IEA TIMSS 2019

CHAPTER 3

TIMSS 2019 Context Questionnaire Framework

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At both the fourth and eighth grades, students participating in TIMSS complete questionnaires about their experiences, instruction, and attitudes toward learning mathematics and science. Their teachers and school principals complete questionnaires to provide data about school and classroom resources and approaches, and parents of fourth graders fill out a questionnaire about students' home contexts for learning. To better understand national contexts and policies, representatives from each participating country complete a curriculum questionnaire and contribute a chapter to the *TIMSS 2019 Encyclopedia*. Students taking TIMSS using a computer or tablet also fill out a short questionnaire about their experiences with computers and the Internet.

The TIMSS questionnaires have undergone a process of evolution and development since TIMSS was first administered in 1995, a process that continually sought to improve the quality and relevance of the data while keeping the response burden on principals, teachers, students, and parents to a minimum. In each four year assessment cycle, the questionnaire development team at the TIMSS & PIRLS International Study Center worked with the TIMSS Questionnaire Item Review Committee (QIRC) to review the questionnaires and suggest ways to update them—including adding new topics, refining individual questions, and deleting questions or topics that are no longer useful.

The TIMSS 2019 Context Questionnaire Framework describes those aspects of the learning context to be addressed by the TIMSS 2019 questionnaires, together with a rationale for why they should be included and research literature references as appropriate.

As a study of trends in student achievement and mathematics, TIMSS' first priority in characterizing the educational context is to gather data on policy relevant and malleable attributes of the home and school that can help interpret achievement changes from assessment to assessment. Where possible, such contextual data are summarized as context questionnaire scales that are used to measure changes from one assessment to the next. Relating changes in student achievement to changes in educational policies or practice can be a powerful source of evidence that the policy or practice is beneficial for student learning.

For example, TIMSS 2015 reported differences from TIMSS 2011 on a number of background scales such as the *Early Literacy and Numeracy Activities* scale and the *Students Like Learning Mathematics* scale. TIMSS 2019 plans to improve and expand trend measurement using these and other scales.

The TIMSS 2019 Context Questionnaires have the dual purpose of linking to the past and building a bridge to the future. The world is changing in important ways, and so are educational policies and practices around the world. It is important for the TIMSS 2019 Context Questionnaires to reflect these changes. This will be managed by updating aspects of existing scales to reflect new and improved understandings of the constructs being measured, and also by including new scales about important aspects of educational effectiveness.

The framework also includes other topics that are important to TIMSS participating countries and education researchers but have not been shown to be related to achievement on the TIMSS assessment. These topics are generally considered to be important aspects of the education systems and beneficial for student learning, and TIMSS plays a key role in collecting data on these topics in the international context. For example, through the curriculum questionnaire and TIMSS Encyclopedia, TIMSS plays an important role in documenting international trends in curricular policy and other educational policies. However, many country level policies do not show a direct relationship with TIMSS achievement.

The remainder of this chapter details the topics to be covered in the TIMSS 2019 context questionnaires. The chapter is structured to focus on five broad areas:

- Community and national policies
- Home contexts
- School contexts
- Classroom contexts
- Student attitudes toward learning

Community and National Policies

Countries, regions, and communities make key educational policy decisions about the curriculum and how it is best implemented. Primarily through the TIMSS Encyclopedia and curriculum questionnaires, TIMSS 2019 will cover five broad national and community policies:

- Intended mathematics and science curriculum
- Language(s) of instruction
- Student flow
- Teacher education
- Principal certification

Intended Mathematics and Science Curriculum

Since 1995, TIMSS has collected extensive data on the content of the intended curriculum. Whether formulated at the national, community, or school level, curricular documents define and communicate the curriculum, providing expectations for students in terms of the knowledge, skills, and attitudes to be developed or acquired through their formal mathematics and science education.

Internationally, mathematics and science curricula differ across countries and are constantly evolving. In mathematics, countries differ in the degree of emphasis they place on acquiring basic skills, memorizing rules, procedures, or facts, understanding mathematical concepts, applying mathematics to "real life" situations, communicating or reasoning mathematically, and problem solving in everyday situations. In science, countries vary in the extent that they focus on acquiring basic science facts, understanding and applying science concepts, formulating hypotheses, designing and conducting investigations to test hypotheses, using inquiry-based learning, and communicating scientific explanations. Differences in the structure of the science curriculum can result in different experiences for students in different countries. By the eighth grade, some countries teach science as separate subjects (biology, chemistry, physics, and earth science), and others teach it as one integrated subject.

