UNESCO INSTITUTE FOR STATISTICS | GLOBAL ALLIANCE TO MONITOR LEARNING | SUSTAINABLE DEVELOPMENT GOALS

Monitoring Progress towards SDG 4.1: Comparative Analysis of Curriculum and Assessment National Frameworks for Mathematics – Summary

September 2018

This paper presents the comparative analysis of 20 countries' national curriculum frameworks (NCFs) and national assessment frameworks (NAFs) for Mathematics. The study was conducted with the purpose of examining the alignment between what countries intend to teach and what they assess. The study falls under the overall aim of the UNESCO Institute for Statistics (UIS) to support the monitoring of learning outcomes with regards to SDG 4.1, by finding ways to link them globally in a comparable way.

> *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.*

The initial analysis of 115 NAFs from 53 Member States revealed a consistently low coverage of the *Math Proficiency* domain in NAFs (IBE-UNESCO and UIS, 2017). In the analysis among different income classification levels, High-Income Member States had a higher coverage of that domain in their NAFs. A possible reason that was believed to contribute to higher coverage of domains and sub-domains within NAFs of High-Income Member States, was critical mass. Critical mass could potentially lead to a better alignment between NCFs and NAFs. The study emphasized the need to further investigate this hypothesis, the possibility of alignment of curriculum and assessment and a call for better correlation between NCFs and NAFs. This would allow Member States not only to develop competency-related indicators within their NCFs, but also to effectively reflect them within their NAFs.

Methodology

The investigation into this hypothesis led to a decision to map and analyse the NCFs of 20 Member States, whose NAFs had already been mapped. For this study's comparative analyses, the NAFs and NCFs were mapped using the *same* Coding Scheme as the one used in the previous study (IBE-UNESCO and UIS, 2017), which allowed for a meticulous documentation of the presence and/or absence of learning outcomes and objectives in each framework. Moreover, commonalities and differences in the assessed and curricular content were identified and analysed by country, income classification levels, education levels, and languages.

NAF and NCF - mapping alignment:

The following categories and their descriptors inform the methodology used to guide the data analysis.

Symmetry: NAF and NCF criteria (in reference to domains and sub-domains, as they conform to the Coding Scheme) are both present (values of 1).

Asymmetry: NAF and NCF criteria are not aligned as per conformity to the Coding Scheme.

- Curriculum- based: NAF criteria are absent (0) in the presence (1) of NCF criteria.
- Assessment- based: NAFs criteria are present (1) in the absence (0) of NCF criteria.

A total of 53 NAFs and 53 NCFs, in English, French and Spanish, from a sample of 20 Member States[1] and 6 regions of the world[2], covering the three points of measurement of Indicator 4.1.1 (grades 2/3, end of primary and end of lower secondary education) were analysed in this study. The NAFs and NCFs criteria were coded into one quantitative database to allow for valid comparisons. The database denoted the presence or absence, with a value of "1" or "0", of a certain sub-domain or domain in each NAF and NCF. Once coded, the database analysed incidents of alignment (symmetry) between criteria to identify where in a NCF corresponding assessment criteria were present. Similarly, the database analysed incidents of asymmetry between corresponding NAF and NCF criteria at the domain or sub-domain levels. In cases where

[1] The 20 Member States whose NAFs and NCFs were analysed for the purposes of this study were (in alphabetical order): Australia, Canada-Ontario, Dominica, Dominican Republic, England-UK, Estonia, Fiji, France, Gambia, Guatemala, Honduras, India, Ireland, Ivory Coast, Micronesia, New Zealand, Pakistan, Peru, Seychelles, and Uganda.
[2] No countries from Central Asia and the Arab States were used in this study, due to language limitations.

an entire category - either domain or sub-domain - did not exist, a value of “0” was assigned across that category in the database.

Limitations of the study:

Before viewing the findings, it must be noted that due to the relatively small sample size used in this comparative analysis, the findings must be interpreted with careful attention and valid consideration before drawing invalid conclusions. One must note that the region of Central and Eastern Europe was solely represented by Estonia. Additionally, the information in the quantitative database was analysed for quantity and presence of criteria, not quality, and therefore does not necessarily represent rigor of curricular or assessment objectives, or capture the nuances present in pedagogy- integral to curriculum, nor represent a way to standardise information across content areas. It is important, when interpreting the results of these analyses that careful consideration be given.

