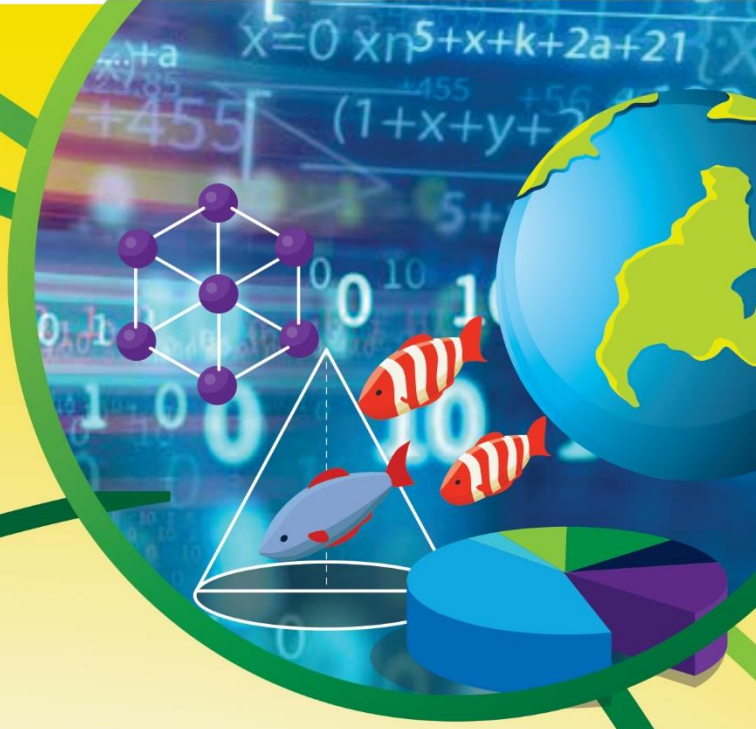
TIMSS 2019



Report for Bosnia and Herzegovina

THE AGENCY FOR PRE-PRIMARY, PRIMARY AND SECONDARY EDUCATION

IEA

Researching education, improving learning

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Expressions written in only one grammatical gender refer equally to the feminine and masculine genders.

By participating in the TIMSS study in 2019, the Agency for Pre-Primary, Primary and Secondary Education sustained the process of involving Bosnia and Herzegovina in various international studies in the field of education.

Bosnia and Herzegovina has participated in an international survey for the very first time by administering the TIMSS 2007 assessment in 8th grade. Then, BiH went on and participated in PISA 2018 survey, assessing, for the first time, the functional knowledge of 15-year-olds. Unfortunatelly, the results were devastating – every other student in Bosnia and Herzegovina is functionally illiterate while BiH lags behind the countries that scored above OECD average by almost three school years.

With the support of the international partner institutions and competent educational authorities, the Agency continued to participate in the international studies, this time in theTIMSS 2019 study, evaluating the achievement of primary school fourth graders in mathematics and science. This report presents the TIMSS 2019 research results and the recommendations for BiH.

In order to make the obtained data form international studies fully useful to the improvement of education in Bosnia and Herzegovina, it is necessary to emphasize the importance of using the data and performing further analyzes, bearing in mind that this report is actually an initial report for Bosnia and Herzegovina with the general insight into the research results.

Therefore, we invite all the teachers, professors, educators, representatives of the academic community and the relevant ministries of education and pedagogical institutes in Bosnia and Herzegovina to cooperate in further analysis of the TIMSS 2019 data.

Only by cooperative engagement, we can establish the quality in education, advance new approaches in teaching and learning and cultivate analyzes, research and critical thinking, to ultimately help young people shape society and improve economy of our country.

On the occasion, I take the opportunity to thank the employees of the Agency for Pre-Primary, Primary and Secondary Education, especially the TIMSS team and the team leader, the author of the Report, for their dedicated work and effort in perforing all the activities in a quality and timely manner.

Furthermore, the Agency plans to participate in the international survey PIRLS, scheduled in spring 2021, thus continuing the process of quality assurance in education in Bosnia and Herzegovina.

Maja Stojkić, MA/PGDip
Agency Director

FOREWORD

One of the strategic goals of any country in the world is to improve their educational system and monitor educational trends with the aim of improving student achievement and their readiness for life in the 21st century. Bosnia and Herzegovina certainly has this goal in the process of European integrations. Hence, assisted by education authorities, BiH strives to reach international educational standards by implementing international studies in education. Clearly, education is fundamental and inalienable right to be preserved at any cost. The knowledge society, functional knowledge, skills and competencies of students are needed as well as the existence of conditions for strategic goals to be achieved and monitored.

