Introduction

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TIMSS 2023: First Fully Digital TIMSS Assessment

TIMSS (Trends in International Mathematics and Science Study) is a long-standing international assessment of mathematics and science at the fourth and eighth grades that has been collecting trend data every four years since 1995. About 70 countries use TIMSS trend data for monitoring the effectiveness of their education systems in a global context, and more countries join TIMSS with each subsequent assessment cycle.

Because it marks the successful transition to its first fully digital assessment cycle, TIMSS 2023 is a watershed cycle in the 28 year history of TIMSS. Half the TIMSS countries pioneered the transition to digital assessment in TIMSS 2019 paving the way for an "all digital" turning point in TIMSS 2023. Capitalizing on the benefits of technological advances is necessary for TIMSS to remain in sync with global realities, and TIMSS 2023 will set the wheels in motion to improve the quality of TIMSS data, increase efficiency in data collection, and make the data more useful.

To provide deeper insights into how students approach mathematics and science assessment tasks, solve problems, and communicate their responses, TIMSS 2023 will include more complex and innovative item types that capture both responses and process indicators. A digital item designer and translation system will support TIMSS 2023 item development, enabling interactive opportunities and provision of various digital tools for students to use in developing and providing their responses. The idea of Problem Solving and Inquiry (PSI) Tasks introduced in TIMSS 2019 will be further developed (see *Findings from the TIMSS 2019 Problem and Inquiry Tasks*).[1] PSI tasks are based on attractive, interactive scenarios that allow students to follow a series of steps toward a solution or goal. A variety of PSI tasks will be integrated into the mathematics and science assessments. Finally, a concerted effort will be made to increase the degree of automated scoring to improve scoring accuracy and comparability across countries, including research into using machine learning to evaluate graphical and short written responses.

The TIMSS 2023 Mathematics and Science Frameworks

As a major ongoing program of IEA, TIMSS has the benefit of drawing on the cooperative expertise provided by representatives from countries all around the world (see *IEA's TIMSS and PIRLS: Measuring Long-term Trends in Student Achievement*).[2]

Chapters 1 and 2 of the *TIMSS 2023 Assessment Frameworks* contain the *TIMSS 2023 Mathematics and Science Frameworks*, respectively. Since its inception, TIMSS has used participating countries' curricula, broadly defined, as the basis for creating and then subsequently updating the mathematics and

science frameworks for each assessment cycle during its 28 year history. As a trend assessment, TIMSS needs stability from cycle to cycle and so the majority of the items (about two-thirds) are carried forward from each assessment to the next. An item typically appears in three adjacent assessment cycles before being retired. However, it is also necessary to keep the assessment frameworks educationally relevant, and so a substantial number of items are newly developed for each cycle in accordance with the updated frameworks. This permits the TIMSS assessment instruments and procedures to evolve gradually into the future.[3]

Consistent with procedures implemented with each new assessment cycle, the *TIMSS 2023 Mathematics and Science Frameworks* for fourth and eighth grades were updated from those used in TIMSS 2019 through an iterative review process. Taking into account curricular information provided by the participating countries in the *TIMSS 2019 Encyclopedia*,[4] the TIMSS & PIRLS International Study Center worked with the TIMSS 2023 expert group, named the Science and Mathematics Item Review Committee (SMIRC), to develop and review the first drafts of the updated frameworks. Listed in the Acknowledgments, the SMIRC members also participated in iterative reviews of the items newly developed for TIMSS 2023.

The TIMSS 2023 National Research Coordinators (NRCs), comprised of the one or two individuals that are responsible for implementing TIMSS within each participating country, also had opportunities to review the frameworks. The TIMSS 2023 NRCs (see Acknowledgments) introduced fresh ideas and current information about curricula, standards, goals, and objectives related to mathematics and science instruction. The TIMSS & PIRLS International Study Center worked with the SMIRC to incorporate the NRCs' recommendations into the frameworks, such that the content of the frameworks evolved gradually.

TIMSS is directed by the **TIMSS & PIRLS International Study Center** established in Boston College's Lynch School of Education and Human Development. PIRLS (Progress in International Reading Literacy Study) is an international assessment of reading, and together **TIMSS and PIRLS** comprise the core cycle of international assessments managed by **IEA (the International Association for the Evaluation of Educational Achievement)**. IEA is an independent international cooperative of national research institutions and government agencies that has been conducting studies of cross-national achievement since 1959. Today, **IEA Amsterdam** manages country participation in a number of international studies and projects, and **IEA Hamburg** is a large research and data processing center.

