TIMSS Advanced 2015 Context Questionnaire Framework

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Because the global community's prosperity and welfare depend on technological development and scienti c discovery, it is crucial that the world's educational systems provide students with advanced skills in science, technology, engineering, and mathematics (STEM). Future leaders in science and technology need to be fully prepared to produce innovative ideas that can spark economic and human development. Recognizing this, countries across the world invest tremendous resources in specialized programs to ensure that at least some students study STEM subjects at the high level through the nal years of upper secondary school and have the skills to excel in STEM elds at the tertiary level.

e degree of selectivity and intensity of these programs varies across countries, as does the advanced nature of the content.

the opportunity to invest in programs that promote mathematics and physics education and incentivize students to enter these elds, such as special science schools with cutting edge technological equipment or partnerships with researchers in high-tech industries.

Organization and Structure of the Educational System

Some countries have highly centralized educational systems in which most policy-related decisions are made at the national or regional level. In these systems, there is typically a high-level of educational uniformity across the system, in terms of curriculum, textbooks, and general policies. Nati-5.6(h)4.3AducolTe(ol.4(m, in t0s9(h)4.)-5.6(

The relative emphasis on communicating scientific theory, constructing explanations, and engaging in arguments from evidence varies across countries, as does the use of technology to support student work.

Teachers and Teacher Education

(Robinson, Lloyd, & Rowe, 2008). Within the constraints of the educational system, it is often the principal's responsibility to ensure that instructional time, and in particular the time devoted to advanced mathematics and physics, is sufficient for the purposes of curriculum implementation.

School Climate

One of the principal's central duties is maintaining a safe, orderly, and disciplined school. Results from TIMSS Advanced 2008 showed that there was not much concern about discipline or safety problems at schools for students in these specialized programs. Respect among individual students and teachers as

Instructional Time

At the school level, the relative emphasis and amount of time speci ed for advanced mathematics and physics can a ect students' opportunities to learn. Results from TIMSS Advanced 2008 show that there is variation between countries in the intended instructional time prescribed by the curriculum and the actual time of implementation in the classroom. In some countries, the advanced mathematics or physics programs of study are highly specialized, and students receive almost exclusive instruction in these subjects and related

In order for advanced mathematics and physics students to grasp difficult content, it is important that teachers link the new material and concepts to the students' prior knowledge and understanding (Kleime et al., 2009; McLaughlin et al., 2005). Students also are more engaged when they are challenged and face greater cognitive demands (Sherno et al., 2003; Yair, 2000). However, with the complexity of the content covered in these advanced subjects, it is important that the teacher conveys to the students that the challenges of the tasks are attainable. In this respect, effective teaching is setting challenging yet attainable goals for each student and supporting the students in reaching the goals (Hattie 2009; Klein, Wesson, Hollenbeck, & Alge, 1999). In setting goals, it is important that students understand the process of achievement, what outcome is expected, and why the goal is important for the learning process (Hattie, 2009; Martin, 2006).

STEM teachers have an important role, not only to foster student learning in the classroom, but also to act as ambassadors for these career paths (OECD, 2006, 2008). Many countries face the problem that students decide to leave STEM fields to study other subjects during their upper secondary or undergraduate education. An inspiring teacher who can model enthusiasm for STEM fields of study can convey the idea that STEM careers can offer interesting and fruitful career options.

Student Characteristics and Attitudes Toward Learning

In order to better understand the factors that support and motivate students

Educational and Career Intentions

The TIMSS Advanced questionnaire data provide important information about whether students intend on continuing along the STEM path in their postsecondary education as well as whether students are interested in entering STEM careers upon completion of their postsecondary education. Policy makers can use these data to inform projections about the future workforce in these fields. Longitudinal research has confirmed that early student career plans are an important predictor of student likelihood to obtain a university degree in a STEM field (Maltese & Tai, 2011; Tai, Liu, Maltese, & Fan, 2006).

Student Motivation to Learn Advanced Mathematics and Physics

TIMSS Advanced 2008 results showed a positive relationship between student affect towards advanced mathematics and physics and student achievement in these subjects. Students participating in these specialized programs tend to have a high level of motivation to excel in school, although their intent to continue on toward careers in STEM fields varies considerably. The source of academic motivation and how it can be facilitated within the school, classroom, and home have been recurrent areas of research (Bandura, 1997; Csikszentmihalyi, 1990; Deci & Ryan, 1985). Intrinsic motivation is an "energizer of behavior" (Deci & Ryan, 1985, p.32), and as such tends to be strongly related to student achievement and career choice. Students who are intrinsically motivated to learn mathematics or physics find the subject to be interesting and enjoyable (Deci & Ryan, 1985).

Nevertheless, not all students have a penchant for studying advanced mathematics or physics. A common strategy to recruit students into these fields is to instill motivation into students by advising them of the career options available for engineers, scientists, and mathematicians. Extrinsic motivation refers to the drive that comes from external rewards like praise, career success, money, and other incentives. However, while extrinsic rewards can entice students to study and even excel in STEM fields, research shows that intrinsic motivation is more closely related to achievement than extrinsic motivation (Becker, McElvany, & Kortenbruck, 2010; Vansteenkiste, Timmermans, Lens, Soenens, & Van den Broeck, 2008).

Expectations for Educational Attainment

Student Gender

The underrepresentation of women in advanced mathematics and physics careers is a concern in many countries (OECD, 2008). While TIMSS results have demonstrated increasing similarities in mathematics and science achievement between the genders at the fourth and eighth grades, TIMSS Advanced 2008 results showed that in most participating countries more male students were taking the advanced mathematics and physics courses than female students, and in many countries male students performed better than female students in advanced mathematics and physics. e pattern agrees with research on STEM career paths (OECD, 2006, 2008).

Tutoring

In some countries, students in advanced courses enroll in shadow education programs, private tutoring, or classes outside of formal schooling to supplement the academic instruction received at school. e reason advanced students enroll in this supplemental schooling varies. Some students enroll in these programs to keep pace with the class, and they nd the support provided to be critical for understanding the complex material covered in these courses (Baker, Akiba, LeTendre, & Wiseman, 2001). Students also enroll in shadow education programs with the goal of mastering the curriculum in order to excel in school or to do well on a high-stakes examination (Bray, 2007; Buchman, Condron, & Roscigno, 2010), especially in circumstances where students compete for limited opportunities in select educational programs (Baker & LeTendre, 2005).