	M061034	1.230 (0.051)	0.673 (0.025)			
M08_04	M061040	1.711 (0.117)	0.601 (0.030)	0.169 (0.015)		
M08_05	M061228	0.780 (0.026)	0.878 (0.026)		-0.309 (0.042)	0.309 (0.050)
M08_06	M061166	1.141 (0.045)	-0.158 (0.025)			
M08_07	M061171	1.316 (0.086)	-0.240 (0.054)	0.201 (0.028)		
M08_08	M061080	0.854 (0.039)	0.598 (0.033)			
M08_09	M061222	0.904 (0.094)	0.401 (0.089)	0.326 (0.032)		



**TIMSS 2015 Fourth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M08_10	M061076	0.583 (0.030)	-0.477 (0.048)		
M08_11	M061084	1.119 (0.050)	0.869 (0.031)		
M10_01	M061018	0.889 (0.038)	0.147 (0.029)		
M10_02	M061274	0.791 (0.070)	-0.396 (0.132)	0.249 (0.051)	
M10_03	M061248	0.932 (0.033)	0.431 (0.020)		0.400 (0.031) -0.400 (0.035)
M10_04	M061039	1.224 (0.049)	0.354 (0.023)		
M10_05	M061079	1.324 (0.055)	0.724 (0.025)		
M10_06	M061179	1.225 (0.080)	0.122 (0.046)	0.158 (0.023)	
M10_07	M061052	1.049 (0.064)	0.121 (0.046)	0.075 (0.022)	
M10_08	M061207	1.537 (0.092)	0.316 (0.031)	0.115 (0.016)	
M10_09	M061236	0.788 (0.036)	0.318 (0.032)		
M10_10	M061266	0.494 (0.017)	0.750 (0.033)		-0.820 (0.066) 0.820 (0.073)
M10_11	M061106	1.065 (0.081)	0.038 (0.067)	0.229 (0.030)	
M12_01	M061178	0.866 (0.037)	0.144 (0.029)		
M12_02	M061246	1.065 (0.066)	0.151 (0.045)	0.086 (0.021)	
M12_03	M061271	0.700 (0.032)	-0.544 (0.042)		
M12_04	M061256	0.933 (0.039)	0.212 (0.028)		
M12_05	M061182	1.188 (0.056)	1.140 (0.035)		
M12_06	M061049	0.971 (0.080)	-0.362 (0.100)	0.301 (0.041)	
M12_07	M061232	0.859 (0.091)	0.604 (0.082)	0.285 (0.029)	
M12_08	M061095	0.951 (0.039)	-0.015 (0.028)		
M12_09	M061264	0.636 (0.023)	0.473 (0.026)		-0.126 (0.046) 0.126 (0.051)
M12_10	M061108	0.564 (0.071)	0.548 (0.142)	0.161 (0.047)	
M12_11A	M061211A	1.290 (0.051)	0.224 (0.022)		
M12_11B	M061211B	1.514 (0.121)	0.624 (0.039)	0.254 (0.018)	
M14_01	M061240	0.795 (0.037)	0.631 (0.035)		
M14_02	M061254	0.882 (0.037)	0.086 (0.029)		
M14_03	M061244	1.045 (0.081)	0.031 (0.072)	0.251 (0.031)	
M14_04	M061041	1.374 (0.136)	1.104 (0.045)	0.242 (0.016)	
M14_05	M061173	0.737 (0.033)	-0.222 (0.036)		
M14_06	M061252	1.327 (0.092)	0.669 (0.035)	0.132 (0.016)	
M14_07	M061261	1.337 (0.051)	0.195 (0.021)		
M14_08	M061224	0.872 (0.039)	0.622 (0.032)		
M14_09	M061077	0.879 (0.058)	-0.038 (0.064)	0.069 (0.028)	
M14_10A	M061069A	0.741 (0.034)	-0.713 (0.045)		
M14_10B	M061069B	0.743 (0.034)	-0.055 (0.035)		

## Appendix 13B: TIMSS 2015 Fourth Grade Science Item Parameters from Concurrent Calibration

**TIMSS 2015 Fourth Grade Science Item Parameters from Concurrent Calibration**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
<b>Items Released in 2011:</b>					
S01_01	S031356	1.128 (0.101)	-0.924 (0.117)	0.485 (0.039)	
S01_02	S031291	1.368 (0.090)	-0.780 (0.064)	0.260 (0.031)	
S01_03	S031230	0.770 (0.060)	-1.374 (0.155)	0.231 (0.053)	
S01_04	S031325	0.620 (0.034)	0.440 (0.041)		
S01_05	S031068	1.163 (0.108)	0.589 (0.051)	0.276 (0.022)	
S01_06	S031418	0.807 (0.072)	0.551 (0.062)	0.152 (0.024)	
S01_07Z	S031197Z	0.441 (0.016)	-0.873 (0.046)		-0.548 (0.083) 0.548 (0.067)
S01_08	S031371	0.790 (0.079)	0.588 (0.070)	0.193 (0.027)	
S01_09	S031376	1.197 (0.121)	0.917 (0.047)	0.220 (0.018)	
S01_10	S031044	0.635 (0.033)	-0.023 (0.038)		
S01_11Z	S031390Z	0.760 (0.030)	0.195 (0.022)		0.399 (0.038) -0.399 (0.038)
S02_01	S051057	0.692 (0.034)	-0.092 (0.036)		
S02_02	S051032	0.962 (0.081)	0.400 (0.057)	0.199 (0.024)	
S02_03Z	S051049Z	0.328 (0.027)	0.599 (0.080)		
S02_04	S051033	0.791 (0.111)	0.941 (0.085)	0.304 (0.028)	
S02_05	S051173	0.914 (0.050)	1.120 (0.047)		
S02_06	S051086	0.757 (0.063)	-0.757 (0.128)	0.248 (0.044)	
S02_07	S051179	0.883 (0.063)	-0.815 (0.098)	0.209 (0.038)	
S02_08	S051074	0.452 (0.033)	1.252 (0.091)		
S02_09	S051119	0.634 (0.038)	1.039 (0.059)		
S02_10	S051071	0.890 (0.086)	0.644 (0.060)	0.196 (0.024)	
S02_11	S051100	1.353 (0.128)	1.040 (0.041)	0.148 (0.014)	
S02_12	S051156	1.420 (0.169)	1.275 (0.052)	0.185 (0.013)	
S03_01	S041117	0.558 (0.051)	-2.428 (0.318)	0.282 (0.092)	
S03_02	S041120	1.784 (0.276)	1.166 (0.054)	0.436 (0.014)	
S03_03	S041003	0.603 (0.032)	0.010 (0.040)		
S03_04	S041224	0.869 (0.033)	0.433 (0.021)		0.380 (0.032) -0.380 (0.037)
S03_05	S041163	0.566 (0.140)	1.784 (0.196)	0.278 (0.033)	
S03_06	S041039	0.788 (0.037)	-0.032 (0.032)		
S03_07	S041014	1.739 (0.239)	1.317 (0.052)	0.250 (0.013)	
S03_08	S041181	0.601 (0.031)	-0.533 (0.048)		
S03_09	S041174	0.821 (0.040)	0.455 (0.032)		
S03_10	S041049	1.041 (0.089)	0.461 (0.054)	0.212 (0.024)	

**TIMSS 2015 Fourth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S03_11	S041208	0.259 (0.074)	1.138 (0.521)	0.277 (0.086)		
S03_12	S041060	1.008 (0.056)	1.138 (0.046)			
S03_13A	S041201A	1.181 (0.050)	0.200 (0.023)			
S03_13B	S041201B	1.187 (0.054)	0.444 (0.024)			
S05_01	S031340	0.810 (0.086)	0.692 (0.070)	0.213 (0.026)		
S05_02	S031236	0.743 (0.061)	-0.584 (0.117)	0.222 (0.040)		
S05_03Z	S031391Z	0.557 (0.024)	0.287 (0.028)		0.141 (0.050)	-0.141 (0.052)
S05_04	S031361	0.790 (0.088)	0.441 (0.090)	0.301 (0.031)		
S05_05	S031001	1.113 (0.071)	-0.775 (0.071)	0.192 (0.031)		
S05_07	S031410	0.473 (0.070)	-0.047 (0.248)	0.305 (0.058)		
S05_08	S031421	0.513 (0.029)	-0.622 (0.058)			
S05_09	S031298	1.262 (0.207)	1.468 (0.081)	0.266 (0.016)		
S05_10	S031076	0.700 (0.037)	0.520 (0.038)			
S05_11	S031275	0.899 (0.152)	1.484 (0.100)	0.242 (0.021)		
S06_01	S041311	0.594 (0.052)	-2.574 (0.314)	0.298 (0.095)		
S06_02	S041178	1.170 (0.143)	0.830 (0.060)	0.380 (0.021)		
S06_03	S041182	0.692 (0.035)	0.285 (0.035)			
S06_04	S041180	1.452 (0.098)	0.180 (0.039)	0.220 (0.021)		
S06_05	S041187	1.189 (0.229)	1.698 (0.117)	0.224 (0.015)		
S06_06A	S041013A	0.586 (0.036)	0.890 (0.056)			
S06_06B	S041013B	0.577 (0.040)	1.431 (0.086)			
S06_07	S041067	0.929 (0.040)	-0.326 (0.032)			
S06_08	S041305	1.276 (0.121)	0.743 (0.045)	0.261 (0.019)		
S06_09	S041048	0.901 (0.041)	0.259 (0.028)			
S06_10	S041110	0.698 (0.034)	-0.249 (0.038)			
S06_11	S041069	1.152 (0.111)	0.431 (0.060)	0.350 (0.024)		
S06_12	S041100	1.314 (0.098)	0.495 (0.038)	0.185 (0.019)		
S06_13	S041092	0.843 (0.082)	0.232 (0.085)	0.288 (0.031)		
S07_01	S031254	0.644 (0.113)	0.930 (0.128)	0.381 (0.035)		
S07_02	S031266	1.210 (0.079)	0.158 (0.042)	0.158 (0.020)		
S07_03	S031233	0.644 (0.032)	-0.446 (0.044)			
S07_04	S031204	0.652 (0.035)	0.495 (0.040)			
S07_05	S031273	1.451 (0.108)	0.284 (0.041)	0.261 (0.021)		
S07_06	S031299	0.563 (0.033)	0.502 (0.046)			
S07_07	S031281	0.965 (0.069)	-0.982 (0.100)	0.238 (0.039)		

