

# **SMSO**

**Survey of Mathematics  
& Science Opportunities**

**CURRICULUM ANALYSIS  
TECHNICAL REPORT SERIES**

**No. 1**

**THE TIMSS CURRICULUM ANALYSIS:  
AN OVERVIEW OF AN INTEGRATED SYSTEM OF  
CURRICULUM MEASUREMENT.**

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# *The TIMSS Curriculum Analysis: Overview of an Integrated System of Curriculum Measurement*

- Resource constraints have made it necessary for TIMSS to focus on curriculum guides, textbooks and experts.
- TIMSS designed a set of curriculum analysis procedures which include:
  - > document analysis (of curriculum guides and textbooks),
  - > topic tracing across all grade levels,
  - > expert questionnaires and
  - > participation questionnaires.
- These procedures are integrated by the language system of the curriculum frameworks.
- In Document Analysis (DA), a methodology of content analysis is used which involves the partitioning of documents into relatively homogeneous blocks, the substance of which is then coded according to the frameworks. This is done for curriculum guides and textbooks at all three populations.
- In In-depth Topic Trace Mapping (ITTM) for a small number of topics (called in-depth topics) documents are analyzed to provide information about the topic coverage at all grade levels from the beginning of schooling to the end of secondary school.

- A similar task called Modified Topic Trace Mapping (MTTM) is also done for all topics in the frameworks but based on judgment rather than on formal document analysis; experts (using documents where necessary) having been asked to provide this information.
- The expert questionnaire which addresses broader issues such as reforms and calculator and computer usage has been answered by a set of mathematics and science experts.

# ***Intention: What We Learn from Curriculum Guides and Textbooks***

## ***The official definition of intention***

At the national or regional level statements of student learning goals are almost always defined by official government documents such as curriculum guides. These documents, however, vary in the degree of detail with which the learning goals are specified. Ministry officials and other experts in the country are also sources of information about what students are expected to learn. For TIMSS, all but two countries (Iran and Bulgaria) have such national or regional curriculum guides and as such, an analysis of them serves as a primary measurement of intention.

## ***What we learn from textbooks***

Although these curriculum guides are the official statements, and the ones we rely on as defining national intention, they suffer at times from a lack of detail and do not exist in two of the TIMSS countries. Textbooks, on the other hand, are utilized in all countries and always are detailed. However, they provide official or semi-official statements of intent only in some countries and require inference to determine goals from them. We view the textbooks as providing an alternative and in most cases supporting specification of learning goals. In some countries such a specification is official and hence defines the intended curriculum while in others it represents the specifications of related industries such as publishers, university professors acting as authors, professional societies or others and, as such, does not formally define the intended curriculum. In such cases they may be viewed as semi-official alternative specifications of curricular intention.

## *A Unifying Principle: The TIMSS Curriculum frameworks*

The measurement of the curriculum demands a language system that can make the measurement coherent across components and that can integrate such measurements with other aspects of the TIMSS study, especially with educational opportunities and achievement scores. That language system is provided by the TIMSS curriculum frameworks.

- The Frameworks represent a multi-category, multi-aspect specification of the content of mathematics and the sciences in a form relevant to documents and to questions about schooling.
- The Frameworks provide a set of conventions that can serve as a common language system and the basis for common terms in TIMSS.
- The Frameworks include three aspects defining different dimensions of the content of educational documents and practice:
  - ) topics (content),
  - ) performance expectations and
  - ) perspectives (noncognitive aspects of content such as interest, attitudes, etc.).
- These frameworks, arrived at through iterations of international consensus, define the subject matter domains of mathematics and the sciences.
- As a language system the curriculum frameworks can be used to describe the international tests, the specification of what students are expected to learn, and aspects of how instruction is organized and presented and who delivers the instruction. As such, it provides a means of intellectual integration across research questions and across the levels of the educational system.