According to many studies, skills and knowledge in mathematics and science acquired in primary school make the basis for achieving the learning goals in education. It is preferably for the results of international studies to initiate changes in BiH as it was the case with other countries where the results of student achievement have been improved based on the implemented measures that improved education. Regardless of the fact that international standardized studies rank student achievement, this has never been the primary goal of the assessment. It should be emphasized that international assessment is not a competition since it measures, inter alia, the success of educational policies based on objective indicators, providing guidelines for the improvement of educational systems. This research and their results provide an opportunity for educational policies to take adequate measures in the education systems. In short, the revised curricula as well as the teaching methods can the successfuly implemented only on the basis of the objective findings and recommendations.

TIMSS (Trends in International Mathematics and Science Study) survey provides insight into the students' cognitive progress, but also into the advantages and disadvantages of the educational systems at the national and international levels. TIMSS survey was, for the very first time, conducted in BiH in 2007 in the final grade of primary school. Unfortunately, the educational alarm that rang at the time with the objective indicators did not "wake up" educational authorities from the considerable educational lethargy. Since BiH did not continue with the participation in the study, it was not possible to follow neither the trends in mathematics and science nor the improvement of educational systems based on education goals. This trend of non-participating in the international studies in education has changed with the first participation of BiH in PISA (Program for International Student Assessment) survey in 2018 and in the TIMSS 2019 survey for primary school fourth graders. The results on student achievement in TIMSS 2007 were published in the TIMSS 2007 Secondary Analysis in Bosnia and Herzegovina. The purpose of the TIMSS assessement is to try to jointly provide conditions in education that will improve student performance and help apply acquired knowledge in everyday life, based on objective indicators, i.e. student achievements and factors that affect those achievements. The purpose of the TIMSS study is that on the basis of objective indicators of the level of student achievement, and on the basis of indicators of factors that affect student achievement, we try to jointly provide conditions in education that will improve student performance and application of acquired knowledge in everyday life.

Based on such assessments, the advantages and disadvantages of education can be determined. All these objective indicators should serve us to improve the education systems, educational policies, and education in general.

1. INTRODUCTION

The report presents the results of the primary school fourth grade student achievement in TIMSS 2019 study in mathematics and science (nature and society, my environment, nature, society – by the name given to science subjects in the education systems of Bosnia and Herzegovina)

What is the TIMSS Study

Trends in International Mathematics and Science Study (TIMSS) is a series of international assessments of the mathematics and science knowledge of students around the world, which is also a framework program aimed at monitoring the trends in student achievements and mathematics and science teaching in fourth and eighth grade of primary school. This study is designed to inform responsible education authorities on the results of student achievement in mathematics and science.

TIMSS 2019 study is the seventh cycles of the international student assessment, organized by the IEA (International Association for the Evaluation of Educational Achievement). TIMSS data have been collected from primary school students at grades 4 and 8 every 4 years since 1995. The study is designed to measure and interpret variances between different education systems in order to help improve the education, student achievement, and the teaching of mathematics and science around the world.

TIMSS assessment in mathematics and science is based on three content domains and three cognitive domains. Content domains relate to the subject matter being examined; in mathematics for the fourth grade those are: Number, Measurement and Geometry, and data while in science the domains are: Life Science, Physical Science, and Earth Science. During assessment, students complete test booklets with items representing all three content domains in mathematics and science. At the same time, every item examines one of the three cognitive domains: Knowing, Applying and Reasoning. TIMSS assessment is conducted in the fourth grade and in the eighth grade of primary school and participating countries decide which grade will participate in the assessment.

Competencies in mathematics and science are important, both for the economy and for the individual. Nowadays, socially and economically prestigious occupations require knowledge in these areas and it is considered that students' competences in mathematics and science are a predictor of the competitiveness of the country's economy.

In addition to the test booklets, TIMSS survey also uses the questionnaires for students, parents, teachers and school principals, which collect data on home learning tools, school environment, teaching methods, curricula, school and classroom climate suitable for learning and general socio-economic indicators. All of these indicators are important factors for improving student achievement.

The total of 56 countries and 6 benchmarking participants have participated in the TIMSS 2019 survey for the fourth grade, including Bosnia and Herzegovina and, for the first time, all countries of the Western Balkans.

* Ms. Branka Popić, TIMSS NRC Deputy, contributed to the Introduction

TIMSS 2019 participating countries for the fourth grade

Albania
Armenia
Austria
Azerbaijan
Belgium (Flemish)
Bosnia and Herzegovina
Kazakhstan
Montenegro
Chile
Czech Republic
Denmark
England
Philippines
Finland
France
Georgia
Croatia
Hong Kong SAR
Iran
Ireland
Italy
Japan
South Africa
Canada
Qatar
Kazakhstan
Chinese Taipei
Cyprus
Korea, Rep. of
Kosovo•
Kuwait
Latvia
Lithuania
Hungary
Malta
Morocco
Netherlands
Norway
New Zealand
Germany
Oman
Pakistan
Poland
Portugal
Russian Federation
USA
Saudi Arabia
Singapore
Northern Ireland
North Macedonia
Slovak Republic
Serbia
Spain
Sweden
Turkey
UAE

Benchmarking Participants

Quebec, Canada
Ontario, Canada
City of Moscow, Russian Federation
Madrid, Spain
Abu Dhabi, UAE
Dubai, UAE

• "This inscription does not prejudge the status of Kosovo and is in line with Resolution 1244 and the ICJ opinion on the Kosovo Declaration of Independence."