**TIMSS 2015 Fourth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S07_08	S031077	0.710 (0.072)	-0.375 (0.143)	0.332 (0.043)		
S07_09	S031311	1.200 (0.093)	0.085 (0.057)	0.290 (0.026)		
S07_10Z	S031088Z	0.583 (0.017)	0.136 (0.034)		1.498 (0.052)	-1.498 (0.053)
S07_11	S031389	1.229 (0.131)	0.943 (0.048)	0.240 (0.018)		
<b>Items Common in 2011 and 2015:</b>						
S01_01	S041010	1.003 (0.052)	-0.763 (0.066)	0.253 (0.028)		
S01_02	S041034	0.631 (0.048)	-0.167 (0.108)	0.259 (0.034)		
S01_03	S041017	0.978 (0.085)	1.031 (0.045)	0.256 (0.016)		
S01_04	S041124	1.128 (0.087)	0.882 (0.038)	0.276 (0.015)		
S01_05	S041186	0.643 (0.028)	1.086 (0.042)			
S01_06	S041037	0.568 (0.015)	-0.101 (0.020)		-0.104 (0.038)	0.104 (0.035)
S01_07	S041119	1.115 (0.077)	0.112 (0.058)	0.438 (0.021)		
S01_08	S041105	0.957 (0.047)	-0.105 (0.045)	0.157 (0.020)		
S01_10Z	S041149Z	0.632 (0.015)	0.969 (0.021)		-1.015 (0.043)	1.015 (0.049)
S01_11	S041032	0.886 (0.029)	-1.284 (0.040)			
S01_12	S041068	0.768 (0.027)	0.283 (0.023)			
S01_13	S041303	0.708 (0.066)	0.777 (0.069)	0.258 (0.024)		
S03_01	S051041	0.987 (0.084)	0.726 (0.051)	0.359 (0.018)		
S03_02	S051037	0.804 (0.027)	0.073 (0.022)			
S03_03	S051008	0.917 (0.035)	1.120 (0.032)			
S03_04	S051004	1.422 (0.068)	-0.031 (0.033)	0.254 (0.018)		
S03_05Z	S051026Z	0.538 (0.024)	0.810 (0.040)			
S03_06	S051130	0.580 (0.028)	1.384 (0.058)			
S03_07	S051114	1.283 (0.082)	0.640 (0.032)	0.262 (0.015)		
S03_08Z	S051121Z	0.398 (0.020)	0.191 (0.041)			
S03_09	S051147	0.821 (0.031)	0.972 (0.031)			
S03_10	S051105	1.025 (0.063)	-0.076 (0.059)	0.341 (0.023)		
S03_11	S051110	0.936 (0.053)	0.082 (0.049)	0.207 (0.021)		
S03_12	S051111	1.198 (0.083)	0.382 (0.046)	0.386 (0.018)		
S05_01	S041009	0.842 (0.049)	-0.764 (0.086)	0.283 (0.031)		
S05_02	S041223	1.101 (0.071)	0.385 (0.042)	0.301 (0.018)		
S05_03	S041026	0.532 (0.042)	0.337 (0.085)	0.126 (0.027)		
S05_04	S041177	0.370 (0.015)	1.186 (0.046)		0.325 (0.049)	-0.325 (0.066)
S05_05	S041183	0.660 (0.015)	0.236 (0.020)		1.114 (0.031)	-1.114 (0.033)
S05_06	S041008	1.172 (0.078)	0.706 (0.034)	0.239 (0.014)		

**TIMSS 2015 Fourth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S05_08	S041195	0.675 (0.032)	1.460 (0.056)		
S05_09A	S041134A	0.868 (0.033)	0.967 (0.030)		
S05_09B	S041134B	0.802 (0.027)	0.137 (0.022)		
S05_09C	S041134C	0.797 (0.055)	0.509 (0.051)	0.193 (0.020)	
S05_10	S041191	0.946 (0.088)	0.924 (0.051)	0.322 (0.017)	
S05_11	S041107	0.394 (0.010)	-0.849 (0.034)		-0.940 (0.066) 0.940 (0.056)
S05_12	S041113	0.837 (0.029)	0.414 (0.022)		
S06_01	S051185	1.092 (0.057)	0.362 (0.033)	0.165 (0.015)	
S06_02	S051048	0.653 (0.018)	0.110 (0.017)		0.168 (0.032) -0.168 (0.031)
S06_03	S051164	0.912 (0.042)	1.585 (0.052)		
S06_04	S051186	0.622 (0.022)	-0.939 (0.041)		
S06_05	S051137	0.720 (0.040)	-0.930 (0.095)	0.165 (0.034)	
S06_06	S051007	0.894 (0.028)	-0.048 (0.021)		
S06_07	S051087	1.091 (0.056)	-0.420 (0.054)	0.278 (0.023)	
S06_08Z	S051188Z	0.602 (0.023)	0.277 (0.028)		
S06_10	S051201	0.715 (0.026)	0.419 (0.025)		
S06_11	S051102	0.923 (0.057)	0.175 (0.052)	0.249 (0.021)	
S06_12	S051095	0.585 (0.022)	-0.364 (0.033)		
S07_01	S041027	0.727 (0.025)	-1.765 (0.055)		
S07_02	S041043	0.626 (0.022)	-0.557 (0.034)		
S07_03	S041050	0.457 (0.049)	0.614 (0.127)	0.180 (0.037)	
S07_04	S041070	0.930 (0.059)	0.452 (0.045)	0.215 (0.019)	
S07_05	S041006	0.463 (0.016)	0.646 (0.027)		0.302 (0.040) -0.302 (0.047)
S07_06	S041052	1.036 (0.064)	-0.225 (0.065)	0.381 (0.025)	
S07_07	S041301	0.657 (0.027)	0.915 (0.036)		
S07_09	S041033	0.884 (0.034)	1.049 (0.031)		
S07_11	S041077	0.749 (0.027)	0.348 (0.024)		
S07_12	S041209	0.707 (0.057)	0.763 (0.057)	0.172 (0.021)	
S07_13	S041081	0.535 (0.014)	0.514 (0.020)		-0.408 (0.040) 0.408 (0.043)
S07_14	S041102	0.982 (0.055)	-0.120 (0.054)	0.244 (0.023)	
S09_01	S051044	0.524 (0.022)	0.178 (0.032)		
S09_03	S051003	0.765 (0.041)	-0.024 (0.051)	0.112 (0.020)	
S09_04	S051168	0.778 (0.026)	-0.076 (0.023)		
S09_05	S051010	0.830 (0.027)	0.093 (0.021)		
S09_06	S051035	1.462 (0.137)	1.283 (0.039)	0.250 (0.010)	

**TIMSS 2015 Fourth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S09_07	S051059	0.632 (0.024)	0.193 (0.027)			
S09_08	S051142	0.954 (0.063)	0.613 (0.040)	0.197 (0.017)		
S09_09A	S051131A	1.099 (0.055)	-0.002 (0.040)	0.205 (0.019)		
S09_09B	S051131B	1.154 (0.072)	0.632 (0.033)	0.210 (0.015)		
S09_10	S051151	0.998 (0.031)	-0.976 (0.031)			
S09_11	S051157	0.839 (0.070)	0.956 (0.048)	0.200 (0.017)		
S11_01	S051161	0.495 (0.054)	0.683 (0.114)	0.207 (0.034)		
S11_02	S051051	1.821 (0.191)	1.349 (0.037)	0.311 (0.009)		
S11_03Z	S051138Z	0.592 (0.023)	0.378 (0.029)			
S11_04	S051194	1.004 (0.036)	1.014 (0.027)			
S11_05	S051029	0.527 (0.070)	1.330 (0.095)	0.216 (0.028)		
S11_06	S051077	0.842 (0.027)	-0.154 (0.023)			
S11_07	S051200	0.737 (0.031)	1.156 (0.040)			
S11_08	S051075	0.749 (0.025)	-0.471 (0.029)			
S11_09	S051065	1.026 (0.065)	-0.015 (0.059)	0.352 (0.023)		
S11_10	S051191	1.348 (0.075)	0.552 (0.028)	0.204 (0.014)		
S11_11	S051099	0.927 (0.057)	0.298 (0.049)	0.222 (0.020)		
S11_12	S051175	0.912 (0.034)	0.946 (0.028)			
S13_01	S051054	1.026 (0.051)	-0.387 (0.052)	0.223 (0.023)		
S13_02	S051024	0.689 (0.026)	0.646 (0.028)			
S13_03A	S051132A	0.975 (0.037)	1.163 (0.032)			
S13_03B	S051132B	0.864 (0.033)	0.977 (0.030)			
S13_04	S051040	0.430 (0.021)	0.553 (0.042)			
S13_05	S051193	1.043 (0.062)	0.035 (0.051)	0.307 (0.021)		
S13_06	S051063	1.263 (0.083)	0.810 (0.030)	0.220 (0.013)		
S13_07	S051012	1.149 (0.068)	0.323 (0.039)	0.272 (0.018)		
S13_08	S051115	1.216 (0.036)	0.142 (0.016)			
S13_09	S051180	1.014 (0.073)	0.228 (0.059)	0.395 (0.021)		
S13_10	S051106	1.150 (0.080)	0.785 (0.035)	0.240 (0.015)		
S13_11	S051148	1.145 (0.068)	0.277 (0.041)	0.276 (0.018)		
<b>Items Introduced in 2015:</b>						
S02_01	S061105	0.685 (0.094)	0.184 (0.166)	0.416 (0.045)		
S02_02	S061010	0.431 (0.028)	0.023 (0.053)			
S02_03	S061028	0.931 (0.141)	1.183 (0.079)	0.326 (0.024)		
S02_04	S061065	1.076 (0.076)	-0.144 (0.065)	0.214 (0.031)		

**TIMSS 2015 Fourth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S02_05	S061130	0.856 (0.041)	0.433 (0.030)		
S02_06	S061081	0.979 (0.047)	0.762 (0.032)		
S02_07	S061060	0.851 (0.039)	0.024 (0.030)		
S02_08	S061075	0.584 (0.055)	-0.371 (0.154)	0.088 (0.053)	
S02_09	S061031	1.085 (0.051)	0.817 (0.030)		
S02_10A	S061049A	0.682 (0.048)	-0.473 (0.093)	0.017 (0.034)	
S02_10B	S061049B	0.584 (0.064)	0.235 (0.129)	0.130 (0.045)	
S02_11	S061098	0.836 (0.130)	1.257 (0.086)	0.276 (0.026)	
S02_12	S061172	0.628 (0.038)	1.015 (0.056)		
S04_01	S061135	0.734 (0.066)	-0.690 (0.149)	0.246 (0.052)	
S04_02	S061069	0.400 (0.026)	-0.365 (0.064)		
S04_03	S061134	0.634 (0.057)	0.124 (0.096)	0.086 (0.035)	
S04_04	S061140	1.031 (0.103)	0.586 (0.063)	0.296 (0.025)	
S04_05	S061019	0.892 (0.046)	0.934 (0.039)		
S04_06	S061022	0.639 (0.075)	0.301 (0.129)	0.245 (0.042)	
S04_07	S061036	0.997 (0.048)	0.852 (0.033)		
S04_08	S061160	0.748 (0.035)	-0.885 (0.050)		
S04_09	S061159	0.907 (0.040)	-0.715 (0.041)		
S04_10	S061091	0.444 (0.022)	1.207 (0.055)	-0.162 (0.062)	0.162 (0.082)
S04_11	S061118	1.080 (0.101)	0.641 (0.054)	0.245 (0.023)	
S04_12	S061097	0.825 (0.095)	0.584 (0.087)	0.300 (0.032)	
S08_01	S061141	1.416 (0.123)	0.524 (0.045)	0.305 (0.021)	
S08_02	S061023	0.777 (0.037)	0.178 (0.031)		
S08_03	S061054	0.470 (0.016)	0.738 (0.040)	1.567 (0.055)	-1.567 (0.074)
S08_04	S061007	0.680 (0.060)	-0.235 (0.118)	0.130 (0.044)	
S08_05	S061006	0.897 (0.040)	-0.566 (0.038)		
S08_06	S061108	1.090 (0.102)	0.266 (0.071)	0.345 (0.029)	
S08_07	S061109	0.525 (0.080)	0.605 (0.166)	0.210 (0.052)	
S08_08	S061080	0.986 (0.088)	0.258 (0.072)	0.273 (0.030)	
S08_09	S061088	0.756 (0.045)	1.252 (0.059)		
S08_10	S061151	0.987 (0.045)	0.473 (0.027)		
S08_11	S061150	0.711 (0.037)	0.458 (0.036)		
S08_12	S061169	1.133 (0.093)	0.191 (0.062)	0.273 (0.028)	
S10_01	S061071	0.375 (0.035)	-0.951 (0.122)	0.250 (0.000)	
S10_02	S061138	0.689 (0.034)	-0.023 (0.036)		