Findings of the study

Analysis of NAF symmetry to NCF presence

When analysing the data for instances of symmetry (presence of criteria in both NAFs and NCFs of a Member Statae), an overall analysis, as shown in *Figure 1,* revealed that the domain with the highest percentage of symmetry between assessment and curriculum criteria was *Number Knowledge* domain (100%), which means that this domain was present in both the NAFs and NCFs analysed. *Math Proficiency* was the domain with the lowest percentage of symmetry, with only 22%. This domain had significant asymmetrical incidents, more than all other domains - a fact that remained apparent across all levels of analysis. Several possibilities could explain this low percent of symmetry, many of which would require further research and analysis into the structure, terminology, definition and application intended in this domain. One possible explanation, however, is that both NAFs and NCFs view and represent ‘proficiency’ as an area and even a practice that should be taught within each domain and subject. The majority of Member States’ frameworks included *Math Proficiency,* (or similar terminology, such as, ‘mathematical processes’, ‘applying’, ‘solving’ and ‘cognitive domains’) as a current running throughout curricular and assessment outcomes, and not a stand-alone category which can be easily quantified. *Math Proficiency* is critically important to teach, yet extremely hard to assess, especially in the context of a national standardized assessment. Consequently, in the coding of this domain, it was mapped present if Member States dedicated an individual domain to *Math Proficiency* (or analogous terminology), in either their NAF or NCF. This presence demonstrated the importance to which certain Member States prescribe and ascribe to this approach. For example, in the majority of NCFs, Member States describe the vision, goals and curricular expectations for learners, at all education levels, clearly detailing the relevance of scope and sequence of learning outcomes and objectives. As such, if the organization and terminology used in NCFs were analogous and thus comparable to the criteria found in *Math Proficiency* domain in the Coding Scheme, the presence of this domain was indicated.

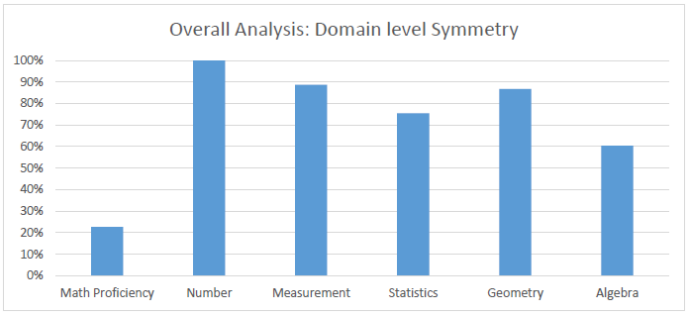

Figure 1: Overall analysis: Domain level Symmetry

When analysing the data by income classification, all High-Income Member States displayed the highest percent of symmetry across all six domains. Two possible reasons could perhaps explain this phenomenon. First, it is important to note that High-Income Member States represent the largest percent of Member States within this study, at 40%, therefore, with a larger sample of High-Income nations, it is natural to see the data indicate a higher percent of symmetry. An additional factor that may contribute to higher symmetry of domains and sub-domains in NAFs to NCFs of High-Income Member States is critical mass, which may be an advantage counter to Member States of lower income levels. Is the higher symmetry of sub-domains, within NAFs and NCFs, of High-Income Member States a guarantee that learners of these Member States develop

skills and knowledge, and have them equally assessed, in contrast to learners of Member States of other income levels who may not? From an assessment point of view, symmetry of domains and sub-domains within NAFs and CNFs equals more 'content' precision in the assessment, because students are being assessed what they have been taught and learnt. In the case of countries that show no alignment between the two frameworks (higher levels of asymmetry), there is a higher chance that the test does not reflect what the students have been taught (and learnt), which only decreases the content validity of the test. Subsequently, low learning outcomes might be a derivative of the lack of content validity in the test, as students fail to perform what they have never learnt.

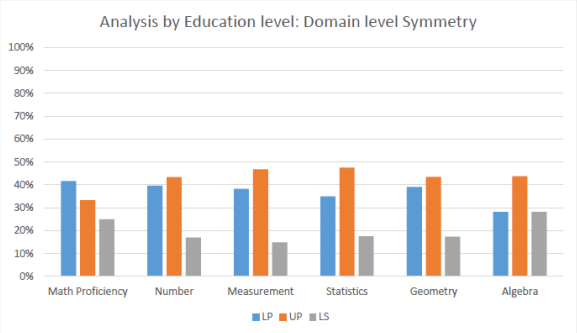

Figure 2: Analysis by Education level: Domain level symmetry

Not surprising to education practitioners, a pertinent finding was indicated through the analysis be level of education - the disparities between Upper Primary and Lower Secondary were quite noticeable (*Figure 2)*. A higher symmetry and correlation between Lower and Upper Primary is logical, considering the scope and sequence of mathematical concepts within primary education grades; yet increasingly evident in data is a precipitous transition between Upper Primary and Lower Secondary in both curricular and assessment outcomes. This claim would be better elaborated upon with an increase in Lower Secondary classified national frameworks (larger than the existing 19% in this study). Nonetheless, this finding is woven throughout all domains and calls for Member States to re-examine the scope and sequence of NCFs and their corresponding NAFs to ensure learning outcomes and objectives are not only horizontally but vertically articulated and aligned.

