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GLOBAL ALLIANCE TO MONITOR LEARNING

SUSTAINABLE DEVELOPMENT GOALS

UIS-TIMSS Framework Alignment: Methodology and Results

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This paper is presented to explain the methodology, and present the results, of an alignment between two educational standards frameworks:

1) the UNESCO Global Framework for School Mathematics, and
2) the TIMSS 2019 Mathematics Framework

The purpose of this alignment is to determine the suitability of the TIMSS 2019 Mathematics Framework to serve as a global metric for SDG 4, Indicator 4.1.1.

4.1: By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes.

4.1.1 Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex.

Framework comparison

Beginning in 1995, the Trends in International Mathematics and Science Study (TIMSS) assessment has been given to students in grades 4 and 8 every four years (no grade 4 assessment was administered in 1999). The assessment was last given in 2015 and is scheduled to be next administered in 2019. The content of the TIMSS assessment is based on the TIMSS 2019 Mathematics Framework (TF-19). This framework contains three levels: domain, topic area, and topic. There are three content domains in grade 4 and four content domains in grade 8, as well as a set of three cognitive domains that applies to both grades. Each domain contains a number of topics, which describe the specific expectations for TIMSS test takers. The content domains describe specific mathematical skills, while the cognitive domains describe process, or problem-solving, skills (this distinction is discussed later in this paper). Grade 4 contains 34 topics, and grade 8 contains 35 topics. Table 1 provides a summary of the TF-19 domains for each grade and the number of topics in each domain.

Table 1. TIMSS 2019 Mathematics Framework—domains and number of topics.

Grade 4		Grade 8	
Domain	**Number O41f Topics**	**Domain**	**Number of Topics**
Number	10	Number	6
Measurement and Geometry	6	Algebra	6
Data	3	Geometry	4
		Data and Probability	4
*Cognitive Domains	15	Cognitive Domains	15

*As noted above, the three cognitive domains of the TF-19 apply to both grades.

In contrast to the TF-19, the UNESCO Global Framework for School Mathematics (GF) is unleveled—that is, the framework does not make any distinctions as to the intended, or appropriate, grade level(s) for the skills described in the framework. The GF contains four levels: domain, sub-domain, construct, and sub-construct. The GF contains six domains—five content domains (e.g., Geometry, Number Knowledge, etc.) and one process/problem-solving domain, Math Proficiency, that is similar to the cognitive domains of the TF-19. (It should be

noted that Math Proficiency is not defined separately as a process domain in the GF.) The six domains of the Global Framework contain a total of 85 sub-constructs—10 in Math Proficiency, the rest in the content domains. Table 2 provides a summary of the GF domains and the number of sub-constructs in each.

Table 2. Global Framework for School Mathematics—domains and number of sub-constructs.

Domain	Number of Sub-constructs
Math Proficiency	10
Number Knowledge	28
Measurement	16
Statistics	5
Geometry	11
Algebra	15

Methodology for framework alignment

The first step in performing an alignment between the two frameworks was to identify the appropriate level of each framework to examine for comparison. In order to provide the most detailed and accurate comparison possible, the lowest, most granular level of each framework was utilized. For the GF, this was the sub-construct level; for the TF-19, this was the topic level. These levels of their respective frameworks contain the most explicit and comprehensive descriptions of the specific skills and expectations for students and/or test takers. The next step in the alignment process was to decide which framework to use as the foundation for comparison; the 'foundation' framework would be reviewed and presented as published, with the indicators from the other framework (i.e., GF sub-constructs or TF-19 topics) being mapped onto the corresponding indicator(s) of the foundation framework. Since the GF is unleveled and contains more indicators in total than the TF-19, the GF was selected as the foundation framework.

As is typical in a framework-to-framework alignment, the comparison of GF sub-constructs and TF-19 topics focused on the *cognitive process* required by the mathematical and/or cognitive skills described by the text of each indicator. The purpose of this comparison was to identify sub-constructs and topics that demonstrated a degree of overlap in the respective cognitive processes of each indicator. An alignment was said to be present when a sub-construct and a topic each described one or more mathematical skills requiring identical, or nearly identical, cognitive processes. Instances of alignment do not *necessarily* represent a 100% complete, one-to-one correspondence, as all the GF sub-constructs describe multiple mathematical skills, typically spanning a wide range of grade levels. Nearly all the TF-19 topics also contain multiple skills, although they contain far fewer skills than the GF sub-constructs; some GF sub-constructs contain as many as 20 separate mathematical skills.