**TIMSS 2015 Fourth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S10_03A	S061016A	0.939 (0.083)	0.397 (0.064)	0.210 (0.028)	
S10_03B	S061016B	1.032 (0.047)	0.570 (0.027)		
S10_04	S061011	0.823 (0.037)	-0.393 (0.036)		
S10_06	S061083	0.723 (0.034)	-0.872 (0.051)		
S10_07	S061034	0.832 (0.047)	1.120 (0.049)		
S10_08	S061044	0.800 (0.040)	0.568 (0.034)		
S10_09A	S061142A	0.678 (0.036)	0.451 (0.037)		
S10_09B	S061142B	0.841 (0.046)	0.992 (0.044)		
S10_10A	S061115A	1.649 (0.128)	0.419 (0.038)	0.282 (0.020)	
S10_10B	S061115B	1.465 (0.141)	0.669 (0.044)	0.325 (0.020)	
S12_01	S061132	0.794 (0.087)	0.654 (0.078)	0.222 (0.030)	
S12_02	S061120	1.033 (0.086)	0.411 (0.057)	0.212 (0.026)	
S12_03	S061025	0.556 (0.030)	-0.445 (0.051)		
S12_04A	S061133A	1.417 (0.110)	0.263 (0.048)	0.303 (0.024)	
S12_04B	S061133B	1.835 (0.131)	0.824 (0.025)	0.120 (0.012)	
S12_05	S061074	0.860 (0.040)	0.227 (0.029)		
S12_06	S061093	0.817 (0.027)	0.009 (0.024)	0.914 (0.040)	-0.914 (0.034)
S12_07	S061161	0.693 (0.038)	0.686 (0.040)		
S12_08A	S061042A	1.493 (0.136)	0.801 (0.038)	0.250 (0.018)	
S12_08B	S061042B	0.812 (0.078)	0.672 (0.064)	0.141 (0.026)	
S12_09A	S061041A	0.903 (0.041)	0.127 (0.028)		
S12_09B	S061041B	0.836 (0.040)	0.236 (0.030)		
S12_10	S061155	0.809 (0.077)	-0.453 (0.138)	0.305 (0.049)	
S14_02	S061014	0.521 (0.022)	-0.646 (0.037)	0.853 (0.066)	-0.853 (0.047)
S14_03	S061056	0.951 (0.041)	-0.682 (0.038)		
S14_04	S061015	0.786 (0.036)	-0.304 (0.036)		
S14_05	S061113	0.829 (0.043)	0.866 (0.039)		
S14_06	S061107	1.017 (0.090)	0.677 (0.051)	0.180 (0.022)	
S14_07	S061046	1.220 (0.118)	0.842 (0.046)	0.233 (0.019)	
S14_08	S061047	0.849 (0.081)	-0.380 (0.126)	0.366 (0.043)	
S14_09	S061048	1.466 (0.120)	0.590 (0.039)	0.252 (0.019)	
S14_10	S061096	1.221 (0.116)	0.730 (0.048)	0.264 (0.021)	
S14_11	S061124	0.628 (0.039)	1.201 (0.065)		
S14_12	S061116	0.707 (0.036)	0.192 (0.034)		



## Appendix 13C: TIMSS 2015 Eighth Grade Mathematics Item Parameters from Concurrent Calibration

**TIMSS 2015 Eighth Grade Mathematics Item Parameters from Concurrent Calibration**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
<b>Items Released in 2011:</b>						
M01_01	M032166	1.015 (0.079)	0.060 (0.068)	0.188 (0.029)		
M01_02	M032721	0.941 (0.126)	1.280 (0.078)	0.269 (0.021)		
M01_03	M032757	0.540 (0.016)	-0.347 (0.030)		-1.922 (0.100)	1.922 (0.097)
M01_04A	M032760A	1.040 (0.031)	0.546 (0.019)		-1.082 (0.064)	1.082 (0.066)
M01_04B	M032760B	1.747 (0.080)	0.876 (0.025)			
M01_04C	M032760C	1.888 (0.094)	1.108 (0.027)			
M01_05	M032761	1.381 (0.052)	1.085 (0.022)		-0.096 (0.033)	0.096 (0.042)
M01_06	M032692	0.688 (0.022)	0.924 (0.030)		-1.302 (0.077)	1.302 (0.084)
M01_07	M032626	0.934 (0.075)	0.303 (0.066)	0.154 (0.027)		
M01_08	M032595	1.550 (0.102)	0.220 (0.036)	0.137 (0.017)		
M01_09	M032673	1.451 (0.110)	0.414 (0.042)	0.201 (0.019)		
M02_01	M052216	1.333 (0.100)	-0.294 (0.062)	0.262 (0.030)		
M02_02	M052231	0.699 (0.037)	-1.182 (0.059)			
M02_03	M052061	0.992 (0.043)	0.249 (0.030)			
M02_04	M052228	1.475 (0.098)	0.569 (0.033)	0.098 (0.013)		
M02_05	M052214	1.193 (0.130)	1.057 (0.058)	0.262 (0.018)		
M02_06	M052173	2.602 (0.242)	1.335 (0.029)	0.076 (0.007)		
M02_07	M052302	1.078 (0.077)	-0.486 (0.076)	0.185 (0.036)		
M02_08	M052002	1.083 (0.039)	1.230 (0.027)		-0.507 (0.050)	0.507 (0.060)
M02_09	M052362	1.093 (0.046)	0.281 (0.028)			
M02_10	M052408	0.899 (0.042)	0.624 (0.036)			
M02_11	M052084	1.579 (0.106)	0.311 (0.035)	0.143 (0.016)		
M02_12	M052206	1.088 (0.050)	0.865 (0.035)			
M02_13	M052429	0.941 (0.080)	0.476 (0.064)	0.168 (0.025)		
M02_14A	M052503A	0.645 (0.039)	1.482 (0.079)			
M02_14B	M052503B	0.563 (0.041)	1.833 (0.113)			
M03_01	M042032	0.911 (0.074)	-0.464 (0.103)	0.227 (0.044)		
M03_02	M042031	1.670 (0.136)	0.474 (0.040)	0.259 (0.017)		
M03_03	M042186	1.087 (0.046)	0.182 (0.028)			
M03_04	M042059	0.852 (0.027)	-0.023 (0.022)		-0.209 (0.043)	0.209 (0.043)
M03_05	M042236	1.532 (0.117)	0.221 (0.044)	0.243 (0.020)		

**TIMSS 2015 Eighth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M03_06	M042226	1.421 (0.058)	0.163 (0.023)		
M03_07	M042103	0.985 (0.052)	1.341 (0.052)		
M03_08	M042086	1.258 (0.054)	0.530 (0.028)		
M03_09	M042228	0.808 (0.038)	0.521 (0.039)		
M03_10	M042245	1.871 (0.158)	1.080 (0.034)	0.127 (0.010)	
M03_11	M042270	0.944 (0.041)	0.043 (0.031)		
M03_12	M042201	1.359 (0.056)	0.119 (0.024)		
M03_13	M042152	0.723 (0.083)	0.716 (0.099)	0.218 (0.033)	
M03_14	M042269	0.745 (0.083)	0.207 (0.127)	0.292 (0.041)	
M03_15	M042179	0.851 (0.067)	-0.010 (0.081)	0.149 (0.033)	
M03_16	M042177	1.059 (0.084)	0.113 (0.065)	0.207 (0.028)	
M03_17	M042207	0.403 (0.012)	-0.210 (0.036)	-2.851 (0.137)	2.851 (0.135)
M05_01	M032094	1.334 (0.105)	0.038 (0.057)	0.282 (0.026)	
M05_02	M032662	2.085 (0.200)	1.282 (0.034)	0.130 (0.009)	
M05_03	M032064	1.438 (0.063)	0.698 (0.026)		
M05_04	M032419	1.490 (0.136)	0.768 (0.044)	0.263 (0.017)	
M05_05	M032477	1.878 (0.149)	0.575 (0.034)	0.232 (0.015)	
M05_06	M032538	1.400 (0.058)	0.226 (0.024)		
M05_07	M032324	1.300 (0.113)	0.847 (0.044)	0.182 (0.016)	
M05_08	M032116	1.336 (0.128)	0.810 (0.050)	0.271 (0.018)	
M05_09	M032100	1.043 (0.078)	0.314 (0.055)	0.144 (0.023)	
M05_10	M032402	0.921 (0.110)	0.827 (0.081)	0.315 (0.026)	
M05_11	M032734	0.787 (0.036)	-0.471 (0.039)		
M05_12	M032397	1.150 (0.102)	0.645 (0.054)	0.219 (0.021)	
M05_13	M032695	0.593 (0.018)	-0.148 (0.028)	-0.927 (0.069)	0.927 (0.067)
M05_14	M032132	0.697 (0.062)	0.275 (0.093)	0.128 (0.033)	
M06_01	M042041	1.452 (0.112)	-0.234 (0.057)	0.297 (0.028)	
M06_02	M042024	1.612 (0.106)	0.051 (0.037)	0.167 (0.019)	
M06_03	M042016	0.882 (0.086)	0.491 (0.078)	0.232 (0.028)	
M06_04	M042002	0.761 (0.039)	0.884 (0.047)		
M06_05A	M042198A	1.205 (0.052)	-0.767 (0.032)		
M06_05B	M042198B	1.071 (0.046)	0.250 (0.028)		
M06_05C	M042198C	1.882 (0.091)	1.014 (0.026)		
M06_06	M042077	1.621 (0.131)	0.487 (0.040)	0.252 (0.018)	
M06_07	M042235	1.586 (0.100)	0.181 (0.033)	0.123 (0.016)	

**TIMSS 2015 Eighth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M06_08	M042067	2.243 (0.248)	1.122 (0.037)	0.285 (0.013)		
M06_09	M042150	0.834 (0.089)	0.827 (0.074)	0.198 (0.025)		
M06_10Z	M042300Z	0.814 (0.026)	0.316 (0.023)		-0.352 (0.046)	0.352 (0.048)
M06_11	M042260	0.997 (0.090)	-0.065 (0.090)	0.307 (0.035)		
M06_12A	M042169A	1.240 (0.052)	0.187 (0.025)			
M06_12B	M042169B	0.349 (0.029)	1.137 (0.110)			
M06_12C	M042169C	0.818 (0.050)	1.572 (0.072)			
M07_01	M032352	1.474 (0.140)	0.356 (0.056)	0.391 (0.022)		
M07_02	M032725	1.305 (0.059)	0.804 (0.030)			
M07_03	M032683	0.638 (0.020)	0.767 (0.030)		-1.196 (0.073)	1.196 (0.079)
M07_04	M032738	1.450 (0.105)	-0.169 (0.050)	0.234 (0.026)		
M07_05	M032295	1.489 (0.113)	-0.420 (0.059)	0.290 (0.030)		
M07_06	M032331	2.251 (0.231)	1.209 (0.035)	0.188 (0.011)		
M07_07	M032623	1.911 (0.133)	0.613 (0.028)	0.126 (0.012)		
M07_08	M032679	1.261 (0.098)	0.285 (0.050)	0.216 (0.022)		
M07_09	M032047	2.155 (0.281)	1.095 (0.046)	0.426 (0.014)		
M07_10	M032398	1.683 (0.168)	0.838 (0.045)	0.320 (0.016)		
M07_11	M032507	1.840 (0.166)	1.013 (0.036)	0.187 (0.012)		
M07_12	M032424	1.217 (0.090)	0.352 (0.046)	0.161 (0.020)		
M07_13A	M032681A	0.519 (0.030)	-0.720 (0.060)			
M07_13B	M032681B	0.551 (0.033)	0.889 (0.064)			
M07_13C	M032681C	1.067 (0.048)	0.400 (0.030)			
<b>Items Common in 2011 and 2015:</b>						
M01_01	M042182	1.660 (0.105)	0.280 (0.035)	0.375 (0.015)		
M01_02	M042081	0.912 (0.030)	0.676 (0.026)			
M01_03	M042049	1.177 (0.073)	0.108 (0.049)	0.308 (0.020)		
M01_04	M042052	1.809 (0.080)	-0.043 (0.023)	0.134 (0.013)		
M01_05	M042076	1.202 (0.071)	0.515 (0.036)	0.207 (0.015)		
M01_06A	M042302A	0.951 (0.022)	0.381 (0.015)		-0.203 (0.028)	0.203 (0.030)
M01_06B	M042302B	0.937 (0.020)	0.477 (0.015)		-0.633 (0.034)	0.633 (0.036)
M01_06C	M042302C	0.527 (0.015)	1.639 (0.042)		-1.036 (0.059)	1.036 (0.076)
M01_07	M042100	1.391 (0.079)	0.183 (0.037)	0.270 (0.017)		
M01_08	M042202	1.599 (0.095)	0.479 (0.030)	0.274 (0.013)		
M01_09	M042240	1.408 (0.066)	0.169 (0.028)	0.137 (0.014)		
M01_10	M042093	1.743 (0.062)	1.112 (0.020)			

