Foreword

IEA (The International Association for the Evaluation of Educational Achievement) is an independent international cooperative with a network composed of national research institutions, governmental research agencies, distinguished scholars, and analysts from around the globe. Founded with the goal of improving education worldwide, IEA undertakes rigorous, high-quality, large-scale studies that offer deep insights into how students across different education systems are performing.

Our core mission is to enhance our understanding of educational policies, practices, and processes, contributing to the improvement of quality teaching and learning both within and across countries. IEA's studies provide essential information to educators, policymakers, and researchers, enabling meaningful insights and providing data for secondary research to enhance education worldwide.

TIMSS (Trends in International Mathematics and Science Study), conducted by IEA, is one of our flagship international assessments. Managed by IEA's TIMSS & PIRLS International Study Center at Boston College's Lynch School of Education and Human Development, TIMSS assesses the mathematics and science achievement of students at fourth and eighth grades around the world. Since its inception in 1995, TIMSS has provided countries with reliable, comparable data that highlight trends in educational outcomes, allowing for evidence-based reforms in mathematics and science instruction.

TIMSS offers participating countries a detailed picture of student performance in mathematics and science, and, through repeated cycles, provides trend data critical for evaluating the effectiveness of educational reforms and policy changes over time. The unique quasi-longitudinal design of TIMSS enables countries to monitor student cohorts from fourth grade through eighth grade, facilitating early interventions and adjustments to curricular policies when needed.

For over three decades, this large-scale international assessment has provided invaluable insights into mathematics and science education worldwide, offering educators and policymakers information to foster continuous improvement in educational outcomes. The release of the *TIMSS 2027 Assessment Frameworks* marks another milestone in the longstanding tradition of TIMSS and provides details on the content specifications and methodology shaping the next cycle of this flagship study.

Building on the successful transition to a fully digital assessment initiated in 2023, TIMSS 2027 advances our commitment to leveraging technology to enhance the efficiency of logistics and reporting while staying true to the standards of quality set forth by IEA's history in educational measurement. The assessment's adaptive digital design now integrates even more sophisticated

and interactive items, enabling more precise measurement and engaging assessments tailored to a diverse global student population. These enhancements ensure that TIMSS remains a relevant and powerful tool for capturing nuanced insights into student achievement. The four chapters inside this framework highlight and contextualize many of these aspects.

The TIMSS 2027 mathematics and science frameworks for both fourth and eighth grades reflect the international collaboration of IEA's work, ensuring alignment with current curricular goals and global educational priorities. Across the various aspects of the assessment design process, we emphasize not only foundational mathematics skills but also mathematical reasoning, problem-solving capabilities, and real-world applications crucial to today's learning environments. Similarly, the science frameworks now comprehensively integrate environmental literacy, underscoring its importance in addressing global challenges and fostering informed citizenship.

The foundational work for TIMSS 2027 also deepens our understanding of the contexts surrounding student learning through enriched background questionnaires completed by students, parents, teachers, and school leaders. These questionnaires capture critical data attitudes towards mathematics and science, socioeconomic background, and aspects of school environment, but also digital technologies, including the use of artificial intelligence, family involvement in education, school leadership practices, and students' views on environmental issues. New topics will allow for richer insights into the learning environments that support student success.

This publication is made possible by the dedicated contributions of numerous experts and organizations around the world. Our appreciation goes to all of the staff of the TIMSS & PIRLS International Study Center at Boston College and across both IEA offices for their support and excellence in managing this extensive international effort. I further extend my gratitude to the authors of the assessment frameworks: Ray Philpot and Charlotte Aldrich for the Mathematics Assessment Framework; Berenice Michels and Allison Bookbinder for the Science Assessment Framework; Katherine Reynolds, Audrey Gallo, and Deepthi Kodamala for the Contextual Framework; and Liqun Yin and Eugenio Gonzalez for the Assessment Design. Their expertise and dedication have been instrumental in shaping this comprehensive information.

Special thanks are also due to the Science and Mathematics International Research Committee (SMIRC), the Questionnaire International Research Committee (QIRC), the TIMSS National Research Coordinators, and the countless educators and researchers whose collective input ensures the rigor and relevance of the frameworks.

Finally, I wish to acknowledge the support of the IEA member institutions, governmental bodies, and all participating countries. Their sustained commitment to educational excellence and international collaboration enables TIMSS to continue making meaningful contributions to global educational improvement.

With these frameworks, TIMSS 2027 is poised to deliver rich, actionable insights, helping education systems around the globe meet the evolving demands of teaching mathematics and science effectively in a rapidly changing world.