Asymmetry analysis

When analysing the data for instances of asymmetry (criteria being present in NAFs but absent from NCFs, and vice versa), the count of curriculum-based asymmetry for the domain, *Math Proficiency* was most notable and concurrent throughout the study, as can be seen in *Figure 3*. Although symmetry between NAF and NCFs presence appear higher than asymmetrical ones, of keen interest is the *increasing* occurrences of assessment-based asymmetry. Recalling the line of inquiry of this study – are assessment frameworks measuring learning outcomes that are present in curriculum frameworks for Mathematics, and what findings are most salient within such an inquiry? Although assessment-based asymmetry instances are less than instances of symmetry, assessment-based asymmetry instances highlight a troubling trend in response to this study's line of inquiry. Are learners being assessed on content they have not been taught? Given the definition of an assessment-based asymmetry, a few sub-domains appear to be assessed without being included in the NCF; *Chance, Probability and Probability Experiments (Statistics domain); Functions (Algebra); Numerical Patterns (Algebra); Properties of Space (Geometry).* Explanations and needed investigations into these instances would require further levels of analyses.

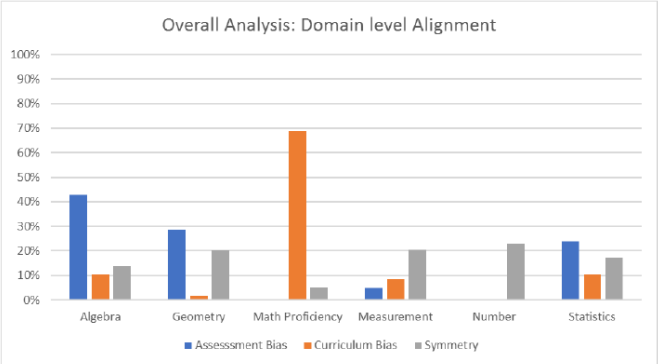

Figure 3: Overall analysis: Domain level alignment

Competency-based learning approach

The increasing prevalence of competency-based national frameworks or components of competency-based education (CBE) within national frameworks suggests a paradigm shift from traditional, subject-based curricula and assessment approaches (common in the 1960's-70's)

towards competency-based approaches (Harden, 2002). Gradually emerging since the 1970's, CBE is comprised of a competency framework and competency assessments – the former describes skills, knowledge and abilities while the latter measures and determines mastery (McClarty and Gaertner, 2015). This study has shown that within this paradigm shift, well-articulated competency-based assessment (types, tools, metrics and scale) are lacking. Many Member States, in this study, detailed in great length the importance of assessment and learning; however, there is a need for a concerted and data-driven approach to determine how best to measure competency-based curricula nationally and globally. Further questions are raised; what metrics are used in assessing 'cognitive domains' and 'general competencies' which are, by nature of their function, often loosely understood or difficult to describe as an observable behaviour? In cases that these assessment tools are framed and designed - are well resourced capacity building programmes in place for educational practitioners so that they may develop, implement and manage the assessment data in service of the learner?

In order to fully comprehend the complexities inherent within these discussions, a recommendation is made to caste a wider net in data collection and data analysis - to collect an extended number of national frameworks, related documents and additional pieces of evidence from Member States (such as educator input, lesson plans, regional school districts, student testimonials and more). This wider net will help to better capture the real 'look and feel' of assessment and curriculum's ongoing relationship as it relates to the monitoring of learning outcomes with regard to SDG 4.1 - Education 2030.

Bibliography

IBE-UNESCO and UIS. 2017. Monitoring Progress towards SDG 4.1: Initial Analysis of National Assessment Frameworks for Mathematics. *In-Progress Reflections Series No 15*. Geneva, IBE-UNESCO. http://unesdoc.unesco.org/images/0025/002596/259685E.pdf (Accessed 30 January 2018).

Harden R.M, 2002. *Developments in outcome-based education*. Medical Teacher, Vol. 24, No. 2, 2002. Editorial, Taylor & Francis Ltd.

McClarty, K. Larsen and Gaertner, Matthew N. 2015. *Measuring Mastery: Best Practices for Assessment in Competency-Based Education*. April 2015, AEI Series on Competency-Based Higher Education.