**TIMSS 2015 Eighth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M01_11	M042271	1.143 (0.057)	0.256 (0.034)	0.122 (0.015)		
M01_12	M042268	1.530 (0.095)	1.037 (0.027)	0.151 (0.009)		
M01_13	M042159	0.474 (0.021)	-0.834 (0.049)			
M01_14	M042164	1.393 (0.043)	0.507 (0.018)			
M01_15	M042167	1.371 (0.045)	0.803 (0.020)			
M03_01	M052209	1.459 (0.068)	-0.052 (0.031)	0.157 (0.016)		
M03_02	M052142	1.030 (0.064)	0.818 (0.037)	0.144 (0.014)		
M03_03	M052006	1.481 (0.112)	1.016 (0.035)	0.303 (0.011)		
M03_04	M052035	1.473 (0.043)	0.318 (0.016)			
M03_05	M052016	1.487 (0.043)	0.400 (0.016)			
M03_06	M052064	1.536 (0.090)	0.613 (0.030)	0.240 (0.012)		
M03_07	M052126	1.861 (0.065)	1.115 (0.019)			
M03_08	M052103	1.126 (0.058)	0.247 (0.037)	0.140 (0.016)		
M03_09	M052066	1.408 (0.077)	0.440 (0.031)	0.212 (0.014)		
M03_10	M052041	1.230 (0.044)	1.280 (0.029)			
M03_11	M052057	0.659 (0.045)	0.048 (0.093)	0.151 (0.034)		
M03_12	M052417	0.962 (0.030)	0.298 (0.022)			
M03_13	M052501	0.874 (0.031)	1.000 (0.031)			
M03_14	M052410	0.848 (0.068)	0.599 (0.067)	0.286 (0.023)		
M03_15	M052170	1.143 (0.098)	1.221 (0.045)	0.270 (0.013)		
M05_01	M042183	0.681 (0.044)	-0.105 (0.091)	0.143 (0.034)		
M05_02	M042060	1.333 (0.066)	0.112 (0.033)	0.169 (0.016)		
M05_03	M042019	0.765 (0.026)	0.488 (0.028)			
M05_04	M042023	1.286 (0.038)	0.490 (0.019)			
M05_05	M042197	1.084 (0.036)	0.928 (0.026)			
M05_06	M042234	1.470 (0.074)	0.300 (0.029)	0.176 (0.014)		
M05_07	M042066	0.683 (0.024)	0.253 (0.029)			
M05_08	M042243	1.926 (0.084)	0.358 (0.019)	0.095 (0.009)		
M05_09	M042248	1.508 (0.046)	0.682 (0.018)			
M05_10Z	M042229Z	1.187 (0.028)	0.759 (0.014)		-0.300 (0.027)	0.300 (0.030)
M05_11A	M042080A	0.752 (0.026)	0.499 (0.028)			
M05_11B	M042080B	1.313 (0.048)	1.313 (0.028)			
M05_12	M042120	1.075 (0.067)	0.023 (0.058)	0.295 (0.023)		
M05_13	M042203	1.512 (0.072)	0.123 (0.028)	0.154 (0.014)		
M05_14	M042264	0.837 (0.032)	1.281 (0.039)			

**TIMSS 2015 Eighth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M05_15	M042255	0.657 (0.041)	-0.367 (0.101)	0.134 (0.038)	
M05_16	M042224	0.915 (0.029)	-0.075 (0.023)		
M06_01	M052017	1.238 (0.065)	0.126 (0.038)	0.187 (0.017)	
M06_02	M052217	1.368 (0.043)	0.777 (0.020)		
M06_03	M052021	1.025 (0.023)	0.627 (0.015)	-0.332 (0.029)	0.332 (0.032)
M06_04	M052095	1.636 (0.048)	0.442 (0.016)		
M06_05	M052094	1.189 (0.041)	1.126 (0.027)		
M06_06	M052131	1.256 (0.084)	0.829 (0.036)	0.241 (0.013)	
M06_07	M052090	1.276 (0.086)	0.881 (0.036)	0.227 (0.013)	
M06_08A	M052121A	1.045 (0.052)	0.260 (0.036)	0.098 (0.016)	
M06_08B	M052121B	1.890 (0.079)	1.472 (0.025)		
M06_09	M052042	0.910 (0.029)	0.533 (0.025)		
M06_10	M052047	1.136 (0.034)	0.342 (0.020)		
M06_11	M052044	1.636 (0.151)	1.157 (0.039)	0.398 (0.011)	
M06_12A	M052422A	0.825 (0.063)	0.054 (0.090)	0.318 (0.031)	
M06_12B	M052422B	0.705 (0.048)	0.266 (0.076)	0.143 (0.028)	
M06_13	M052505	1.165 (0.065)	-0.831 (0.069)	0.242 (0.037)	
M07_01	M042015	0.947 (0.050)	-0.432 (0.064)	0.158 (0.029)	
M07_02	M042196	1.098 (0.050)	0.013 (0.036)	0.091 (0.016)	
M07_03	M042194	1.184 (0.035)	-0.441 (0.020)		
M07_04A	M042114A	1.537 (0.044)	-0.055 (0.016)		
M07_04B	M042114B	1.549 (0.045)	0.205 (0.015)		
M07_05	M042112	0.869 (0.085)	1.113 (0.062)	0.318 (0.018)	
M07_06	M042109	1.656 (0.110)	1.020 (0.029)	0.222 (0.010)	
M07_07	M042050	1.152 (0.036)	0.684 (0.021)		
M07_08A	M042074A	1.067 (0.033)	0.556 (0.022)		
M07_08B	M042074B	0.970 (0.032)	0.739 (0.025)		
M07_08C	M042074C	1.754 (0.058)	0.977 (0.018)		
M07_09	M042151	0.892 (0.028)	0.014 (0.023)		
M07_10	M042132	1.847 (0.127)	1.158 (0.027)	0.200 (0.009)	
M07_11	M042257	0.708 (0.054)	0.855 (0.060)	0.132 (0.021)	
M07_12	M042158	0.782 (0.066)	0.310 (0.091)	0.337 (0.029)	
M07_13	M042252	1.141 (0.071)	0.798 (0.036)	0.175 (0.013)	(0.013)
M07_14	M042261	0.692 (0.045)	-0.079 (0.088)	0.142 (0.033)	
M09_01	M052413	1.194 (0.070)	0.096 (0.046)	0.276 (0.020)	

**TIMSS 2015 Eighth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M09_02	M052134	1.227 (0.060)	-0.156 (0.039)	0.159 (0.020)	
M09_03	M052078	1.052 (0.071)	0.926 (0.040)	0.181 (0.014)	
M09_04	M052034	1.406 (0.092)	0.634 (0.036)	0.301 (0.014)	
M09_05A	M052174A	1.088 (0.033)	0.284 (0.020)		
M09_05B	M052174B	1.167 (0.039)	1.055 (0.026)		
M09_06	M052130	1.289 (0.078)	0.949 (0.031)	0.151 (0.011)	
M09_07	M052073	1.486 (0.075)	0.521 (0.026)	0.146 (0.011)	
M09_08	M052110	1.527 (0.047)	0.682 (0.018)		
M09_09	M052105	1.144 (0.044)	1.490 (0.036)		
M09_10	M052407	1.294 (0.092)	0.399 (0.048)	0.404 (0.017)	
M09_11	M052036	0.756 (0.026)	0.420 (0.027)		
M09_12	M052502	1.146 (0.034)	-0.237 (0.020)		
M09_13	M052117	0.580 (0.031)	2.163 (0.095)		
M09_14	M052426	0.794 (0.045)	-0.833 (0.099)	0.168 (0.044)	
M11_01	M052079	1.057 (0.074)	0.529 (0.050)	0.296 (0.018)	
M11_02	M052204	0.855 (0.057)	0.505 (0.054)	0.179 (0.021)	
M11_03	M052364	1.135 (0.033)	0.023 (0.019)		
M11_04	M052215	0.853 (0.027)	-0.186 (0.024)		
M11_05	M052147	1.586 (0.104)	0.820 (0.031)	0.273 (0.011)	
M11_06	M052067	1.083 (0.063)	0.125 (0.049)	0.237 (0.021)	
M11_07	M052068	1.475 (0.095)	1.236 (0.030)	0.125 (0.008)	
M11_08	M052087	1.591 (0.056)	1.156 (0.022)		
M11_09	M052048	1.006 (0.036)	1.166 (0.031)		
M11_10	M052039	1.292 (0.038)	0.341 (0.018)		
M11_11	M052208	2.351 (0.131)	1.128 (0.019)	0.077 (0.005)	
M11_12A	M052419A	0.912 (0.042)	-0.237 (0.047)	0.077 (0.021)	
M11_12B	M052419B	1.419 (0.063)	-0.546 (0.036)	0.124 (0.021)	
M11_13	M052115	1.800 (0.078)	0.398 (0.019)	0.085 (0.009)	
M11_14	M052421	0.802 (0.027)	0.640 (0.028)		
M13_01	M052024	1.628 (0.091)	0.530 (0.027)	0.228 (0.012)	
M13_02A	M052058A	1.226 (0.036)	-0.259 (0.019)		
M13_02B	M052058B	1.529 (0.050)	0.998 (0.020)		
M13_03	M052125	1.344 (0.067)	0.652 (0.026)	0.109 (0.011)	
M13_04	M052229	0.960 (0.029)	0.095 (0.021)		
M13_05	M052063	1.316 (0.075)	0.635 (0.031)	0.186 (0.013)	

**TIMSS 2015 Eighth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M13_06	M052072	1.043 (0.054)	0.048 (0.043)	0.138 (0.020)		
M13_07A	M052146A	0.849 (0.027)	0.247 (0.024)			
M13_07B	M052146B	1.655 (0.059)	1.221 (0.022)			
M13_08	M052092	1.198 (0.095)	1.499 (0.042)	0.139 (0.009)		
M13_09	M052046	1.148 (0.101)	1.517 (0.047)	0.186 (0.010)		
M13_10	M052083	1.553 (0.090)	0.900 (0.026)	0.159 (0.010)		
M13_11	M052082	1.185 (0.064)	0.248 (0.038)	0.181 (0.017)		
M13_12	M052161	1.163 (0.062)	-0.093 (0.046)	0.203 (0.022)		
M13_13A	M052418A	1.976 (0.108)	0.742 (0.022)	0.165 (0.009)		
M13_13B	M052418B	1.738 (0.102)	0.611 (0.027)	0.244 (0.012)		
<b>Items Introduced in 2015:</b>						
M02_01	M062208	1.027 (0.043)	-0.102 (0.029)			
M02_02	M062153	0.927 (0.090)	0.551 (0.075)	0.209 (0.029)		
M02_03A	M062111A	1.376 (0.056)	0.164 (0.023)			
M02_03B	M062111B	1.676 (0.072)	0.646 (0.022)			
M02_04	M062237	1.731 (0.084)	1.050 (0.027)			
M02_05	M062314	1.127 (0.056)	1.166 (0.039)			
M02_06	M062074	1.112 (0.145)	1.248 (0.067)	0.295 (0.019)		
M02_07	M062183	0.955 (0.042)	0.259 (0.031)			
M02_08	M062202	1.135 (0.087)	-0.035 (0.068)	0.189 (0.033)		
M02_09	M062246	2.166 (0.197)	1.105 (0.031)	0.172 (0.011)		
M02_10	M062286	1.083 (0.043)	1.354 (0.030)		-0.174 (0.041)	0.174 (0.056)
M02_11	M062325	0.887 (0.134)	1.062 (0.097)	0.378 (0.028)		
M02_12	M062106	0.504 (0.051)	1.101 (0.101)	0.250 (0.000)		
M02_13	M062124	1.444 (0.104)	0.607 (0.037)	0.122 (0.016)		
M04_01	M062329	0.809 (0.079)	-0.615 (0.173)	0.240 (0.072)		
M04_02	M062151	1.251 (0.055)	0.813 (0.030)			
M04_03	M062346	1.136 (0.050)	0.779 (0.031)			
M04_04	M062212	1.344 (0.117)	1.170 (0.042)	0.113 (0.012)		
M04_05	M062056	1.326 (0.064)	1.127 (0.034)			
M04_06	M062317	1.419 (0.063)	0.871 (0.028)			
M04_07	M062350	1.342 (0.153)	1.588 (0.057)	0.124 (0.011)		
M04_08	M062078	1.599 (0.069)	0.704 (0.024)			
M04_09	M062284	0.674 (0.094)	0.463 (0.163)	0.306 (0.050)		
M04_10	M062245	1.277 (0.108)	0.710 (0.047)	0.192 (0.019)		
M04_11	M062287	1.237 (0.067)	1.450 (0.045)			