The Aim of the Study

The aim of the study is to collect high-quality information on student achievements and educational frameworks of those achievements. The study collects information on various topics and subjects, contributing to deeper understanding of educational processes across participating countries and in international context.

TIMSS survey does not aim to evaluate achievements of individual students, teachers or principals. No information that would allow a student, teacher or school to be identified will be published. Collected data will help BiH education authorities to monitor the functioning of the education systems and to provide relevant information to education policy makers without revealing the identity of the participants in the study.

The Purpose of the Study

Participation in international studies enables participating countries to obtain data and determine trends on student achievement. The achievement trend is important when considering whether education systems in the examined areas are making progress and to what extent.

The data collected through contextual questionnaires provide a comprehensive insight into the educational context of the system, representing important pillars for analysis and an attempt to explain the obtained student achievement. Also, since a large number of countries participate in TIMSS, the possibility of comparing data is of particular importance. At a time when the competitiveness of national economies is emphasized, and the effectiveness of educational systems is seen as a key prerequisite, access to internationally comparable data on students' competencies in mathematics and science is of great importance. Participating countries receive information on their students' position in an international context, although this information is not primary when considering and analyzing the achievement. In addition to providing the information on the knowledge in mathematics and science, TIMSS also deals with a number of issues related to teaching and important actors in the teaching process. Based on the data provided in the study, we learn about the education processes in different countries, preparedness of teachers and school principals, attitudes of students towards school and subjects, safety and discipline, practices of parents in early learning, home conditions, and more. These data enable insights into the educational context of the participating countries, allowing for the identification of factors that influence student achievement.

The Significance of the TIMSS Study

Here are some important reasons to participate in TIMSS survey:

- TIMSS study enables the assessment of the present situation and progress of primary education
- Based on the collected data, the quality of teaching mathematics and science can be assessed
- TIMSS provides an opportunity to monitor student achievement trends every four years, which is one of the main benefits of this large international survey. Thus, there is an insight into the progress of students' knowledge in mathematics and science in the fourth and eighth grade through survey cycles
- Based on the TIMSS data, a comparison is made with the countries of the region, Europe and the world in terms of student achievement in mathematics and science. TIMSS data enable the identification of factors that affect student achievement in mathematics and science
- TIMSS provides information on the quality of the pedagogical context of learning in the fourth and eighth grade of primary school
- TIMSS data inform on the family resources in terms of early learning and education of students in the first cycle of schooling

Who Conducts the TIMSS Study

TIMSS survey is organized by the IEA - International Association for the Evaluation of Educational Achievement. It is an independent international organization that brings together national research institutions and various government agencies and has been conducting similar international research on student achievement since 1959.

This organization includes over 66 educational institutions and over 100 different educational systems and countries from 6 continents.

The goal of the IEA is to gather high-quality information on student achievement and the educational framework of that achievement. The organization was founded in 1959 to conduct comparative research that studies educational policies and practices around the world.

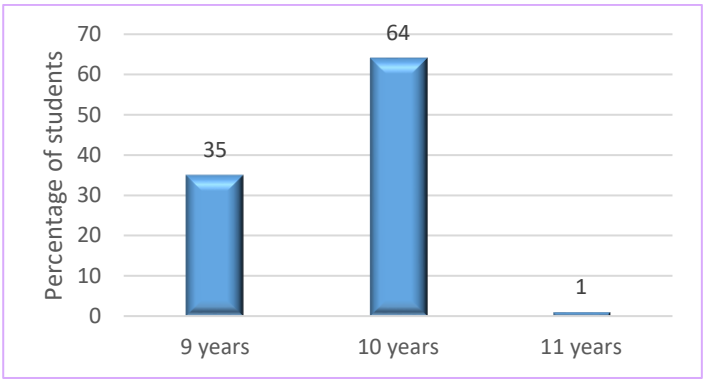
In the last 50 years, more than 60 countries have become members of the IEA. The Secretariat of the association is located in Amsterdam, the Netherlands, and the IEA Data Processing and Research Center (DPC) in Hamburg, Germany. IEA research has gathered knowledge on various fields, topics and subjects, and each of them has contributed to a deeper understanding of educational processes within individual education systems, countries and in a wider international context.

The goal of the IEA is to help all members learn on effective practices in education and on developing evidence-based policies to improve education. Comparable research on education systems around the world provides a better understanding of policies and practices, which encourage progress in education and play a key role in helping countries build their own knowledge and research capacity. The basic motto of this organization is that only quality research contributes to better quality education and the improvement of educational systems that will prepare students for the future. By providing insight into the effects of educational interventions and social change on the quality of education, the ability to track achievement trends is one of the major benefits of this large international study.