The TIMSS 2023 Context Questionnaire Framework

Chapter 3 of the *TIMSS 2023 Assessment Frameworks* contains the *TIMSS 2023 Context Questionnaire Framework*. Similar to the process used to update the content area frameworks, the TIMSS & PIRLS International Study Center worked with the TIMSS 2023 Questionnaire Item Review Committee (QIRC) to update the *TIMSS 2019 Context Questionnaire Framework* and the questionnaires for TIMSS 2023. The QIRC members are listed in the Acknowledgments.

To take into account students' opportunities to learn mathematics and science in each country, TIMSS collects an extensive amount of information about students' learning experiences. As part of each assessment cycle, TIMSS publishes an Encyclopedia about countries' curricula and instructional policies. TIMSS also updates and measures trends on the existing questionnaire scales, and develops new context questionnaire scales that address emerging areas of research in educational effectiveness.

Consistent with prior assessment cycles, the forthcoming *TIMSS 2023 Encyclopedia: Education Policy and Curriculum in Mathematics and Science* will contain a chapter prepared by each country and benchmarking participant summarizing the structure of the country's education system, the mathematics and science curricula in the primary and secondary grades, the teacher education requirements, and the types of examinations and assessments employed. To provide standard information about countries that supplements the chapters, countries complete a TIMSS Curriculum Questionnaire about policies associated with their mathematics and science curricula, school organizational approaches, and instructional practices.

TIMSS 2023 also collects information about students' home and school experiences relevant to learning mathematics and science. Students, their parents or caregivers, their teachers, and their school principals are asked to complete questionnaires about the students' mathematics and science instructional contexts. The *TIMSS 2023 Context Questionnaire Framework* and array of questionnaires were updated through a sequence of reviews conducted by the QIRC and NRCs and include some new areas of interest.

A New Assessment Design for TIMSS 2023

Chapter 4 of the *TIMSS 2023 Assessment Frameworks* describes the populations assessed by TIMSS, as well as the organization of the assessment instruments. With the transition to a completely digital assessment, TIMSS 2023 took advantage of the opportunity to introduce a new group adaptive assessment design, which includes items of three difficulty levels—easy, medium, and difficult. For each subject, a student will be assigned a block of easy and a block of medium items, or a block of medium and a block of difficult items. All countries will take all items, but higher performing countries can have higher proportions of students taking more difficult item blocks and countries that perform less well can have higher proportions of students taking less difficult item blocks.

The group adaptive design enables countries to better match the difficulty of the TIMSS assessment items to their students' level of achievement, resulting in less frustration among low achievers and less boredom among more able students. This in turn should lead to greater engagement and higher motivation, with improved response rates and less omitted or not reached data.

References

1 Mullis, I.V.S., Martin, M.O., Fishbein, B., Foy, P., & Moncaleano, S. (2021). *Findings from the TIMSS 2019 problem solving and inquiry tasks*. Retrieved from Boston College, TIMSS & PIRLS International Study Center website: https://timssandpirls.bc.edu/timss2019/psi/

2 Mullis, I.V.S. & Martin, M.O. (2022). IEA's TIMSS and PIRLS: Measuring long-term trends in student achievement. In T. Nilsen, A. Stancel-Pitątak, & J. Gustafsson (Eds.), *International handbook of comparative large-scale studies in education: perspectives, methods, and findings*. Springer, forthcoming.

3 Mullis, I.V.S. & Martin, M.O. (2022). IEA's TIMSS and PIRLS: Measuring long-term trends in student achievement. In T. Nilsen, A. Stancel-Pitątak, & J. Gustafsson (Eds.), *International handbook of comparative large-scale studies in education: perspectives, methods, and findings*. Springer, forthcoming.

4 Kelly, D.L., Centurino, V.A.S., Martin, M.O., & Mullis, I.V.S. (2020). *TIMSS 2019 encyclopedia: Education policy and curriculum in mathematics and science*. Retrieved from Boston College, TIMSS & PIRLS International Study Center website: https://timssandpirls.bc.edu/timss2019/encyclopedia/