Continuing previous practices, countries will provide summaries of their fourth and eighth grade mathematics and science curricula in the *TIMSS 2019 Encyclopedia* and answer questions about their curricula in the curriculum questionnaire. Collecting data on curricular content over time can provide insights into the evolution of national curricula. For example, the *TIMSS 2015 Encyclopedia* (Mullis, Martin, Goh, & Cotter, 2016) found that countries are increasingly incorporating problem solving into their mathematics curricula and are incorporating inquiry and investigative skills into the science curricula. To an increasing extent, curricula are also emphasizing the integration of technology into mathematics and science learning.

Language(s) of Instruction

A multilingual population can increase the challenge of implementing the mathematics and science curricula, and for these reasons the *TIMSS 2019 Encyclopedia* will contain information about languages of instruction. Some countries have one commonly spoken language, while others are historically multilingual. Immigration also can increase the language diversity in countries. Most of the TIMSS participating countries deliver instruction in multiple languages.

Student Flow

TIMSS 2019 will continue collecting data on student flow through the education system through the curriculum questionnaire. Student flow decisions made at the national and community levels include decisions on access to preprimary education, age of entry into formal education, and policies on grade retention and educational tracking.

- **Preprimary Education**—Even before they begin formal primary school, children receive considerable exposure to literacy, numeracy, and science as part of their preprimary educational experience (e.g., preschool, Kindergarten). Preprimary education is an area of investment for many countries. Research findings indicate that attendance at preprimary programs can have a positive effect on academic outcomes (Duncan & Magnusson, 2013). As described in the *TIMSS 2015 Encyclopedia* (Mullis, Martin, Goh, & Cotter, 2016), almost all countries participating in TIMSS 2015 provided universal preprimary education for children age 3 or older, and a number of countries also sponsored universal programs for children younger than 3 years old.
- **Age of Entry**—Policies about the age of entry into formal education (first year of primary school, ISCED Level 1) are important for understanding achievement as well as the variation in students' ages across countries at the fourth grade (Martin, Mullis, & Foy, 2011). Typically, across the TIMSS countries, students enter primary school at ages 5 to 7.
- **Grade Retention**—Because TIMSS is a grade-based study, the degree of grade retention can be an important factor to consider when evaluating achievement results. Research has shown that grade retention does not have a positive relationship with student achievement or the emotional well-being of the student and is overall inefficient (García-Pérez, Hidalgo-Hidalgo, & Robles-Zurita, 2014; Hattie, 2009). Many TIMSS countries practice automatic promotion, especially in the primary grades (Mullis, Martin, Goh, & Cotter, 2016).
- **Tracking**—Some education systems address differential student abilities and interests by assigning students to different schools that provide academic or vocational routes. A breadth of literature has suggested that tracking students into different schools or routes early in the educational process can exacerbate differences in student achievement (Hanushek & Wößmann, 2006; Marks, 2005; Parker, Jerrim, Schoon, & Marsh, 2016; Schütz, Ursprung, & Wößmann, 2008; Van de Werfhorst & Mijs, 2010). Given that educational tracking can begin as early as middle school, the timing and extent of educational tracking is especially important for interpreting the eighth grade results.

Teacher Education

In every country, teachers are the primary implementers of the curriculum, so teacher education policies and practices are a major interest. TIMSS 2019 will collect information about teacher preparation, certification, and professional development. As described in the *TIMSS 2015 Encyclopedia*, many countries have increased the educational requirements for teachers, particularly for primary school teachers as well as secondary school science teachers. As of 2015, almost all TIMSS countries called for fourth and eighth grade teachers to have a four year degree from a university, and the percentage of teachers at both grade levels who had a bachelor's degree increased from 2007. A number of countries

have also strengthened the requirements for entry to teacher education programs, with some requiring that prospective teachers achieve a minimum grade point average or pass an examination.