TIMSS 2019 marks the seventh cycle of the study and 24 years of monitoring trends. The TIMSS & PIRLS International Study Center at Lynch School of Education, Boston College, USA, serves as the TIMSS 2019 International Study Center, closely collaborating with the IEA and the national centers of the participating countries.

In BiH, TIMSS survey is conducted by the Agency for Pre-Primary, Primary and Secondary Education in cooperation with the competent ministries of education and the Department of Education of the Brčko District of BiH. All phases of the study are realized in accordance with the detailed instructions in order to achieve the highest possible degree of uniformity of the conditions in which the assessment is realized. The TIMSS 2019 survey involved over 580,000 students from 64 countries, including fourth and eighth grade. Over 310 000 parents completed the questionnaire, as did 19 000 school principals and 52 000 teachers. In BiH, 5 628 fourth grade primary school students (2 876 boys, 51% and 2 752 girls, 49%) with average age of 9.5 to 10.5 years participated in this TIMSS cycle at the time of testing, from 336 classes in 178 primary schools. The average age of students from BiH is 10.1 years. The distribution of BiH students by age is given in the following exhibit.

Exhibit 1.1 Student distribution by age



The school participation rate was 100%, the class participation rate 99.2%, and the student participation rate 95.5%. In total, exclusion rate in BiH was about 2%, before school sampling 0.6%, and during sampling an additional 1.4%. Students who have more severe developmental difficulties and cannot answer questions on their own were not included in the survey. Each school was instructed by the professional pedagogical service to assess students that could not meet test requirements and to inform the parents accordingly. Parents/guardians of all students participating in the survey signed statements confirming that they were informed about the TIMSS 2019 survey and that they agreed that the data provided by their child could be used for the very survey. Data obtained by the questionnairaes for school principals, teachers, parents or legal guardians of students, who participate in TIMSS, are collected and stored in an agreed manner. This information cannot be used to identify individual respondent by the name, while TIMSS data are secured and cannot be accessed by any external person or system.

Test booklets and all TIMSS materials for the survey process were translated into all three official languages in BiH. Students completed test booklets and questionnaires in the language in which they are taught and in which the curriculum is implemented in their school. All international standards were met and all procedures were performed in prescribed time intervals.

In addition to test booklets, TIMSS survey also uses questionnaires for students, parents, teachers and principals to collect data on home learning tools, school environment, school and classroom climate, teaching methods, curriculum and general socio-economic indicators.

The TIMSS Assessment Framework

The starting point of the survey is the TIMSS curriculum model, which is considered at three levels (Mullis et al., 2009). The intended curriculum refers to what society expects students to learn in mathematics and science, as well as what education systems should look like for this to happen. The implemented curriculum refers to what is actually taught in the classroom, including the characteristics of teaching and teachers. Finally, the attained curriculum represents what students have learned as well as their attitudes toward these subjects. Taking this model as a starting point, TIMSS uses tests in mathematics and science, questionnaires for students, teachers and principals, curricular questionnaires, as well as data provided for the TIMSS encyclopedia by national/state research centers. These testing instruments serve to obtain detailed data on the three defined curricular aspects, i.e. what students should learn, what they are really learning, and what they have learned in the end, i.e. learning outcome of the teaching.

The Domains in the TIMSS Study

TIMSS items examine achievement within three cognitive domains: Knowing (knowledge of facts, concepts, procedures), Applying (application of knowledge in problem solving) and Reasoning (goes beyond solving routine problems and enters the domain of unknown, complex content).

Table 1. 1 Examined contents in mathematics and science

Mathematics	
Number	Whole numbers with zero (25%); Fractions and decimals (10%); Numerical expressions; Simple equations and relations (15%)
Measurement (15%) and Geometry (15%)	Scale score, lines, angles; Two-dimensional and three-dimensional shapes
Data	Reading, interpreting and presenting data (15%); Using data to solve problems (5%)
Science	
Life Science	Characteristics and life processes of organisms; Life cycles, reproduction and heredity; Organisms, environment, and their interactions; Ecosystems; Human health
Physical Science	Classification and properties of matter and changes in matter; Forms of energy and energy transfer; Forces and motion;
Earth Science	Earth's physical characteristics, resources, and history; Earth's weather and climates, Earth in the Solar System

In the introduction, it was emphasized that TIMSS research is focused on mathematics and science. Numerous analyzes of the previous six cycles have found that all children can benefit from developing skills in mathemataics and understanding mathematics. Primarily, learning math improves problem-solving skills, and working through problems can teach perseverance and persistence. Mathematics is important in everyday life for activities such as counting, cooking, money management and creating new skills. In addition, many career areas require a strong mathematical foundation, such as engineering, architecture, accounting, banking, business, medicine, ecology, natural processes, and more. Mathematics is vital to economics and finance, as well as to computer technology and software development that are at the core of our technologically advanced information world. The TIMSS 2019 mathematical frameworks for fourth and eighth grade are regularly upgraded every four years. In general, the fourth and eighth grade frameworks are similar to those used in TIMSS 2015. However, there have been minor updates to certain topics to better reflect the curricula, standards and frameworks of the participating countries, as noted in the TIMSS Encyclopedia 2015 (Mullis, Martin, Goh & Cotter, 2016). Also, as some countries moved to eTIMSS in TIMSS 2019, the mathematics frameworks have been updated to be suitable for both digital and paper assessment formats. The aim is to take advantage of computer-based assessment to start incorporating new and better assessment methods, especially in the domains of Applying and Reasoning.