Dirk Hastedt
IEA Executive Director

Introduction to the TIMSS 2027 Assessment Frameworks:

Advancing Digital Assessment in Mathematics and Science

Matthias von Davier

TIMSS (Trends in International Mathematics and Science Study) is a long-standing international assessment of mathematics and science at the fourth and eighth grades, collecting trend data every four years since 1995. Over 70 countries rely on TIMSS to monitor their education systems in a global context, benchmarking national curricula and informing policy and practice. Building on the successful transition to digital assessment in 2023, TIMSS 2027 marks the second fully digital cycle, further harnessing technology to enhance data quality, improve operational efficiency, and strengthen the utility of results.

TIMSS uses the curriculum—broadly defined—as the foundation for understanding educational opportunities and outcomes across educational systems. The TIMSS Curriculum Model comprises three interconnected aspects: the intended, implemented, and attained curriculum. The intended curriculum encompasses contexts that include system-level policies, curricular standards, and organizational structures designed to facilitate learning. The implemented curriculum covers contexts surrounding the translation of curricula into practice, including instructional delivery, teacher practices, and home and school environments. The attained curriculum focuses on student achievement and attitudes toward mathematics and science. This model guides TIMSS in analyzing how educational systems shape student outcomes.

The TIMSS mathematics and science frameworks are updated with each assessment cycle through a collaborative, expert-driven process to ensure alignment with current educational objectives, practices, and priorities across participating countries. At the same time, frameworks retain key elements to ensure valid measurement of achievement trends across cycles. Updates for TIMSS 2027 mathematics and science frameworks also include descriptions of the TIMSS problem-solving and inquiry tasks (PSIs) integrated within the broader discussion of the cognitive domains. The assessment also integrates more complex, interactive item types to capture problem-solving approaches and processes. These innovations leverage expanded capabilities in automated scoring, including machine learning for both graphical and written responses.

The *T*IMSS 2027 Mathematics Framework presents the updated assessment frameworks for mathematics at the fourth and eighth grades. The framework specifies the content domains, including number, measurement and geometry, and data, and the target percentages of the assessment devoted to covering topics within each content domain. Cognitive domains—knowing, applying, and reasoning—evaluate students' conceptual understanding, problem-solving processes and skills, and analytical thinking. Newly developed items incorporate current curricular priorities in mathematics education, such as computational thinking, and a continued emphasis on real-world applications.

The TIMSS 2027 Science Framework, structured around the domains of biology, physical science, chemistry, and earth science, reflects current priorities in global science education. Like mathematics, the cognitive domains assess foundational knowledge, practical application, and

higher-order reasoning. Updates focus on integrating environmental knowledge within specific topics from relevant content domains and incorporating existing science practices into the discussion of the cognitive domains.

The TIMSS 2027 Contextual Framework outlines the comprehensive system for collecting background data on policies, classroom practices, and student learning environments that support and characterize students' mathematics and science achievement. Student, parent, teacher, and school questionnaires cover students' attitudes and behaviors, home learning environments, classroom practices, and school climate. New scales address the use of digital devices and AI tools in education, family involvement in education, and school leadership practices. Also included is a description of the planned *TIMSS 2027 Encyclopedia*, which documents national policies and, mathematics and science curricula at the fourth and eighth grades, and teacher training, along with curriculum questionnaires providing standardized cross-country data on the organization of the education system, including the system for preprimary education, teacher and principal preparation, and curriculum specifications.

The TIMSS 2027 Assessment Design features an innovative, digitally enabled approach, building on the group adaptive design introduced in TIMSS 2023. The adaptive testing design incorporates easy, medium, and difficult blocks arranged into more and less difficult booklets. A new feature introduces performance-based routing after the first half of the assessment, allowing very low-performing students to receive easier second-half blocks. This approach aims to improve measurement precision at the lower end of the achievement scale, where previous cycles often proved too difficult to provide precise estimates. The TIMSS 2027 assessment also fully integrates interactive problem-solving and inquiry tasks, which include simulations, multimedia content, and innovative response formats. Leveraging the success of automated scoring in TIMSS 2023, the TIMSS 2027 assessment will include a higher proportion of automatically scored constructed-response items while following rigorous assessment design and block assembly guidelines for the fourth- and eighth-grade assessments. The key features of the TIMSS 2027 assessment design aim to optimize engagement, reduce measurement error, and ensure robust cross-country comparisons.

TIMSS 2027 builds on a strong tradition of providing assessments in mathematics and science at the fourth and eighth grades with updated content, an expanded use of digital tools, and an innovative test design. The frameworks reflect current educational priorities in mathematics while preserving the ability to report trends in student achievement. With enhanced item formats, adaptive testing, and enriched contextual questionnaires, TIMSS 2027 supports a comprehensive view of how educational systems prepare students to meet evolving curricular goals and instructional expectations around the world.