Principal Certification

Given the central role principals play in managing teachers, students, and school resources, TIMSS will continue collecting data on national principal certification policies. To encourage the development of strong leadership skills, some countries have specific education and training requirements for principals, such as the completion of certification programs in school leadership or specialized principal training programs.

Home Contexts

Parents or guardians and the general home environment are very influential on children's upbringing and their success in school. To better understand the effects of the home context on student achievement in mathematics and science, TIMSS 2019 will collect data through the home questionnaire given to the parents or caregivers of fourth grade students, supplemented by the student questionnaire at the fourth and eighth grades. This will include the following topics:

- Home resources for learning
- Language(s) spoken in the home
- Early literacy and numeracy activities
- Preprimary education

Home Resources for Learning

In education research, the aspects of home background that show the most consistent association with student achievement tend to be those that measure the socioeconomic status of the parents or caregivers (Dahl & Lochner, 2012; Davis-Kean, 2005; Martin, Foy, Mullis, & O'Dwyer, 2013; Sirin, 2005; Willms, 2006). Socioeconomic status is often indicated through proxy variables such as parental level of education, income, occupational class, and the number of books in the home. TIMSS has developed two scales that expand upon the classic conception of socioeconomic status to include home resources with the potential to facilitate student learning (e.g., an Internet connection): 1) the fourth grade TIMSS *Home Resources for Learning* scale based primarily on data from the home questionnaire, and 2) the eighth grade *Home Educational Resources* scale based on the data from the eighth grade student questionnaire. These two scales have shown a strong positive relationship with students' mathematics and science achievement in previous TIMSS cycles, and also will be included in TIMSS 2019.

Language(s) Spoken in the Home

TIMSS 2019 will collect information from students and parents on the language the child speaks in the home. Internationally, there are many reasons why some children speak a different language in the home than they do in the school. Some countries have numerous national languages and in these countries it is not uncommon for students to speak one language at home and another at school. Speaking another language in the home can also be common among immigrant families. In addition, some parents prioritize multilingualism and make great efforts to ensure their child is exposed to more than one language in the home.

Early Literacy and Numeracy Activities

Children's first teachers are their parents/guardians. The TIMSS 2019 home questionnaire will ask the parents/guardians of fourth grade students to provide information on the frequency that they engaged their child in early literacy and numeracy activities before beginning primary school. The questionnaire also will ask parents to report how well their child could do certain literacy and numeracy tasks upon entering primary school.

Considerable research, including results from TIMSS and PIRLS, has documented the importance of early childhood learning activities and their relationship with student achievement and other educational outcomes (Anders et al., 2012; Gustafsson, Hansen, & Rosén, 2013; Hart & Risley, 2003; Hooper, 2017; Melhuish et al., 2008; Sarama & Clements, 2009; Sénéchal & LeFevre, 2002; Skwarchuk, Sowinski, & LeFevre, 2014).

Engaging children in early numeracy activities can stimulate their interest in mathematics and enhance the development of their numeracy skills (Anders et al., 2012; Claessens & Engel, 2013; Melhuish et al., 2008; Sarama & Clements, 2009). These activities include playing with blocks or construction toys, saying counting rhymes or singing counting songs, playing games involving shapes, and playing other types of games that involve quantitative reasoning. Students who have early numeracy skills when entering school often have higher achievement in primary school (Duncan et al., 2007; Princiotta, Flanagan, & Hausken, 2006).

As recently demonstrated by analyses of TIMSS and PIRLS 2011 data (Gustafsson et al., 2013; Punter, Glas, & Meelissen, 2016), both early numeracy and literacy activities are related to a child's fourth grade achievement in mathematics, science, and reading. The association between early literacy activities and mathematics achievement could be linked to the fact that completing numeracy tasks often requires reading skills (Mullis, Martin, & Foy, 2013).

Preprimary Education

TIMSS 2019 will collect data from parents on the duration of their child's preprimary school attendance—consistently identifying a positive relationship between duration of preprimary attendance and student achievement. Much research has detailed the importance of preprimary education (e.g., preschool, Kindergarten, early childhood education programs) on fostering higher academic outcomes (Duncan & Magnusson, 2013). It is argued that high quality preprimary education and other early childhood interventions are especially beneficial for disadvantaged students because they can play an important role in breaking the generationally repetitive cycle of poverty and low achievement (Duncan & Sojourner, 2013; Heckman & Masterov, 2007).