The questions and items in the tests were of different types: closed-ended tasks (e.g. multi-choice, true/false) and open-ended tasks where the student needed to solve a problem or explain their answer. The items were classified into 14 test booklets, 14 blocks for mathematics and science. Booklets for students are composed of different combinations of blocks of mathematics and science. A total of 268 items in mathematics and 174 in science were used. Each student had their own ID code and their own test booklet distributed randomly. Students gave answers in two sessions lasting 72 minutes (each session lasted 36 minutes with a 15 minutes break maximum), and each test booklet contained 44 to 50

items. Fourth graders are expected to spend, on average, 18 minutes on each exam block. An additional 30 minutes is planned for completing the questionnaire for students.

When choosing how to distribute the blocks in the booklets, the main goal was to maximize the coverage of the TIMSS framework curriculum, while ensuring that each student responded to enough items to reliably measure trends in mathematics and science. A further goal was to ensure the reliability of performance measurement in mathematical and scientific content and cognitive domains. To allow linking between booklets and keep the number of booklets to a minimum, each block appears in two booklets.

BiH was among countries that used less difficult items in mathematics. The purpose of including less difficult items for the fourth grade was to expand the TIMSS scale of achievement in mathematics in this grade to allow for greater sensitivity at lower scores (lower part of the scale). In 2015, less difficult math tasks, known as TIMSS Numeracy, were given as a separate mathematical assessment, although most countries that participated in TIMSS Numeracy also participated in TIMSS, as usual, in order to have results from science as well. It is important to understand that for TIMSS 2019 in fourth grade:

- both versions of the mathematics assessment, regular and less difficult, were developed according to the fourth grade mathematics framework;
- the availability of two versions of TIMSS mathematics at fourth grade enables TIMSS to target the assessment to each country's situation in order to provide the best possible measurement;
- the mathematics results for all countries participating in TIMSS 2019 will be reported on the same achievement scale, including the results for countries administering the less difficult version of TIMSS mathematics.

Both regular and less difficult versions of TIMSS mathematics in fourth grade are equivalent in scope, and about one-third of the items is identical. The other two-thirds of the items are based on the same areas of the framework, with those in the less difficult version being generally less difficult. A substantial portion of the items in the less difficult version are from TIMSS Numeracy 2015, to enable measuring trends. The identical items in the two versions of mathematics in fourth grade will enable linking of the the two assessments, so the results can be reported together and directly compared.

In both sessions of the mathematics and science tests, used were the items from 2015 cycle and those developed for the TIMSS 2019. The odd-numbered blocks (01, 03 ...) contain the 2015 trend items, while the blocks with even numbering (02, 04 ...) contain new items from TIMSS 2019.

Each of the two assessment frameworks for TIMSS 2019 is organized around two dimensions:

- ✓ Content dimension, specifying the subject matter to be assessed
- ✓ Cognitive dimension, specifying the thinking processes to be assessed

Target percentages of the TIMSS 2019 mathematics and science assessment devoted to content and cognitive domains at the fourth grade are given in the following tables.

Table 1.2 TIMSS 2019 fourth grade content domains in mathematics

Content domains	Percentages
Number	50
Measurement and Geometry	30
Data	20

Content domains differ for fourth and eighth grade. Content domain Number is more represented at fourth than at eighth grade. At eighth grade, two of the four content domains are algebra and geometry. Because they are generally not taught as separate domains in primary school, an introductory or pre-algebraic topics, that are graded in the fourth grade, are included as part of the content domain Number. The content domain data at fourth grade focuses on data collection, reading, and presentation, while in the eighth grade there is a greater emphasis on data interpretation, basic statistics, and probability.