## **In-depth Topics**

In following sections and subsequent reports in this series, as the curriculum procedures are detailed, reference is made to in-depth topics. These are topics from the first aspect (content aspect) of the frameworks for which special curriculum measurement procedures have been designed. Some of them are also included as scales on the TIMSS achievement tests. The following is a list of In-depth Topics:

### **Topics for Mathematics**

#### 1. Place Value and Decimals

- Meaning of whole numbers, as applied to place value and numeration
- Decimal fractions
- Relationship between common and decimal fractions
- Properties of decimal fractions (as applied to decimals)

#### 2. Fractions and Proportionality

- Common fractions
- Conversion of equivalent forms
- Ordering of fractions and decimals (as applied to common fractions)
- Properties of (common) fractions
- Proportionality concepts
- Proportionality problems
- Slope and trigonometry
- Linear interpolation and extrapolation

#### 3. Geometry

- Congruence and similarity

#### 4. Linear Equations

- (Linear) Equations and formulas

#### 5. Measurement

- Units
- Perimeter, area and volume
- Estimation and errors

## 6. Data Analysis

Data representation and analysis

### **Topics for Science**

#### 1. Human Biology (A broad topic but only the following subtopics are included)

Organs, tissues  
Energy handling  
Reproduction  
Genetics

#### 2. Earth Features

Composition  
Landforms  
Bodies of Water  
Atmosphere  
Rocks, soil  
Iceforms

#### 3. Energy

Energy types, sources, conversions

#### 4. Energy

Light

#### 5. Measurement

Using Apparatus  
Conducting Routine Experimental Operations  
Gathering Data

#### 6. Data Analysis

Organizing and Representing Data  
Interpreting Data  
Interpreting Investigational Data  
Formulating Conclusions From Investigational Data

## *A Curriculum Measurement System*

The complete specification of the learning goals at the national/regional level would require an analysis of the curriculum guide(s) and all textbooks available at each grade level and for each track or stream. To conduct such an analysis on a cross-national basis is neither practical nor economically feasible. There is simply too much detail, too many textbooks and too many grade levels (and in some countries too many tracks) to do this in any practical way.

This necessitates a carefully crafted measurement process that is practicable but also meets the criteria of providing an adequate characterization of the intended curriculum that is not biased and that is reliable. The five components listed previously serve as the basis for such a measurement system. The participation questionnaires have been described elsewhere and contain relatively straightforward items designed to characterize the organization of the educational system and the decision making process regarding learning goals. Each of the remaining four components of the measurement system are briefly described in this report. In addition, a discussion of the measurement process itself including how the five components combine to provide measurements that are comprehensive and integrated is also presented.<sup>1</sup>

The task is one of devising a measurement procedure that: 1) balances the need for depth in the specification of learning goals at the focal grade levels at which achievement data will also be collected in TIMSS (Population 1, Population 2, and Population 3) and the need for breadth in the specification of learning goals across all grade levels through secondary school, 2) rests on a sampling plan idiosyncratic to each country that selects a representative sample of curriculum guides and textbooks that derives from the nature of that educational system, 3) provides a general context in which to interpret the specification of intent as found in curriculum guides and textbooks, i.e., a characterization of mathematics and science education and 4) characterizes the

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<sup>1</sup> More detailed treatment of these procedures can be found in subsequent reports

educational system and how it is organized as well as to characterize the decision making process by which the learning goals are specified.

Using the TIMSS Curriculum framework, the curriculum measurement process is comprised of three parts which together are designed to provide a detailed characterization of the learning goals. The three parts are: (1) the document analysis of curriculum guides and textbooks (2) the in-depth topic trace mapping and (3) the modified topic trace mapping.

The second aspect of the curriculum measurement process is based on questions asked on the participation and expert questionnaires relative to the nature of the educational system, the locus of decisions affecting the curriculum, curriculum policies on calculators and computers and current and planned reform efforts. The synthesis of the data describing the learning goals together with the contextual information will permit an extensive characterization of the intended curriculum.

**Document analysis. (DA)** The document analysis of textbooks and curriculum guides is designed to serve the purpose of in-depth characterization of the intended curriculum for populations 1, 2 and 3.