School Contexts

A school's environment and organization can be an important determinant of effectiveness in reaching curricular goals. Accepting that an effective school is not simply a collection of discrete attributes, but rather a well managed, integrated system where each action or policy directly affects all other parts, the TIMSS 2019 school questionnaire will focus on a set of well researched school quality indicators:

- School characteristics and demographics
- Instruction affected by mathematics and science resource shortages
- School emphasis on academic success
- Parents' perception of their child's school
- Safe and orderly schools
- Student bullying
- Sense of school belonging

School Characteristics and Demographics

To provide key contextual information about schools, the TIMSS 2019 school questionnaire will collect data from principals on a number of school characteristics including school size, school location, and school composition by economic status and language use. In addition, principals are asked about the proportion of the students who enter school with various early literacy and numeracy skills.

TIMSS results have typically included data on school composition by economic status, measured by principals' estimates of the percentage of students from advantaged and disadvantaged backgrounds. Since the Coleman report (Coleman et al., 1966), there has been great emphasis on how the socioeconomic composition of the student body is associated with individual student achievement (Martin, Foy, Mullis, & O'Dwyer, 2013; Rumberger & Palardy, 2005; Sirin, 2005). There is evidence that

students from disadvantaged backgrounds may have higher achievement if they attend schools where the majority of students are from advantaged backgrounds. Some have attributed this association to peer effects—observing a strong relationship between students and their classmates (Sacerdote, 2011). The higher achievement for students in socioeconomically advantaged schools may also be partially explained by such schools having better facilities, instructional materials, and teachers. For example, in some countries, schools with high proportions of disadvantaged students have difficulty attracting highly qualified teachers (Akiba, LeTendre, & Scribner, 2007; Clotfelter, Ladd, & Vigdor, 2010).

Instruction Affected by Mathematics or Science Resource Shortages

Adequate working conditions and facilities, as well as sufficient instructional resources, are important for maintaining a favorable learning environment in schools (Cohen, McCabe, Michelli, & Pickeral, 2009). Although "adequacy" in terms of resources can be relative, the extent and quality of school resources have been shown to be critical for quality instruction (Glewwe, Hanushek, Humpage, & Ravina, 2011; Hanushek, 1997; Hanushek & Wößmann, 2017; Lee & Barro, 2001; Lee & Zuze, 2011). Results from TIMSS international reports indicate that students in schools that are well resourced generally have higher achievement than those in schools where shortages of resources affect the capacity to implement the curriculum.

Through the *Instruction Affected by Mathematics Resource Shortages* scale and the *Instruction Affected by Science Resource Shortages* scale, both based on principal reports, TIMSS 2019 will measure how general and subject-specific resource shortages affect curriculum implementation. General resources include teaching materials, supplies, school buildings and grounds, heating/cooling and lighting systems, classroom space, technology-based equipment such as electronic whiteboards, computers and tablets, videos, and Internet access. Subject-specific resources for mathematics and science may include subject-specific software/applications, calculators, laboratory equipment, and instructional materials. In addition, TIMSS typically collects information on whether the school has a library or media center and a science laboratory, as well as the number of computers in the school.

School Emphasis on Academic Success

TIMSS 2019 will ask teachers and principals about the extent to which their school emphasizes academic success. Overall, a positive school atmosphere with high expectations for academic excellence can contribute to the success of a school. Following the TIMSS and PIRLS 2011 school effectiveness study (Martin, Foy, Mullis, & O'Dwyer, 2013), TIMSS 2015 results showed a positive association between academic achievement and a school's emphasis on academic success. Aligning with the literature on academic optimism (Hoy, Tarter, & Hoy, 2006; McGuigan & Hoy, 2006; Wu, Hoy, & Tarter, 2013), indicators for the TIMSS measure of school emphasis on academic success include school administrators'

and teachers' expectations for successful curriculum implementation and student achievement, parental support for student achievement, and the students' desire to achieve.

Schools can also vary on how much they specifically emphasize preparing students in science, technology, engineering, and mathematics (STEM) subjects. The results from TIMSS Advanced 2015, which assessed students at the end of secondary school, showed a relationship between the degree a school supports advanced mathematics and physics education and achievement. Indicators of school STEM support include school initiatives promoting student interest in the subjects, such as after school activities, as well as STEM-specific professional development programs for teachers.