Table 1.3 TIMSS 2019 fourth grade content domains in science

Content domains	Percentages
Life Science	45
Physical Science	35
Earth Science	20

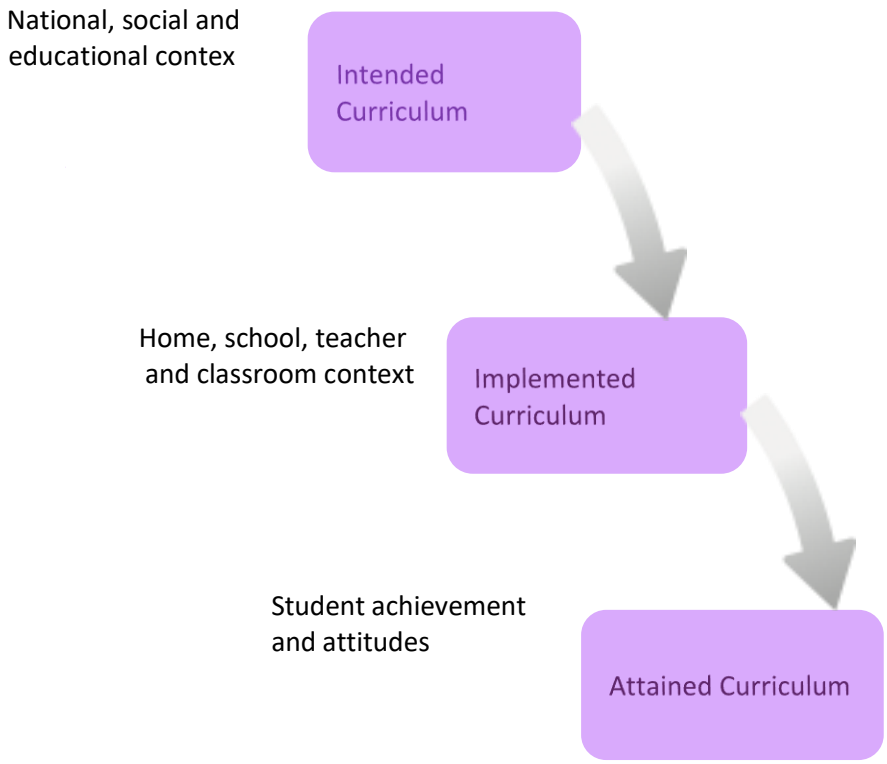
The TIMSS 2019 survey assesses science practice. This practice includes skills from everyday life and school learning that students use systematically to conduct scientific research that is the foundation in all scientific disciplines.

Practice in science is strongly related to the field of science being studied and therefore cannot be assessed separately. Some items in the TIMSS 2019 survey in science in fourth grade will assess one or more important scientific practices along with the content given in the content domain and the thought processes given in the cognitive domain.

The Content and Context for learning Mathematics and Science

TIMSS uses the curriculum, broadly defined, as the major organizing concept in considering how educational opportunities are provided to students and the factors that influence how students use these opportunities. The TIMSS Curriculum Model has three aspects: the intended curriculum, the implemented curriculum, and the attained curriculum. These represent, respectively, the mathematics and science that students are expected to learn as defined by countries' curriculum policies and publications and how the educational system should be organized to facilitate this learning; what is actually taught in classrooms, the characteristics of those teaching it, and how it is taught; and, finally, what it is that students have learned and what they think about learning these subjects.

Exhibit 1.2 TIMSS Curriculum Model



Source: Mullis, I. V. S., Martin, M. O. (2017). TIMMS 2019 Assessment Frameworks, p.4

In order to respond properly to TIMSS items, students must be familiar with the mathematical content assessed, but they must also use a range of cognitive skills. Defining these skills plays a crucial role in the development of assessment such as TIMSS 2019, as they are crucial to ensure that assessment covers an appropriate range of cognitive skills across content domains.

Table 1.4 TIMSS 2019 cognitive domains in mathematics for fourth grade

Cognitive Domains	Percentages
Knowing	40
Applying	40
Reasoning	20

Table 1.5 Cognitive requirements in TIMSS 2019 mathematics curriculum

Cognitive requirements	Description
Knowing	Recalls definitions, terms, units of measurement, geometric properties, and records (e.g., a + a + a + = 3a). Recognizes numbers, expressions, quantities and shapes. Recognizes terms that are mathematically equivalent (e.g., equivalent fractions, decimal numbers, and percentages; different orientations of simple geometric figures). Classifies and groups numbers, expressions, quantities and shapes according to common properties. Calculates with natural numbers, fractions and decimal numbers. Evaluates the result of a computational operation. Performs routine arithmetic operations. Compare numbers and objects by property. Finds information on a chart, table, text, or other source. Uses measuring instruments and selects appropriate units of measurement.
Applying	Selects the appropriate operation, strategy, or troubleshooting tool when a resolution procedure, algorithm, or method is known. Presents information and data with a table and graph. Creates an appropriate model, for example an equation, an inequality, a geometric figure, or a diagram that models a problem situation. Generates equivalent representations of given mathematical concepts or relationships. It applies problem-solving strategies and operations including known mathematical concepts and procedures.
Reasoning	Defines, describes, and uses relationships between numbers, expressions, quantities, and shapes. It connects different mathematical concepts, combines mathematical facts, concepts and procedures to come up with a solution to a problem. Evaluates alternative strategies and problem solving. Makes valid conclusions based on information and evidence. Gives statements that represent relationships at a more general and widely applicable level. Explains mathematical arguments supporting a strategy or solution.