An additional consideration for aligning the frameworks was that of 'content standards' vs 'process standards' (as described in the National Council of Teachers of Mathematics' *Principles and Standards for School Mathematics* (NCTM, 2000)). Content standards describe specific *mathematical* skills such as those found in the five 'classic' strands of mathematics—Number Sense/Computation; Measurement; Geometry; Data/Statistics; and Algebra. These five strands can be found in both the GF and the TF-19, albeit with different titles and

organized a bit differently in each framework. Process standards, by contrast, describe *cognitive* skills that are necessary for students and test takers to utilize content knowledge in various problem-solving situations. The GF domain Math Proficiency contains a number of cognitive skills, while the TF-19 groups these skills in three Cognitive Domains (Knowing, Applying, and Reasoning). A further, related consideration is that several of the topics listed in the TF-19 Cognitive Domains are described in terms of *content* skills—for example, the topic 'Retrieve—Retrieve information from graphs, tables, texts, or other sources'. Because of this approach, several topics of this type in the TF-19 Cognitive Domains have been aligned both to sub-constructs in the GF (process) domain of Math Proficiency, *and* to the appropriate sub-construct(s) in the GF content domains.

Summary of alignment results

The results of the alignment between the GF and the TF-19 contain several points of interest. In grade 4, a total of 36 GF sub-constructs (42%) were aligned to one or more TF-19 topics. In grade 8, 51 GF sub-constructs (60%) were aligned to the TF-19. These percentages are not altogether surprising, considering that grade 8 math classes generally cover a wider range of topics than is typical at grade 4. All the TF-19 topics, both in the content and cognitive domains, were aligned to one or more GF sub-constructs. Because the TF-19 Cognitive Domains apply to both grades 4 and 8, the alignments in each grade to the GF domain of Math Proficiency was identical for both grades. These results can most likely be attributed to the different organizational approaches of the two frameworks—specifically, unleveled (GF) vs grade level-specific (TF-19), as well as the comprehensive nature of the GF sub-constructs. Table 3 displays these results, in addition to information regarding the number of alignments by domain, compared to the total number of GF sub-constructs in each domain.

Table 3. Summary of alignment results by Global Framework domain.

Global Framework Domain	Grade 4 TIMSS (Alignments/Total Number of Sub-constructs)	Grade 8 TIMSS (Alignments/Total Number of Sub-constructs)
Math Proficiency	9/10	9/10
Number Knowledge	10/28	15/28
Measurement	6/16	3/16
Statistics	3/5	5/5
Geometry	6/11	10/11
Algebra	2/15	9/15
TOTAL	**36/85 (42%)**	**51/85 (60%)**

As is common in framework alignments, there were multiple instances of overlap in the alignment of TF-19 topics to the GF. Overlap can be defined in several ways, depending on the organization of the frameworks and the parameters of the alignment. In this case, overlap is defined as instances where a GF sub-construct was aligned to TF-19 topics in grade 4 *and* grade 8. As previously mentioned, this occurred in the GF domain of Math Proficiency, where 9 of the 10 sub-constructs were aligned to the TF-19; because the GF is unleveled, these results were the same for both grades of the TF-19. This also occurred, to varying degrees, in each of the GF content domains. Additionally, there were several GF sub-constructs that did not align to *any* of the TF-19 topics, in either grade. This was not a wholly unexpected development, given that the TF-19 covers only two grades. Table 4 provides a summary of overlap and non-alignments.

Table 4. Overlapping alignments and unaligned sub-constructs by Global Framework domain.

Global Framework Domain	Overlapping Alignments	Non-alignments
Math Proficiency	9	1
Number Knowledge	5	8
Measurement	2	9
Statistics	3	0
Geometry	6	1
Algebra	2	6
TOTAL	**27***	**22 (26%)**

*A percentage is not provided for overlapping alignments, as it is not statistically important.

Conclusions

When examining the results of the alignment between the GF and the TF-19, two important points also become apparent. The first is that all of the content and cognitive skills described in the TF-19 can be found in the GF. The second is that there are many instances (as shown in Table 4) where the GF contains content and cognitive skills that the TF-19 does not. Again, this is not surprising, considering that the TF-19 covers only two grades. While this is not a problem for the TIMSS assessment itself, it is likely to be problematic in satisfying the requirements of Indicator 4.1.1. Many national and regional assessments are given at grades other than 4 and/or 8. This renders the TF-19 impractical for use in assessments in other grades.

Bibliography

National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics.* Reston, VA: Key Curriculum Press.