Parents' Perceptions of Their Child's School

TIMSS 2019 will collect information on what parents think about their child's school, by asking parents to indicate their level of agreement with statements that evaluate the school academically as well as school safety and the extent that schools communicate with and involve parents in their child's education. TIMSS 2015 results show that most parents tended to be satisfied with the school their child attended, which is consistent with results from other educational surveys (Barrows, Peterson, & West, 2017; Stacer & Perrucci, 2013).

Safe and Orderly Schools

TIMSS 2019 will ask teachers and principals to report on school safety and discipline. TIMSS reports have consistently shown a positive relationship between student achievement and teachers' and principals' reports that the school is safe and orderly, and school effectiveness research analyzing TIMSS/PIRLS 2011 data showed that school safety was an important predictor of student achievement in many countries (Martin, Foy, Mullis, & O'Dwyer, 2013). Respect for individual students and teachers, a safe and orderly environment, and constructive interactions among administrators, teachers, parents, and students all contribute to a positive school climate and are associated with higher student achievement (Cohen et al., 2009; Greenberg, Skidmore, & Rhodes, 2004; Konishi, Hymel, Zumbo, & Li, 2010). The sense of security that comes from having few behavioral problems and little or no concern about student or teacher safety at school promotes a stable learning environment. A general lack of discipline, especially if students and teachers are afraid for their safety, does not facilitate learning and is related to lower academic achievement (Milam, Furr-Holden, & Leaf, 2010; Stanco, 2012). Schools where there are clear rules and more fairness tend to have atmospheres of greater discipline and safety (Cohen et al., 2009; Gottfredson, Gottfredson, Payne, & Gottfredson, 2005).

Student Bullying

TIMSS 2019 will ask students to report the frequency with which they are bullied. Previous TIMSS reports have shown that bullied students tend to have lower mathematics and science achievement, aligning with findings of other research (Glew, Fan, Katon, & Rivara, 2008; Konishi et al., 2010; Rothon, Head, Klineberg, & Stansfeld, 2011; Rutkowski, Rutkowski, & Engel, 2013). Bullying is repeated aggressive behavior that is intended to harm students who are physically or psychologically less strong, and takes a variety of forms ranging from name calling to inflicting mental and physical harm. Bullying causes distress to victims, leads to low self-esteem, and makes victims feel like they do not belong (Glew et al., 2008). With the prevalence of the Internet, cyberbullying unfortunately appears to be common among students; and, like other bullying, cyberbullying, is associated with low self-esteem, distress, and poor achievement (Mishna, Cook, Gadalla, Daciuk, & Solomon, 2010; Tokunaga, 2010).

Sense of School Belonging

TIMSS 2019 will collect data from students on their sense of school belonging. TIMSS 2015 results showed an association between school belonging and academic achievement, corroborating other research on the subject (Cohen et al., 2009; McMahon, Wernsman, & Rose, 2009). In addition, students' sense of belonging to their school, also referred to as school connectedness, contributes to their general well-being (Joyce & Early, 2014; McLellan & Steward, 2015; Renshaw, Long, & Cook, 2015). Students with a strong sense of belonging feel safe at school, enjoy school, and have good relationships with teachers and classmates.

Classroom Contexts

Because most teaching and learning in school takes place in the classroom, successful learning is likely to be influenced by the classroom environment and instructional activities. Through the teacher and student questionnaires, TIMSS 2019 will focus on the following factors and practices that are influential to teaching and learning:

- Teacher preparation and experience
- TIMSS mathematics and science topics taught
- Instructional time
- Instructional practices and strategies
- Instructional clarity
- Supportive classroom climate
- Use of technology in instruction
- Challenges faced by teachers

Teacher Preparation and Experience

Through the teacher questionnaire, TIMSS 2019 will collect extensive data on teacher preparation, professional development, and teaching experience. Preparation is critical for effective teaching (Darling-Hammond, 2000; Hill, Rowan, & Ball, 2005), and prospective teachers need coursework to gain knowledge in the subjects that they will teach, to understand about how students learn, and to learn about effective pedagogy in teaching mathematics and science.