Source: Mullis, I. V. S., Martin, M. O (2017). TIMMS 2011 Assessment Frameworks, str. 23–25

Each of the cognitive domains in science contains several main thematic areas, and each thematic area in turn includes one or more topics. Each topic is further described by specific objectives that represent the expected knowledge, abilities, and skills of the students assessed within each topic. By grading fourth grade, each objective gains approximately equal weight in terms of the number of assessment items.

Table 1.6 TIMSS 2019 fourth grade cognitive domains in science

Cognitive domains	Percentages
Knowing	40%
Applying	40%
Reasoning	20%

Table 1.7 Cognitive requirements in the TIMSS 2019 science curriculum

Cognitive requirement	Description
Knowing	Recognizes or cites facts, relationships, and concepts. Recognizes the characteristics or properties of certain organisms, materials and processes. Identifies the appropriate uses of scientific equipment and procedures. Recognizes and uses scientific vocabulary, symbols, abbreviations, units and scales. Describes or identifies descriptions of the properties, structures and functions of organisms and materials, and the relationships between organisms, materials, processes and phenomena. Provides or identifies examples of organisms, materials, and processes that have specific characteristics. Clarifies statements of facts or concepts with appropriate examples.
Applying	Identifies or describes similarities and differences between groups of organisms, materials or processes, and distinguishes, classifies or sorts individual objects, materials, organisms and processes based on characteristics and properties. It connects knowledge of a basic scientific concept with observed or concluded properties, behavior or use of objects, organisms or materials. Uses a diagram or other model to demonstrate knowledge of scientific concepts, to illustrate a process, cycle, relationship, or system, or to find solutions to a scientific problem. Uses knowledge of scientific concepts to interpret relevant textual, tabular, pictorial, and graphical information. Lists or determines the explanation of an observed or natural phenomenon using a scientific concept or principle.
Reasoning	Recognizes elements of a scientific problem and uses relevant information, concepts, relationships, and data patterns to answer questions and solve problems. Answers to questions that require consideration of several different factors or related concepts. Formulates questions, hypothesizes, predicts. It formulates questions that can be answered by research and anticipates research results with regard to design information. Formulates verifiable assumptions based on conceptual understanding and knowledge from experience, observation and / or analysis of scientific information. Uses evidence and conceptual understanding to predict the effects of changes in biological or physical conditions. Plans research or procedures appropriate to answer scientific questions or test hypotheses. Describes or recognizes the characteristics of well-designed research in terms of variables that are measured and controlled and cause-and-effect relationships. Evaluates alternative explanations. It weighs the advantages and disadvantages of making decisions about alternative processes and materials. Evaluates the test results with respect to the adequacy of the data supporting the conclusions. Makes valid conclusions based on observations, evidence and / or understanding of scientific concepts. Makes appropriate conclusions regarding questions or hypotheses, and demonstrates an understanding of cause and effect.

Acknowledgement to all TIMSS 2019 Study Participants

Now we would like to emphasize once again the importance of Bosnia and Herzegovina's participation in the international assessments in order to keep pace with modern educational research methods in obtaining objective indicators on educational systems and making comparisons with other countries. Knowing the TIMSS study is improved and upgraded with every new cycle, we hope that our country will take into consideration the international educational trends and provide our children with the quality, fairness and equity in our education systems, enabling access to education systems around the world as well.

In Bosnia and Herzegovina, TIMSS 2019 survey was conducted in period May 20 - June 13, 2019. We thank all representatives of the education authorities and coordinators from the ministries of education for TIMSS study and primary schools for good cooperation during the process of preparation and implementation of the international survey TIMSS 2019.

We thank all school coordinators and test administrators for their effort, work and professionalism invested in conducting this international assessment. Their response and cooperation gave special importance to administering the study. We thank the fourth grade students who participated in the survey for completing the test booklets and questionnaires responsibly and diligently. Also, we extend thanks to their parents/guardians who recognized the importance and purpose of this international survey and gave consent to their children participation in the TIMSS 2019 survey, thus enabling the improvement of education in Bosnia and Herzegovina.

1.1 Test Instruments Used in TIMSS 2019

Two types of test instruments were used in TIMSS 2019 survey: the questionnaires and 14 test booklets that contained items in mathematics and science. There were four types of questionnaires used to collect background data:

- School Questionnaire
- Teacher Questionnaire
- Student Questionnaire
- Early Learning Survey (completed by parents/guardians)

During the development and selection of the items, consulted were TIMSS national/state centers of the participating countries.

School Questionnaire is an instrument that was completed by the school principals participating in the study. This instrument provides data on the context in which learning takes place, such as the size of the school, the size of the place where the school is located, the duration of classes, school equipment, the emphasis the school places on student success, data on student safety and discipline, preparatory teaching for students starting the school and education of school principals (TIMSS 2019, School Questionnaire, fourth grade).