- It produces a detailed description of learning goals but only at the focal grade levels.
- It is designed to be complete and exhaustive in terms of the materials that are analyzed and in terms of coverage of all topics in the frameworks.
- The strength of DA is its completeness and its depth at the focal grade levels.
- The weakness is that, by looking only at selected grades, the measurement does not allow the tracing of the full continuum of topic coverage through all the grades in the pre-university system.
- The absence of a topic, performance expectation, or perspective, however, presents a dilemma since we don't know if it is intended as a goal at other grade levels, but not included at the focal grades, or if it is included in the curriculum at all.
- The presence of a topic, performance expectation, or perspective at a focal grade only tells us of its intention at that level and not whether this is the grade level at which it was first introduced, or whether this is the grade level at which instruction on this topic is concluded. Further, it might be a point of special concentration for the topic or only one of numerous grades in which it is included.

**Topic trace mapping.** Information on the continuity of coverage can only be provided if a topic is traced through the entire educational system from the beginning of schooling to the

end of secondary school. The resulting map allows a more complete characterization of coverage of the topic that is being traced, but unless done for all topics in the mathematics and science frameworks, it is narrow in its description of the intended curriculum.

**Modified topic trace mapping. (MTTM)**

- The possibility of doing such a topic trace mapping for all topics in the frameworks depends on the amount of detail required as a part of the mapping process.
- MTTM focuses only on the characterization of points at which instruction is begun, finalized and concentrated on, and does not require an extensive amount of documentation.
- It is not based on content analysis methodology.
- Done this way, it is possible for all topics defined by the two frameworks to be included.
- The weakness inherent in such an approach is that it is not based on a detailed and exacting content analytic procedure but more on the expert opinions of those completing the trace mapping and their knowledge of the country's intended curriculum.
- The focus of the procedures is on each topic treated in an isolated fashion even though many of the topics are likely related in terms of their specification in the goals.
- This approach, however, is practical and does provide "longitudinal" information of the coverage of all topics in the frameworks.

**In-depth topic trace mapping (ITTM).**

- The focus of ITTM is not only to provide information on the initial and final points and on a point (or points) of concentration, but to characterize the topic in a much richer and fuller way by specifying how the sub-topics fit together in the coverage of the topic as a whole.
- Provides more complete characterization of coverage involving goal specification in greater detail than provided by the Frameworks.
- The amount of documentation necessary to support this approach is more demanding and is based on content analysis of documents.
- The strength of this approach is one of depth and careful analysis but it represents a procedure which is not feasible for all topics in the frameworks.
- This procedure is labeled in-depth topic trace mapping and will be applied only to six in-depth topics in each of mathematics and the sciences (previously outlined).
- The twelve topics were chosen because international coverage of these topics was deemed broad by the modified topic trace mapping data and because they are of interest to the mathematics and science education communities.

### **A Composite Portrayal**

An acceptable characterization of the national/regional learning goals depends on the combination of data derived from each of the three procedures described above. The modified topic trace mapping (MTTM) provides broad information regarding all topics in the frameworks in terms of cross-grade level coverage. More detailed and more well documented information

about cross-grade coverage must be derived from the in-depth topic trace mapping (ITTM), but it is available only on a small number of topics. The document analysis procedure (DA) provides the most complete, detailed and well documented information regarding all topics in the frameworks, but only at the focal grade levels. In this way the former serves as context for the latter.

The combination of procedures provides both a breadth in terms of all topics across all grade levels (MTTM) and a depth in terms of a limited number of topics across all grade levels (ITTM) and in terms of topic coverage at the three focal points (DA).

Learning goals are delivered in the context of an educational system. Those educational systems can be organized in different ways and the decision making procedures regarding the choice of learning goals and how they are to be delivered can vary appreciably from one system to another. This implies that still another context necessary to interpret the curriculum data derived from DA, ITTM and MTTM is a characterization of the instructional delivery system. This is done with the participation questionnaires.

The five components of the TIMSS process for measuring the intended curriculum were each described as was the overall concept of how the components combine to define a practicable and psychometrically acceptable measurement procedure. The document analysis, topic trace mapping procedures and the expert questionnaire are described in detail in subsequent reports.