Professional development through seminars, workshops, and conferences can help teachers increase their effectiveness and broaden their knowledge (Blank & de las Alas, 2009; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). Professional development is especially important for exposing teachers to recent developments such as curricular changes or new technology for classroom instruction. The *TIMSS 2015 Encyclopedia* shows that many countries are increasing efforts to provide teachers with professional development opportunities.

In addition to education and training, teaching experience is essential, and the first years of teaching are especially important for teacher development (Harris & Sass, 2011; Leigh, 2010). Research also has found that teachers continue to develop pedagogical skills after five years of experience, and that this development can positively affect student achievement (Harris & Sass, 2011).

TIMSS Mathematics and Science Topics Taught

Since the first cycle of TIMSS in 1995, TIMSS has collected extensive data on the implemented curriculum—documenting the extent to which the mathematics and science topics in the TIMSS frameworks are covered in the classroom. TIMSS 2019 will collect this information by asking the mathematics and science teachers of the participating students to indicate whether each of the topics assessed has been covered in class in current or previous years.

Instructional Time

Key to curriculum implementation is the amount of instructional time teachers have to teach the mathematics and science curricula. For this reason, TIMSS 2019 will collect information from teachers and principals on instructional time. TIMSS results show that there is variation among countries in the intended instructional time prescribed by the curriculum and in the actual time of implementation in the classroom. Research has found instructional time to be related to student achievement (Hanushek & Wößmann, 2017), although such relationships may depend on how efficiently and effectively instructional time is used (Mullis, Martin, & Loveless, 2016). For example, teachers who are strong classroom managers may be more efficient, as they can focus the instructional time on teaching the curricular content.

Homework is one way teachers can extend instruction and evaluate student learning. The amount of homework assigned varies both within and across countries, with homework not assigned at all to

fourth grade students in some countries. TIMSS 2019 will collect data on homework assignments, including how homework is used, through the teacher questionnaire at the fourth and eighth grades and the student questionnaire at the eighth grade. Although there are differences across countries, most eighth grade mathematics and science teachers assign homework, discuss the homework in class, and provide feedback to students. Students' reports on time spent completing homework do not show a clear relationship with TIMSS achievement—perhaps because struggling students take a longer amount of time to complete their homework. Homework assignments may also be redundant with classroom instruction, not reinforcing or extending the instruction.

Instructional Practices and Strategies

Since 1995, the TIMSS teacher questionnaires have collected important information on the frequency with which teachers implement various instructional practices and strategies. For TIMSS 2019, mathematics-specific practices will include the frequency that students work on problems on their own, the frequency that they explain their answers in class, and the frequency with which they are asked to decide their own problem solving strategies. Science practices will focus on the frequency that teachers emphasize science investigation, with items focusing on student exposure to experiments and investigations within their science lessons.

Instructional Clarity

The TIMSS 2019 student and teacher questionnaires will include a renewed focus on instructional quality, including updating scales measuring instructional clarity (Nilsen, Gustafsson, & Blömeke, 2016). As described by Ferguson (2012), an important quality of an effective teacher is the ability to provide clear instruction—explaining the content clearly and gauging student understanding of the topic. For challenging topics, it is often necessary for the teacher to employ a variety of pedagogical techniques and explanations to ensure student comprehension. Another way that teachers can increase clarity is by linking new concepts to things students already know and understand (McLaughlin et al., 2005).

The TIMSS 2019 Instructional Clarity scales benefit from two previous efforts. Five of the 10 items in each of the TIMSS 2015 *Students' Views on Engaging Teaching* scales at fourth and eighth grades measured instructional clarity. The scales showed positive associations between instructional clarity and student achievement in many participating countries, especially at the eighth grade. A number of countries also included a national extension in the fourth grade student questionnaire, and the results showed higher achievement for students reporting greater instructional clarity by their teachers (Bergem, Nilsen, & Scherer, 2016).