**TIMSS 2015 Eighth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M04_12A	M062345A	0.584 (0.025)	0.569 (0.033)		0.297 (0.051)	-0.297 (0.060)
M04_13	M062115	1.577 (0.179)	1.397 (0.047)	0.199 (0.013)		
M08_01	M062005	0.843 (0.097)	0.491 (0.106)	0.308 (0.036)		
M08_02	M062139	1.008 (0.045)	0.636 (0.033)			
M08_03	M062164	1.389 (0.099)	0.154 (0.046)	0.180 (0.023)		
M08_04	M062142	0.912 (0.040)	-0.224 (0.033)			
M08_05	M062084	1.398 (0.167)	1.582 (0.057)	0.151 (0.012)		
M08_06	M062351	0.797 (0.125)	1.643 (0.098)	0.194 (0.022)		
M08_07	M062223	1.306 (0.092)	-0.140 (0.056)	0.175 (0.029)		
M08_08	M062027	0.765 (0.037)	0.606 (0.040)			
M08_09	M062174	1.521 (0.156)	0.891 (0.049)	0.324 (0.017)		
M08_10	M062244	0.990 (0.043)	0.483 (0.031)			
M08_11	M062261	1.706 (0.183)	1.498 (0.044)	0.128 (0.010)		
M08_12	M062300	0.738 (0.023)	0.472 (0.025)		-0.500 (0.051)	0.500 (0.055)
M08_13	M062254	0.651 (0.042)	1.739 (0.091)			
M08_14A	M062132A	1.186 (0.050)	-0.251 (0.028)			
M08_14B	M062132B	1.123 (0.116)	0.858 (0.061)	0.258 (0.022)		
M10_01	M062150	1.136 (0.047)	-0.174 (0.027)			
M10_02	M062335	1.418 (0.096)	-0.067 (0.048)	0.159 (0.025)		
M10_03	M062219	2.076 (0.179)	0.883 (0.032)	0.224 (0.013)		
M10_04	M062002	0.698 (0.035)	0.670 (0.044)			
M10_05	M062149	1.204 (0.091)	0.613 (0.044)	0.126 (0.019)		
M10_06	M062241	1.764 (0.076)	0.674 (0.022)			
M10_08	M062105	0.800 (0.025)	0.906 (0.026)		-1.435 (0.082)	1.435 (0.086)
M10_09	M062040	0.882 (0.103)	0.967 (0.077)	0.236 (0.026)		
M10_10	M062288	0.809 (0.027)	1.137 (0.030)		-0.842 (0.062)	0.842 (0.071)
M10_11	M062173	1.151 (0.052)	0.819 (0.032)			
M10_12	M062133	1.350 (0.119)	0.722 (0.048)	0.240 (0.019)		
M10_13A	M062123A	1.741 (0.149)	0.436 (0.044)	0.320 (0.020)		
M10_13B	M062123B	1.545 (0.116)	0.752 (0.036)	0.138 (0.014)		
M12_01	M062271	1.631 (0.132)	0.583 (0.041)	0.247 (0.018)		
M12_02	M062152	1.130 (0.048)	0.448 (0.028)			
M12_03	M062215	0.855 (0.029)	0.744 (0.025)		-0.194 (0.042)	0.194 (0.049)
M12_04	M062143	1.650 (0.074)	0.887 (0.025)			
M12_05	M062230	1.624 (0.187)	1.414 (0.048)	0.218 (0.012)		



**TIMSS 2015 Eighth Grade Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
M12_06 M062095	1.674 (0.133)	0.615 (0.038)	0.224 (0.017)		
M12_07 M062076	1.806 (0.145)	0.319 (0.041)	0.294 (0.020)		
M12_08 M062030	0.513 (0.030)	0.039 (0.050)			
M12_09 M062171	0.821 (0.065)	-0.231 (0.102)	0.083 (0.047)		
M12_10 M062301	1.147 (0.054)	1.050 (0.036)			
M12_11 M062194	1.002 (0.088)	-0.308 (0.106)	0.261 (0.047)		
M12_12 M062344	0.890 (0.044)	1.106 (0.045)			
M12_13 M062320	1.886 (0.122)	0.566 (0.028)	0.097 (0.012)		
M12_14 M062296	1.168 (0.049)	0.221 (0.027)			
M14_01 M062001	1.025 (0.127)	0.915 (0.076)	0.346 (0.024)		
M14_02 M062214	1.158 (0.049)	0.453 (0.028)			
M14_03 M062146	1.399 (0.106)	0.759 (0.037)	0.126 (0.015)		
M14_04 M062154	1.352 (0.054)	-0.030 (0.024)			
M14_05 M062067	1.212 (0.112)	0.173 (0.073)	0.344 (0.029)		
M14_06 M062341	1.036 (0.166)	1.727 (0.092)	0.235 (0.017)		
M14_07 M062242	1.248 (0.090)	0.190 (0.051)	0.161 (0.024)		
M14_08A M062250A	1.175 (0.048)	0.186 (0.026)			
M14_08B M062250B	1.388 (0.063)	0.885 (0.028)			
M14_09 M062170	0.524 (0.025)	0.990 (0.044)		0.645 (0.053)	-0.645 (0.074)
M14_10 M062192	1.058 (0.053)	1.178 (0.042)			
M14_11 M062072	1.018 (0.043)	0.204 (0.029)			
M14_13 M062120	1.274 (0.099)	0.540 (0.045)	0.162 (0.020)		

## Appendix 13D: TIMSS 2015 Eighth Grade Science Item Parameters from Concurrent Calibration

**TIMSS 2015 Eighth Grade Science Item Parameters from Concurrent Calibration**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
<b>Items Released in 2011:</b>						
S01_01	S032611	1.027 (0.141)	1.240 (0.069)	0.229 (0.020)		
S01_02	S032614	0.805 (0.039)	-0.155 (0.036)			
S01_03	S032451	0.637 (0.019)	0.012 (0.025)		-1.232 (0.072)	1.232 (0.071)
S01_04	S032156	1.160 (0.120)	0.722 (0.055)	0.259 (0.022)		
S01_05	S032056	0.871 (0.043)	0.407 (0.033)			
S01_06	S032087	0.927 (0.099)	0.739 (0.065)	0.201 (0.025)		
S01_07	S032279	0.768 (0.117)	1.395 (0.094)	0.179 (0.024)		
S01_08	S032238	1.326 (0.118)	0.723 (0.043)	0.191 (0.018)		
S01_09	S032369	0.597 (0.024)	0.702 (0.032)		-0.297 (0.055)	0.297 (0.063)
S01_10	S032160	0.856 (0.097)	0.295 (0.102)	0.340 (0.035)		
S01_11	S032654	0.958 (0.093)	0.588 (0.064)	0.205 (0.025)		
S01_12	S032126	0.764 (0.038)	0.050 (0.036)			
S01_13	S032510	0.965 (0.086)	-0.069 (0.089)	0.295 (0.035)		
S01_14	S032158	0.949 (0.099)	0.268 (0.088)	0.329 (0.032)		
S02_01	S052093	0.579 (0.061)	-1.426 (0.272)	0.299 (0.078)		
S02_02	S052088	0.999 (0.080)	-0.156 (0.078)	0.237 (0.033)		
S02_03	S052030	0.821 (0.113)	0.944 (0.084)	0.268 (0.028)		
S02_04	S052080	0.665 (0.084)	0.255 (0.142)	0.303 (0.044)		
S02_05	S052091	0.834 (0.041)	0.169 (0.033)			
S02_06	S052152	1.500 (0.129)	0.781 (0.037)	0.169 (0.016)		
S02_07	S052136	0.830 (0.041)	0.157 (0.033)			
S02_08	S052046	1.585 (0.123)	-0.447 (0.061)	0.353 (0.032)		
S02_09	S052254	0.826 (0.112)	1.120 (0.078)	0.206 (0.025)		
S02_10	S052207	1.065 (0.051)	0.651 (0.031)			
S02_11A	S052165A	0.867 (0.054)	1.385 (0.065)			
S02_11B	S052165B	0.718 (0.044)	1.124 (0.060)			
S02_11C	S052165C	0.889 (0.047)	0.864 (0.041)			
S02_12	S052297	0.831 (0.087)	0.251 (0.097)	0.277 (0.035)		
S02_13	S052032	1.156 (0.062)	1.101 (0.040)			
S02_14	S052106	0.748 (0.045)	0.948 (0.052)			

**TIMSS 2015 Eighth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S03_01	S042304	0.769 (0.063)	-0.059 (0.086)	0.148 (0.033)	
S03_02	S042038	0.902 (0.080)	0.472 (0.063)	0.160 (0.026)	
S03_03	S042298	1.066 (0.051)	0.679 (0.032)		
S03_04	S042261	0.915 (0.049)	0.929 (0.043)		
S03_05A	S042051A	0.762 (0.038)	0.018 (0.036)		
S03_05B	S042051B	1.323 (0.061)	0.683 (0.027)		
S03_06	S042076	1.020 (0.049)	0.622 (0.032)		
S03_07	S042404	0.934 (0.042)	1.216 (0.035)	0.049 (0.038)	-0.049 (0.057)
S03_08	S042306	1.132 (0.141)	0.986 (0.060)	0.268 (0.021)	
S03_09	S042403	0.963 (0.049)	0.801 (0.037)		
S03_10	S042272	0.902 (0.088)	0.221 (0.085)	0.269 (0.033)	
S03_11	S042100	0.508 (0.023)	0.545 (0.036)	-0.051 (0.060)	0.051 (0.068)
S03_12A	S042238A	0.733 (0.082)	0.793 (0.078)	0.155 (0.028)	
S03_12B	S042238B	0.775 (0.047)	1.166 (0.060)		
S03_12C	S042238C	0.904 (0.043)	-0.600 (0.039)		
S03_13	S042141	0.792 (0.072)	-0.196 (0.110)	0.242 (0.041)	
S03_14	S042215	0.751 (0.167)	1.794 (0.163)	0.237 (0.025)	
S05_01	S032542	1.360 (0.137)	0.692 (0.049)	0.293 (0.020)	
S05_02	S032645	1.014 (0.121)	0.755 (0.070)	0.307 (0.025)	
S05_03Z	S032530Z	0.547 (0.023)	0.348 (0.035)	0.956 (0.054)	-0.956 (0.060)
S05_04	S032007	0.842 (0.041)	0.355 (0.034)		
S05_05	S032502	0.997 (0.089)	0.549 (0.057)	0.172 (0.024)	
S05_06	S032679	0.812 (0.052)	1.429 (0.070)		
S05_07	S032184	0.361 (0.078)	1.376 (0.236)	0.180 (0.056)	
S05_08	S032394	0.981 (0.106)	0.598 (0.071)	0.277 (0.027)	
S05_09	S032151	1.106 (0.101)	0.648 (0.051)	0.179 (0.022)	
S05_10A	S032651A	1.206 (0.053)	0.353 (0.025)		
S05_10B	S032651B	1.031 (0.057)	1.148 (0.046)		
S05_11A	S032665A	0.947 (0.046)	0.505 (0.032)		
S05_11B	S032665B	1.076 (0.056)	0.985 (0.039)		
S05_11C	S032665C	0.990 (0.054)	0.919 (0.040)		
S06_01	S042073	0.764 (0.091)	-0.715 (0.206)	0.507 (0.052)	
S06_02	S042017	1.073 (0.132)	1.130 (0.061)	0.216 (0.019)	
S06_03	S042007	1.349 (0.125)	0.786 (0.043)	0.201 (0.018)	
S06_04	S042024	1.286 (0.185)	1.310 (0.065)	0.273 (0.017)	