Supportive Classroom Climate

TIMSS 2019 also plans for the student and teacher questionnaires to contain new Supportive Classroom Climate scales. The TIMSS 2015 national extension (Bergem et al., 2016; Wendt, Bos, Selter, Köller, Schwippert, & Kasper, 2016) included a scale measuring supportive climate, which was based on the work of Baumert et al. (2010) and Klieme, Pauli, & Reusser (2009). The TIMSS 2015 national extension found a positive relationship between a supportive climate and student achievement. A supportive environment has also been found to increase student motivation and participation (Cornelius-White, 2007; Fauth, Decristan, Rieser, Klieme, & Büttner, 2014; Marzano, Marzano, & Pickering, 2003).

Teachers can create a supportive environment by providing positive feedback, listening and responding to students' questions, and being empathetic to students' needs (Reeve, 2002). Indicators of a supportive climate include the frequency with which the teacher helps students learn and the teacher showing interest in student learning, as well as the frequency that the teacher asks students to express their opinions.

Use of Technology in Instruction

Educational systems throughout the world are investing resources to ensure that classrooms are well equipped with instructional technology, and countries are also using technology more in assessment. TIMSS 2019 will document how mathematics and science teachers use instructional technology in the classroom. For mathematics, data will be collected on teachers' reports of how often they have students do mathematics activities on computers, such as solving mathematics problems or exploring mathematics concepts. In science, data also will be collected on science specific activities such as whether teachers use technology to conduct or simulate experiments and investigations. In addition, students provide data on their use of technology for learning at home and in school.

With TIMSS 2019 being administered in many countries on personal computers and tablets, TIMSS 2019 also will collect data on students' experiences taking tests on digital devices. It is expected that some students will have had extensive experience taking both formative and summative assessments online, and other students will have had less experience with digital assessment.

Challenges Faced by Teachers

Mathematics and science teachers face a number of challenges in fulfilling all of the obligations of their position in the school. The TIMSS 2019 teacher questionnaires will ask about having too many students in the class, being burdened with administrative duties, and not having enough time to prepare lessons. Teaching can also be more difficult when students have frequent absences from school or do not have the prerequisite foundation of content knowledge to learn the new mathematics or science content. It can also be difficult to teach students who come to school tired or hungry.

Student Attitudes Toward Learning

Improving students' attitudes toward learning is a major curricular goal for many countries (Mullis, Martin, Goh, & Cotter, 2016), and an abundance of research has documented the relationship between student achievement and student attitudes. IEA has collected extensive information about student attitudes toward mathematics and science since its initial studies in these curriculum areas.

Student Attitudes Toward Mathematics and Science

As described by Mullis, Martin, and Hooper (2017), TIMSS has been measuring student attitudes toward mathematics and science achievement since 1995. TIMSS 2019 will continue measuring students' attitudes through a number of scales, including *Students Like Learning Mathematics*, *Students Value Mathematics*, and *Students Confident in Mathematics*, with equivalent scales in science measuring similar constructs.

The *Students Like Learning Mathematics* and *Students Like Learning Science* scales measure a student's intrinsic motivation to learn the subjects. Intrinsic motivation is the "energizer of behavior" (Deci & Ryan, 1985, p. 32). Students who are intrinsically motivated to learn mathematics or science find the subject to be interesting and enjoyable. TIMSS data have shown a strong relationship between these scales and student achievement.

TIMSS measures extrinsic motivation through the eighth grade *Students Value Mathematics* and *Students Value Science* scales. Extrinsic motivation refers to the drive that comes from external rewards like praise, career success, money, and other incentives. Research has consistently shown that intrinsic motivation is more closely related to achievement than extrinsic motivation (Becker, McElvany, & Kortenbruck, 2010; Vansteenkiste, Timmermans, Lens, Soenens, & Van den Broeck, 2008). Nevertheless, TIMSS results have consistently shown a strong relationship between students valuing the subject and their achievement.

TIMSS also measures subject-specific self-concept through the *Students Confident in Mathematics* scales and *Students Confident in Science* scales, and the results from six previous TIMSS cycles have shown a strong relationship between students' academic self-concepts and their achievement. Students tend to have distinct views of their ability in different subjects, and their self-appraisal is often based on their past experiences and how they see themselves compared with their peers (Marsh & Craven, 2006).

Student Confidence Using Technology

One of the biggest changes in education since the inception of TIMSS has been schools' increasing reliance on technology. As reported in the *TIMSS 2015 Encyclopedia*, most TIMSS countries are working toward integrating technology into instruction across the curriculum to help make teaching and learning more engaging and efficient. Consistent with increased attention across the TIMSS 2019 questionnaires on the areas of technology availability and use, TIMSS 2019 will assess students' degree of confidence

in using digital devices. The students participating in eTIMSS 2019 will be asked additional questions specific to the eTIMSS experience.

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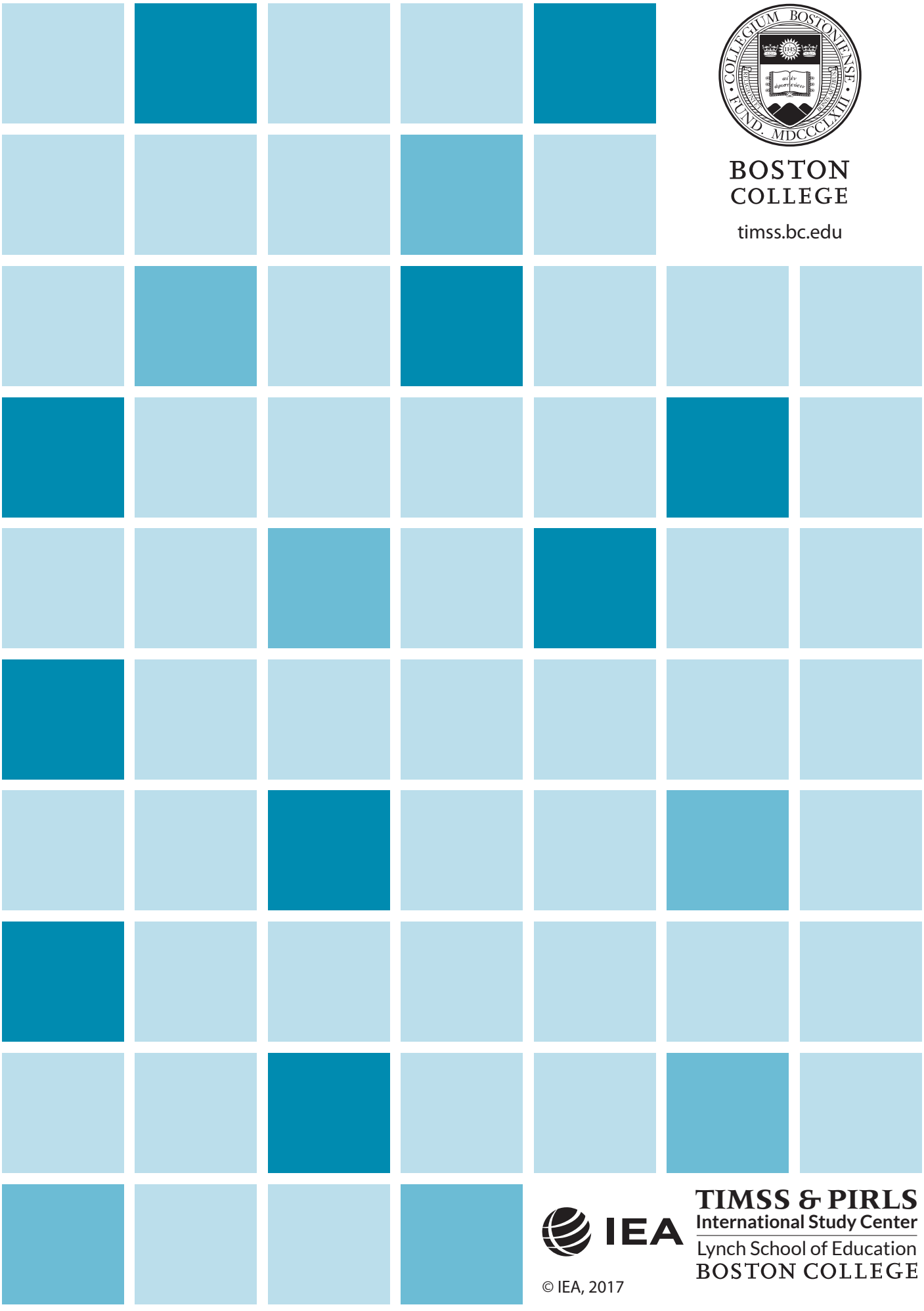

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