**TIMSS 2015 Eighth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S06_05	S042095	1.036 (0.075)	-0.282 (0.071)	0.199 (0.032)	
S06_06	S042022	0.918 (0.044)	0.493 (0.033)		
S06_07	S042063	1.016 (0.093)	-1.154 (0.139)	0.401 (0.052)	
S06_08	S042197	1.098 (0.113)	0.791 (0.055)	0.219 (0.021)	
S06_09	S042297	0.548 (0.021)	1.167 (0.044)		-0.959 (0.073) 0.959 (0.087)
S06_10	S042305	0.556 (0.029)	1.190 (0.051)		0.320 (0.053) -0.320 (0.078)
S06_11	S042112	0.450 (0.057)	-0.012 (0.213)	0.185 (0.056)	
S06_12Z	S042173Z	0.447 (0.019)	-0.667 (0.046)		1.354 (0.084) -1.354 (0.062)
S06_13	S042407	0.528 (0.034)	0.769 (0.062)		
S06_14	S042278	0.804 (0.043)	0.758 (0.042)		
S06_15	S042274	1.450 (0.183)	1.269 (0.053)	0.222 (0.014)	
S06_17	S042317	0.617 (0.021)	-0.097 (0.027)		-0.471 (0.059) 0.471 (0.056)
S07_01	S032465	0.840 (0.083)	0.153 (0.095)	0.270 (0.035)	
S07_02	S032315	0.862 (0.087)	0.590 (0.071)	0.196 (0.027)	
S07_03	S032306	0.527 (0.017)	0.466 (0.030)		-1.229 (0.076) 1.229 (0.080)
S07_04	S032640	0.590 (0.033)	-0.215 (0.046)		
S07_05	S032579	1.254 (0.188)	1.278 (0.067)	0.305 (0.018)	
S07_06	S032570	0.971 (0.046)	0.501 (0.031)		
S07_07	S032024	1.074 (0.157)	1.265 (0.073)	0.252 (0.020)	
S07_08	S032272	1.142 (0.068)	1.369 (0.052)		
S07_09	S032141	2.043 (0.198)	1.005 (0.032)	0.189 (0.013)	
S07_10	S032060	1.168 (0.051)	-0.434 (0.030)		
S07_11	S032463	1.383 (0.109)	0.255 (0.048)	0.238 (0.023)	
S07_12Z	S032650Z	0.757 (0.030)	0.087 (0.024)		0.164 (0.044) -0.164 (0.043)
S07_13	S032514	0.605 (0.089)	0.856 (0.121)	0.223 (0.038)	
<b>Items Common in 2011 and 2015:</b>					
S01_01	S042258	0.803 (0.069)	0.990 (0.053)	0.175 (0.019)	
S01_02	S042005	0.341 (0.008)	0.469 (0.030)		-2.474 (0.089) 2.474 (0.091)
S01_03	S042016	1.019 (0.087)	1.310 (0.045)	0.137 (0.012)	
S01_04A	S042300A	1.389 (0.041)	0.103 (0.016)		
S01_04B	S042300B	0.589 (0.030)	1.603 (0.071)		
S01_04C	S042300C	1.136 (0.035)	0.182 (0.018)		
S01_05	S042319	1.320 (0.044)	0.815 (0.020)		
S01_06	S042068	1.329 (0.098)	0.973 (0.033)	0.216 (0.012)	
S01_07	S042216	1.140 (0.085)	0.494 (0.049)	0.348 (0.019)	

**TIMSS 2015 Eighth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S01_08	S042249	0.858 (0.062)	0.620 (0.051)	0.185 (0.020)	
S01_09	S042094	0.836 (0.031)	0.788 (0.029)		
S01_10A	S042293A	0.910 (0.030)	-0.320 (0.024)		
S01_10B	S042293B	0.902 (0.045)	1.796 (0.063)		
S01_11	S042195	0.658 (0.034)	1.761 (0.074)		
S01_12	S042400	1.063 (0.039)	0.991 (0.027)		
S01_14	S042164	1.047 (0.063)	0.548 (0.037)	0.145 (0.016)	
S03_01	S052261	0.981 (0.075)	0.754 (0.046)	0.234 (0.018)	
S03_02Z	S052092Z	0.340 (0.013)	0.577 (0.038)	1.011 (0.058)	-1.011 (0.067)
S03_03A	S052263A	1.386 (0.054)	1.277 (0.028)		
S03_03B	S052263B	1.627 (0.057)	1.018 (0.020)		
S03_04	S052265	0.810 (0.031)	0.905 (0.032)		
S03_05	S052280	0.976 (0.069)	0.453 (0.052)	0.267 (0.021)	
S03_06	S052256	1.150 (0.077)	0.762 (0.035)	0.194 (0.015)	
S03_07Z	S052043Z	0.503 (0.025)	1.201 (0.059)		
S03_08	S052194	1.148 (0.080)	0.774 (0.037)	0.213 (0.015)	
S03_09	S052179	0.904 (0.081)	1.044 (0.050)	0.218 (0.017)	
S03_10	S052233	0.755 (0.035)	1.490 (0.054)		
S03_11	S052159	0.497 (0.068)	0.365 (0.204)	0.385 (0.046)	
S03_12A	S052289A	0.841 (0.052)	-0.911 (0.104)	0.279 (0.040)	
S03_12B	S052289B	0.563 (0.051)	0.736 (0.084)	0.140 (0.028)	
S03_12C	S052289C	0.822 (0.031)	0.746 (0.029)		
S05_01	S042053	1.226 (0.067)	-0.124 (0.046)	0.265 (0.022)	
S05_02	S042408	0.739 (0.028)	0.650 (0.030)		
S05_03	S042015	0.959 (0.078)	0.710 (0.051)	0.279 (0.019)	
S05_04	S042309	0.321 (0.047)	1.084 (0.211)	0.144 (0.048)	
S05_05A	S042049A	0.980 (0.032)	-0.579 (0.026)		
S05_05B	S042049B	1.141 (0.036)	0.280 (0.019)		
S05_06	S042182	0.694 (0.048)	-0.311 (0.100)	0.214 (0.035)	
S05_07	S042402	0.886 (0.035)	1.144 (0.036)		
S05_08A	S042228A	1.449 (0.053)	1.105 (0.024)		
S05_08B	S042228B	1.285 (0.038)	0.033 (0.017)		
S05_08C	S042228C	1.527 (0.047)	0.556 (0.016)		
S05_09	S042126	0.784 (0.075)	0.273 (0.099)	0.415 (0.029)	
S05_10	S042210	1.018 (0.131)	1.504 (0.069)	0.293 (0.014)	
S05_11	S042176	1.038 (0.036)	0.694 (0.023)		

**TIMSS 2015 Eighth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S05_12	S042211	0.878 (0.030)	0.163 (0.023)		
S05_13	S042135	0.795 (0.028)	-0.167 (0.026)		
S05_14	S042257	0.674 (0.089)	1.163 (0.086)	0.312 (0.025)	
S06_01	S052003	1.062 (0.083)	0.230 (0.065)	0.431 (0.022)	
S06_02	S052071	1.326 (0.075)	0.510 (0.030)	0.182 (0.014)	
S06_03	S052246	0.921 (0.077)	0.898 (0.049)	0.232 (0.018)	
S06_04	S052276	0.687 (0.052)	0.094 (0.089)	0.221 (0.031)	
S06_05A	S052303A	0.609 (0.051)	-0.008 (0.120)	0.247 (0.037)	
S06_05B	S052303B	0.738 (0.028)	0.541 (0.028)		
S06_06	S052125	0.898 (0.118)	1.099 (0.074)	0.456 (0.019)	
S06_07	S052145	1.274 (0.039)	0.426 (0.017)		
S06_08	S052049	0.701 (0.022)	0.808 (0.023)	0.455 (0.029)	-0.455 (0.039)
S06_09	S052063	0.673 (0.057)	0.627 (0.073)	0.189 (0.026)	
S06_10	S052192	1.403 (0.061)	0.247 (0.024)	0.092 (0.012)	
S06_11	S052232	0.460 (0.074)	1.557 (0.125)	0.198 (0.034)	
S06_12	S052141	1.221 (0.043)	0.892 (0.023)		
S06_13	S052096	0.901 (0.061)	0.070 (0.067)	0.281 (0.026)	
S06_14	S052116	0.836 (0.022)	0.218 (0.016)	0.129 (0.028)	-0.129 (0.028)
S06_15	S052110	0.906 (0.036)	1.073 (0.033)		
S07_01	S042042	0.761 (0.062)	-0.227 (0.114)	0.389 (0.035)	
S07_02	S042030	0.843 (0.034)	1.147 (0.037)		
S07_03	S042003	0.690 (0.075)	0.978 (0.075)	0.261 (0.025)	
S07_04	S042110	0.573 (0.041)	-0.592 (0.137)	0.181 (0.044)	
S07_05A	S042222A	1.001 (0.040)	1.233 (0.035)		
S07_05B	S042222B	0.990 (0.035)	0.859 (0.026)		
S07_05C	S042222C	0.853 (0.059)	0.100 (0.071)	0.270 (0.026)	
S07_06	S042065	0.838 (0.062)	-0.556 (0.113)	0.411 (0.036)	
S07_07	S042280	1.289 (0.065)	0.251 (0.032)	0.162 (0.016)	
S07_08	S042088	0.653 (0.025)	0.060 (0.029)		
S07_09	S042218	1.474 (0.088)	0.531 (0.030)	0.243 (0.014)	
S07_10	S042104	0.918 (0.035)	1.040 (0.032)		
S07_11	S042064	0.859 (0.032)	0.770 (0.028)		
S07_12	S042273	1.213 (0.037)	0.288 (0.018)		
S07_13	S042301	0.839 (0.028)	0.053 (0.024)		
S07_14	S042312	0.405 (0.049)	-0.200 (0.282)	0.263 (0.063)	
S07_15	S042217	1.711 (0.111)	0.734 (0.027)	0.257 (0.012)	

**TIMSS 2015 Eighth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S07_16	S042406	1.105 (0.037)	0.680 (0.021)			
S09_01	S052076	0.883 (0.066)	0.497 (0.057)	0.247 (0.022)		
S09_02	S052272	1.115 (0.034)	-0.028 (0.019)			
S09_03A	S052085A	1.009 (0.041)	1.277 (0.036)			
S09_03B	S052085B	1.072 (0.033)	0.052 (0.019)			
S09_04	S052094	0.612 (0.027)	1.047 (0.045)			
S09_05	S052248	1.010 (0.143)	1.487 (0.073)	0.356 (0.015)		
S09_06	S052146	0.993 (0.032)	0.389 (0.021)			
S09_07	S052282	0.828 (0.064)	0.772 (0.051)	0.177 (0.019)		
S09_08	S052299	1.174 (0.075)	0.330 (0.044)	0.287 (0.019)		
S09_09	S052144	1.294 (0.093)	0.742 (0.036)	0.278 (0.015)		
S09_10	S052214	0.995 (0.032)	0.326 (0.021)			
S09_12	S052101	0.590 (0.026)	0.779 (0.039)			
S09_13	S052113	1.713 (0.106)	0.535 (0.028)	0.294 (0.013)		
S09_14	S052107	0.985 (0.089)	1.255 (0.047)	0.173 (0.014)		
S11_01A	S052090A	0.418 (0.054)	-0.163 (0.299)	0.325 (0.063)		
S11_01B	S052090B	0.608 (0.032)	1.805 (0.079)			
S11_02	S052262	0.821 (0.072)	0.790 (0.059)	0.249 (0.021)		
S11_03	S052267	1.003 (0.074)	0.762 (0.043)	0.216 (0.017)		
S11_04	S052273	0.584 (0.019)	0.874 (0.027)		0.201 (0.036)	-0.201 (0.046)
S11_05Z	S052015Z	0.883 (0.029)	-0.119 (0.023)			
S11_06	S052051	1.053 (0.035)	0.683 (0.022)			
S11_07	S052026	0.581 (0.063)	0.348 (0.139)	0.331 (0.038)		
S11_08	S052130	1.005 (0.092)	1.165 (0.046)	0.219 (0.015)		
S11_09	S052028	0.896 (0.074)	0.595 (0.061)	0.304 (0.022)		
S11_10	S052189	1.085 (0.035)	0.424 (0.020)			
S11_11	S052217	0.737 (0.079)	1.015 (0.070)	0.273 (0.023)		
S11_12	S052038	1.002 (0.094)	1.024 (0.050)	0.292 (0.017)		
S11_13	S052099	0.860 (0.031)	0.762 (0.027)			
S11_14	S052118	0.870 (0.036)	1.241 (0.039)			
S13_01	S052006	0.649 (0.019)	-0.067 (0.021)		0.587 (0.036)	-0.587 (0.033)
S13_02	S052069	1.181 (0.099)	0.809 (0.044)	0.342 (0.016)		
S13_03	S052012	0.966 (0.060)	0.421 (0.045)	0.185 (0.019)		
S13_04	S052021	0.892 (0.031)	0.636 (0.025)			
S13_05Z	S052095Z	0.537 (0.022)	-0.220 (0.036)			

**TIMSS 2015 Eighth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S13_06	S052134	2.039 (0.227)	1.399 (0.036)	0.304 (0.009)		
S13_07	S052054	0.764 (0.026)	-0.391 (0.028)			
S13_08	S052150	0.829 (0.084)	1.211 (0.057)	0.213 (0.018)		
S13_09A	S052243A	0.624 (0.025)	0.388 (0.031)			
S13_09B	S052243B	0.778 (0.028)	0.406 (0.026)			
S13_09C	S052243C	0.705 (0.072)	1.070 (0.066)	0.203 (0.022)		
S13_10	S052206	1.133 (0.071)	0.510 (0.038)	0.211 (0.017)		
S13_11A	S052112A	0.809 (0.067)	0.354 (0.077)	0.321 (0.026)		
S13_11B	S052112B	1.045 (0.037)	0.836 (0.025)			
S13_12	S052294	1.105 (0.057)	-0.039 (0.044)	0.185 (0.020)		
<b>Items Introduced in 2015:</b>						
S02_01	S062189	0.433 (0.022)	0.066 (0.038)		0.305 (0.071)	-0.305 (0.069)
S02_02	S062094	0.984 (0.087)	0.439 (0.064)	0.181 (0.028)		
S02_03	S062118	0.866 (0.040)	0.044 (0.032)			
S02_04A	S062103A	1.165 (0.114)	0.621 (0.058)	0.271 (0.024)		
S02_04B	S062103B	0.715 (0.032)	1.057 (0.035)		0.176 (0.043)	-0.176 (0.059)
S02_05	S062010	0.524 (0.034)	0.795 (0.061)			
S02_06	S062253	0.862 (0.082)	0.859 (0.058)	0.094 (0.022)		
S02_07	S062051	0.886 (0.045)	0.844 (0.039)			
S02_08	S062044	1.070 (0.123)	1.338 (0.059)	0.119 (0.016)		
S02_09	S062046	0.855 (0.040)	0.176 (0.032)			
S02_10	S062149	0.426 (0.031)	0.865 (0.076)			
S02_11	S062268	1.024 (0.088)	-0.280 (0.097)	0.296 (0.041)		
S02_12	S062170	0.723 (0.098)	0.280 (0.155)	0.358 (0.047)		
S02_13	S062234	0.791 (0.032)	0.637 (0.027)		0.649 (0.037)	-0.649 (0.047)
S02_14	S062271	0.773 (0.117)	0.991 (0.099)	0.290 (0.033)		
S04_01	S062099	0.827 (0.073)	0.268 (0.079)	0.137 (0.033)		
S04_02	S062095	0.459 (0.022)	0.693 (0.041)		-0.087 (0.065)	0.087 (0.076)
S04_03	S062106	0.651 (0.051)	-1.064 (0.161)	0.000 (0.066)		
S04_04	S062064	0.899 (0.041)	-0.375 (0.035)			
S04_05	S062132	0.918 (0.096)	0.360 (0.088)	0.282 (0.034)		
S04_06	S062163	1.161 (0.066)	1.337 (0.047)			
S04_07	S062153	1.203 (0.142)	0.947 (0.058)	0.298 (0.021)		
S04_08	S062018	0.533 (0.023)	1.452 (0.056)		-0.647 (0.069)	0.647 (0.092)
S04_09	S062143	0.845 (0.057)	1.710 (0.083)			



**TIMSS 2015 Eighth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item	Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S04_10	S062276	0.693 (0.040)	0.919 (0.052)		
S04_11	S062050	0.979 (0.050)	0.944 (0.039)		
S04_12	S0622205	1.070 (0.098)	0.771 (0.050)	0.150 (0.021)	
S04_13	S062190	0.869 (0.072)	0.074 (0.081)	0.144 (0.035)	
S04_14A	S062024A	0.575 (0.099)	0.937 (0.148)	0.237 (0.047)	
S04_14B	S062024B	0.782 (0.050)	1.500 (0.073)		
S08_01	S062055	0.995 (0.118)	0.140 (0.114)	0.463 (0.036)	
S08_02	S062007	1.183 (0.098)	0.464 (0.051)	0.192 (0.023)	
S08_03	S062275	0.916 (0.046)	0.703 (0.035)		
S08_04	S062225	1.201 (0.173)	1.307 (0.065)	0.259 (0.019)	
S08_05	S062111	0.541 (0.024)	0.536 (0.033)	0.013 (0.056)	-0.013 (0.063)
S08_06A	S062116A	1.156 (0.052)	0.580 (0.027)		
S08_06B	S062116B	1.332 (0.064)	0.931 (0.030)		
S08_06C	S062116C	0.910 (0.054)	1.334 (0.056)		
S08_07	S062262	0.900 (0.129)	1.070 (0.079)	0.286 (0.027)	
S08_08	S062035	1.016 (0.116)	0.996 (0.059)	0.198 (0.022)	
S08_09	S062144	0.677 (0.066)	-0.421 (0.161)	0.161 (0.060)	
S08_10	S062162	0.784 (0.042)	0.792 (0.042)		
S08_11	S062233	0.958 (0.126)	0.783 (0.083)	0.349 (0.029)	
S08_13	S062171	0.399 (0.084)	0.558 (0.346)	0.153 (0.092)	
S10_01	S062090	0.988 (0.100)	0.120 (0.095)	0.335 (0.036)	
S10_02	S062274	0.599 (0.024)	0.818 (0.036)	1.097 (0.047)	-1.097 (0.066)
S10_03	S062284	0.399 (0.081)	0.390 (0.372)	0.162 (0.096)	
S10_04A	S062098A	0.616 (0.024)	0.399 (0.028)	-0.070 (0.052)	0.070 (0.055)
S10_04B	S062098B	0.745 (0.033)	1.278 (0.040)	-0.137 (0.047)	0.137 (0.066)
S10_05	S062032	1.779 (0.280)	1.448 (0.057)	0.296 (0.014)	
S10_06	S062043	0.913 (0.047)	0.902 (0.040)		
S10_07	S062158	0.781 (0.117)	0.819 (0.110)	0.349 (0.035)	
S10_08	S062159	0.977 (0.086)	0.336 (0.069)	0.197 (0.029)	
S10_09	S062005	1.309 (0.058)	0.638 (0.026)		
S10_10	S062075	1.073 (0.130)	0.780 (0.071)	0.343 (0.025)	
S10_11	S062004	1.836 (0.150)	0.825 (0.031)	0.171 (0.014)	
S10_12	S062175	0.781 (0.041)	0.641 (0.039)		
S10_13A	S062173A	0.716 (0.037)	0.313 (0.038)		
S10_13B	S062173B	0.881 (0.153)	1.622 (0.104)	0.202 (0.021)	

**TIMSS 2015 Eighth Grade Science Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
S12_01	S062279	1.215 (0.091)	0.238 (0.052)	0.187 (0.024)		
S12_02	S062112	0.554 (0.032)	0.069 (0.047)			
S12_03	S062119	1.214 (0.097)	0.221 (0.057)	0.232 (0.026)		
S12_04	S062093	0.641 (0.027)	0.097 (0.028)		0.289 (0.050)	-0.289 (0.048)
S12_05	S062089	1.301 (0.120)	0.958 (0.042)	0.153 (0.016)		
S12_06	S062006	1.016 (0.046)	0.402 (0.029)			
S12_07	S062067	0.829 (0.040)	0.400 (0.034)			
S12_08	S062247	1.082 (0.159)	1.321 (0.071)	0.264 (0.020)		
S12_09	S062177	0.823 (0.111)	1.065 (0.079)	0.223 (0.027)		
S12_10	S062186	1.592 (0.184)	1.133 (0.044)	0.256 (0.015)		
S12_11A	S062211A	0.780 (0.039)	0.401 (0.036)			
S12_11B	S062211B	0.843 (0.068)	2.084 (0.119)			
S12_13	S062033	1.143 (0.053)	0.673 (0.029)			
S12_14	S062037	0.891 (0.113)	0.698 (0.088)	0.326 (0.030)		
S12_15	S062242	0.755 (0.038)	-1.198 (0.061)			
S14_01A	S062091A	1.052 (0.097)	-0.523 (0.118)	0.384 (0.047)		
S14_01B	S062091B	0.570 (0.043)	-1.056 (0.096)	0.250 (0.000)		
S14_02	S062100	0.884 (0.042)	0.337 (0.032)			
S14_03	S062097	0.912 (0.080)	0.363 (0.069)	0.151 (0.030)		
S14_04	S062101	0.664 (0.028)	0.196 (0.027)		0.297 (0.047)	-0.297 (0.048)
S14_06	S062128	0.890 (0.041)	-0.002 (0.032)			
S14_07	S062047	0.488 (0.033)	0.716 (0.063)			
S14_08	S062042	0.718 (0.039)	0.667 (0.043)			
S14_09	S062250	0.552 (0.037)	1.133 (0.073)			
S14_10	S062246	0.940 (0.139)	1.185 (0.077)	0.279 (0.024)		
S14_11	S062056	1.093 (0.049)	0.459 (0.028)			
S14_12	S062235	0.751 (0.089)	0.707 (0.091)	0.186 (0.034)		
S14_13	S062180	1.272 (0.108)	0.386 (0.053)	0.243 (0.025)		
S14_14	S062022	0.596 (0.035)	0.627 (0.050)			
S14_15	S062243	0.625 (0.022)	0.030 (0.027)		-0.322 (0.056)	0.322 (0.054)

## Appendix 13E: TIMSS Numeracy 2015 Mathematics Item Parameters from Item Calibration

**TIMSS Numeracy 2015 Mathematics Item Parameters from Concurrent Calibration**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
<b>Items Released in 2011:</b>						
N01_01	MN11135	0.808 (0.088)	-1.263 (0.135)	0.228 (0.050)		
N01_02	MN11114	1.266 (0.074)	-0.287 (0.037)			
N01_03	MN11216	1.342 (0.072)	-0.862 (0.032)			
N01_04	MN11255	1.010 (0.104)	-0.848 (0.085)	0.203 (0.035)		
N01_05	MN11027	1.023 (0.057)	-1.115 (0.039)			
N01_06	MN11259	1.624 (0.166)	-0.337 (0.046)	0.180 (0.019)		
N01_07	MN11031	0.813 (0.078)	-1.299 (0.114)	0.163 (0.044)		
N01_08	MN11227	0.549 (0.047)	0.379 (0.111)			
N01_09	MN11267	0.636 (0.047)	-2.646 (0.106)			
N01_10	MN11042	0.624 (0.042)	-1.133 (0.057)			
N01_11	MN11184	0.793 (0.050)	-0.664 (0.048)			
N01_12	MN11190	1.129 (0.069)	-0.220 (0.042)			
N01_13	MN11193	1.745 (0.267)	0.172 (0.059)	0.288 (0.018)		
N02_01	MN11009	0.842 (0.092)	-0.959 (0.112)	0.204 (0.042)		
N02_02	MN11024	1.015 (0.058)	-0.783 (0.039)			
N02_03	MN11134	1.188 (0.139)	-0.477 (0.072)	0.257 (0.028)		
N02_04	MN11212	0.871 (0.051)	-1.142 (0.044)			
N02_05	MN11253	1.028 (0.105)	-0.868 (0.084)	0.201 (0.034)		
N02_06	MN11221	2.020 (0.211)	-0.146 (0.038)	0.147 (0.015)		
N02_07	MN11146	0.740 (0.049)	-0.332 (0.057)			
N02_08	MN11177	1.258 (0.080)	0.005 (0.044)			
N02_09	MN11158	0.598 (0.042)	-0.884 (0.059)			
N02_10	MN11002	1.280 (0.197)	0.297 (0.073)	0.217 (0.019)		
N02_11A	MN11182A	0.953 (0.090)	-2.142 (0.138)	0.218 (0.060)		
N02_11B	MN11182B	0.952 (0.089)	-1.591 (0.113)	0.200 (0.048)		
N02_12	MN11272	0.747 (0.053)	1.001 (0.096)		-0.232 (0.082)	0.232 (0.141)
N03_01	MN11017	0.741 (0.047)	-1.982 (0.067)			
N03_02	MN11125	0.843 (0.052)	-0.515 (0.047)			
N03_03	MN11077	1.111 (0.070)	-0.109 (0.045)			
N03_04A	MN11047A	1.054 (0.093)	-1.920 (0.106)	0.186 (0.049)		
N03_04B	MN11047B	1.130 (0.103)	-1.570 (0.094)	0.212 (0.043)		

**TIMSS Numeracy 2015 Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
N03_05	MN11223	1.115 (0.068)	-0.243 (0.042)			
N03_06	MN11034	0.907 (0.126)	-0.004 (0.083)	0.174 (0.026)		
N03_07	MN11175	1.031 (0.060)	-0.558 (0.040)			
N03_08	MN11262	0.830 (0.123)	-0.031 (0.095)	0.196 (0.031)		
N03_09	MN11239	0.702 (0.155)	0.618 (0.152)	0.207 (0.031)		
N03_10	MN11202	0.842 (0.050)	-1.200 (0.046)			
N03_11	MN11299	1.193 (0.068)	-0.572 (0.036)			
N04_01 *	M061272	0.910 (0.038)	0.121 (0.028)			
N04_02 *	M061243	0.477 (0.015)	-0.220 (0.031)		-0.923 (0.072)	0.923 (0.068)
N04_03 *	M061029	1.151 (0.072)	-0.226 (0.055)	0.139 (0.027)		
N04_04 *	M061031	1.497 (0.087)	0.563 (0.027)	0.066 (0.012)		
N04_05 *	M061050	1.427 (0.104)	0.596 (0.036)	0.184 (0.017)		
N04_06 *	M061167	0.730 (0.033)	-0.826 (0.047)			
N04_07 *	M061206	0.723 (0.069)	0.755 (0.070)	0.105 (0.027)		
N04_08A	M061265A	0.775 (0.083)	1.308 (0.181)			
N04_08B *	M061265B	0.991 (0.103)	1.125 (0.057)	0.183 (0.019)		
N04_09 *	M061185	0.980 (0.063)	-0.503 (0.076)	0.114 (0.036)		
N04_10 *	M061239	1.408 (0.056)	-0.587 (0.026)			
N05_01	MN11076	0.838 (0.087)	-1.454 (0.135)	0.224 (0.051)		
N05_02	MN11141	1.011 (0.056)	-1.115 (0.040)			
N05_03	MN11142	1.693 (0.156)	-0.420 (0.041)	0.133 (0.017)		
N05_04	MN11005	2.124 (0.240)	-0.223 (0.040)	0.225 (0.017)		
N05_05A	MN11256A	0.983 (0.056)	-1.617 (0.046)			
N05_05B	MN11256B	0.944 (0.054)	-1.104 (0.042)			
N05_06	MN11108	1.113 (0.075)	0.151 (0.054)			
N05_07	MN11062	0.322 (0.035)	-0.295 (0.124)			
N05_08	MN11174	0.695 (0.048)	-0.264 (0.062)			
N05_09	MN11067	0.455 (0.070)	-1.218 (0.299)	0.230 (0.074)		
N05_10	MN11043	0.633 (0.056)	-3.583 (0.175)			
N05_11	MN11268	0.725 (0.081)	-0.621 (0.102)	0.130 (0.035)		
N05_12	MN11270	1.152 (0.069)	-0.319 (0.040)			
N06_01	MN11019	0.959 (0.110)	-0.686 (0.091)	0.222 (0.034)		
N06_02	MN11145	0.973 (0.055)	-1.389 (0.043)			
N06_03	MN11211	1.895 (0.172)	-0.683 (0.041)	0.175 (0.020)		
N06_04	MN11014	0.997 (0.059)	-0.475 (0.042)			

\* Items with fixed item parameters estimated in TIMSS 2015 fourth grade item calibration.

**TIMSS Numeracy 2015 Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
N06_05	MN11300	1.071 (0.065)	-0.307 (0.042)			
N06_06	MN11028	1.265 (0.068)	-0.974 (0.034)			
N06_07	MN11231	1.578 (0.339)	0.783 (0.100)	0.199 (0.015)		
N06_08	MN11061	0.795 (0.077)	-2.067 (0.160)	0.204 (0.062)		
N06_09	MN11045	0.953 (0.104)	-0.755 (0.090)	0.200 (0.035)		
N06_10	MN11265	0.760 (0.081)	-2.244 (0.203)	0.261 (0.075)		
N06_11	MN11154	0.594 (0.028)	-0.521 (0.040)		-0.392 (0.077)	0.392 (0.083)
N06_12	MN11240	1.000 (0.197)	0.454 (0.108)	0.267 (0.024)		
N07_01	MN11023	1.494 (0.146)	-0.743 (0.057)	0.227 (0.026)		
N07_02	MN11056	1.062 (0.107)	-0.655 (0.072)	0.169 (0.029)		
N07_03	MN11057	1.110 (0.061)	-1.239 (0.038)			
N07_04	MN11113	0.899 (0.052)	-1.102 (0.043)			
N07_05	MN11200	0.436 (0.019)	-2.284 (0.067)		-1.923 (0.164)	1.923 (0.145)
N07_06	MN11129	1.269 (0.140)	-0.392 (0.062)	0.209 (0.025)		
N07_07	MN11218	0.726 (0.047)	-1.868 (0.065)			
N07_08	MN11036	1.224 (0.157)	0.143 (0.064)	0.157 (0.019)		
N07_09	MN11225	0.652 (0.048)	-0.063 (0.073)			
N07_10	MN11041	0.862 (0.122)	-0.547 (0.122)	0.305 (0.040)		
N07_11	MN11179	0.855 (0.057)	-0.068 (0.058)			
N07_12	MN11303	1.002 (0.075)	0.439 (0.072)			
N07_13	MN11305	0.910 (0.184)	0.445 (0.116)	0.272 (0.027)		
N08_01 *	M061026	0.920 (0.055)	-0.764 (0.079)	0.043 (0.038)		
N08_02 *	M061273	0.815 (0.065)	0.246 (0.073)	0.119 (0.031)		
N08_03 *	M061034	1.230 (0.051)	0.673 (0.025)			
N08_04 *	M061040	1.711 (0.117)	0.601 (0.030)	0.169 (0.015)		
N08_05 *	M061228	0.780 (0.026)	0.878 (0.026)		-0.309 (0.042)	0.309 (0.050)
N08_06 *	M061166	1.141 (0.045)	-0.158 (0.025)			
N08_07 *	M061171	1.316 (0.086)	-0.240 (0.054)	0.201 (0.028)		
N08_08 *	M061080	0.854 (0.039)	0.598 (0.033)			
N08_09 *	M061222	0.904 (0.094)	0.401 (0.089)	0.326 (0.032)		
N08_10 *	M061076	0.583 (0.030)	-0.477 (0.048)			
N08_11 *	M061084	1.119 (0.050)	0.869 (0.031)			
N09_01	MN11128	0.946 (0.057)	-0.446 (0.044)			
N09_02	MN11022	1.170 (0.065)	-1.466 (0.038)			
N09_03	MN11010	1.120 (0.064)	-0.476 (0.038)			

\* Items with fixed item parameters estimated in TIMSS 2015 fourth grade item calibration.

**TIMSS Numeracy 2015 Mathematics Item Parameters from Concurrent Calibration  
(Continued)**

Item		Slope ( $a_j$ )	Location ( $b_j$ )	Guessing ( $c_j$ )	Step 1 ( $d_{j1}$ )	Step 2 ( $d_{j2}$ )
N09_04A	MN11278A	1.186 (0.103)	-1.633 (0.087)	0.191 (0.043)		
N09_04B	MN11278B	1.565 (0.179)	0.051 (0.049)	0.144 (0.016)		
N09_05	MN11136	0.940 (0.054)	-1.033 (0.041)			
N09_06	MN11261	0.975 (0.064)	0.037 (0.055)			
N09_07	MN11033	0.359 (0.035)	-1.269 (0.095)			
N09_08	MN11039	0.615 (0.063)	-1.913 (0.190)	0.176 (0.063)		
N09_09	MN11040	0.381 (0.064)	-0.592 (0.279)	0.172 (0.064)		
N09_10	MN11195	0.644 (0.052)	0.452 (0.103)			
N09_11	MN11188	0.521 (0.043)	-0.087 (0.088)			
N09_12	MN11252	1.793 (0.208)	-0.041 (0.046)	0.183 (0.017)		
N10_01	MN11055	0.939 (0.056)	-1.740 (0.050)			
N10_02	MN11214	1.234 (0.127)	-0.693 (0.068)	0.222 (0.029)		
N10_03A	MN11116A	1.003 (0.059)	-1.807 (0.049)			
N10_03B	MN11116B	1.049 (0.062)	-0.362 (0.042)			
N10_04A	MN11066A	1.105 (0.066)	-0.256 (0.042)			
N10_04B	MN11066B	1.162 (0.075)	0.063 (0.049)			
N10_05	MN11260	1.546 (0.140)	-0.819 (0.052)	0.188 (0.025)		
N10_06	MN11032	0.874 (0.077)	-1.340 (0.097)	0.137 (0.039)		
N10_07	MN11170	0.503 (0.075)	-0.643 (0.200)	0.177 (0.056)		
N10_08	MN11068	0.527 (0.039)	-1.109 (0.066)			
N10_09	MN11269	0.968 (0.056)	-1.415 (0.043)			
N10_10	MN11001	1.049 (0.137)	-0.071 (0.074)	0.196 (0.025)		
N10_11	MN11235	0.501 (0.029)	0.697 (0.088)		-0.796 (0.106)	0.796 (0.144)