Teacher Questionnaire provides a wide range of data on the demographic characteristics of the respondents, on teaching practice, professional qualifications and teacher preparedness. Teachers also provided answers to questions regarding some characteristics of the school environment, cooperation with other teachers, job satisfaction, the way they teach, obstacles caused by student behavior, the degree to which the school values academic success, topics covered within curriculum, and the method of assessment, homework and the use of information technology (TIMSS 2019, Teacher Questionnaire, fourth grade).

Student Questionnaire contains questions about the equipment of the household in which the student lives, origin of parents and students, absence of students from school, use of computers and the purpose of their use. Students provided answers to questions about the way they experience their school, student bullying at school, and attitudes towards subjects - mathematics and the subject/subjects

studying science, as well as towards classes and teachers (TIMSS 2019, Student Questionnaire, fourth class).

Early Learning Survey intended for parents/guardians of students, is an instrument introduced for the first time in the TIMSS 2015 cycle. The answers to this questionnaire provide a database on how parents prepared their children before starting school and knowledge with which children started the first grade. Respondents answer questions about the child attending preschool, reading books, playing with numbers, learning to write and read. The questionnaire provides insight into the socio-economic status (SES) of the family and the attitude of parents towards school and education (TIMSS 2019, Early Learning Survey, fourth grade). In the 2011 cycle, there was a similar instrument - Learning to Read Survey, but it was intended for only a small number of countries - those that participated in the TIMSS and PIRLS surveys at the same time in fourth grades.

The test booklets for the fourth grade measure achievements in six content domains, while in the eighth grade there are eight content domains. Achievements are measured at three cognitive domains.

2. THE ACHIEVEMENTS AND SUCCESS OF FOURTH GRADE STUDENTS IN TIMSS 2019 IN BOSNIA AND HERZEGOVINA

The next chapter examines the results of the TIMSS 2019 survey, and discusses data on fourth grade students in BiH. The chapter provides a basis for understanding student achievement in mathematics and science and for comparing BiH results with the results in other countries.

2.1 The Results in Mathematics and Science

Fourth grade students in BiH recorded 452 scale score in mathematics and 459 scale score in science test. The achievement in both tests positioned BiH below the average on the TIMSS scale, which is 500 scale score, and the difference in relation to the average is statistically significant.

According to the achievement in mathematics, students from BiH scored similar result as their peers from Montenegro (453 scale score North Macedonia (472 scale score) and Qatar (449 scale score). BiH achievement in science is equal to the achievement in Montenegro (453 scale score) and Armenia (466 scale score).

Students from BiH have significantly better average achievement in mathematics compared to their peers from Chile, Iran, Oman, Saudi Arabia, Morocco, South Africa, Pakistan and the Philippines. Statistically significantly better results are achieved by peers in other countries participating in TIMSS 2019, except for peers in Montenegro, Kosovo and Qatar.

Achievements in science are similar. BiH students have statistically significantly better achievements than students from Iran, Oman, Azerbaijan, North Macedonia, Kosovo, Saudi Arabia, Morocco, Kuwait, South Africa, Pakistan and the Philippines. Other participating countries, with the exception of Georgia, Montenegro and Armenia, with statistically significantly better results.

Students from Serbia (508 scale score) and Croatia (509 scale score) achieved better results in mathematics than other neighbouring countries, which are above the average on the TIMSS scale. It is similar with average achievements in science, where students from Serbia scored 517 scale score, and students from Croatia 524 scale score. The following Table exhibits average fourth grade results in mathematics of TIMSS 2019 participating countries.

Exhibit 2.1 TIMSS 2019 average mathematic achievement in fourth grade

Country	Average Scale Score
Singapore	625 (3,9) ▲
Hong Kong SAR	602 (3,3) ▲
Korea, Rep. of	600 (2,2) ▲
Chinese Taipei	599 (1,9) ▲
Japan	593 (1,8) ▲
Russian Federation	567 (3,3) ▲
Northern Ireland	566 (2,9) ▲
England	556 (2,7) ▲
Ireland	548 (2,5) ▲
Latvia	546 (2,6) ▲
Norway	543 (2,2) ▲
Lithuania	542 (2,8) ▲
Austria	539 (2,0) ▲
The Netherlands	538 (2,2) ▲
USA	535 (2,5) ▲
Czech Republic	533 (2,5) ▲
Belgium (Flemish)	532 (1,9) ▲
Cyprus	532 (2,9) ▲
Finland	532 (2,3) ▲
Portugal	525 (2,6) ▲
Denmark	525 (1,9) ▲
Hungary	523 (2,6) ▲
Turkey	523 (4,4,) ▲
Sweden	521 (2,8) ▲
Germany	521 (2,3) ▲
Poland	520 (2,7) ▲
Australia	516 (2,8) ▲
Azerbaijan	515 (2,7) ▲
Bulgaria	515 (4,3) ▲
Italy	515 (2,4) ▲
Kazakhstan	512 (2,5) ▲
Canada	512 (1,9) ▲
Slovak Republic	510 (3,25) ▲
Croatia	509 (2,2) ▲
Malta	509 (1,4) ▲
Serbia	508 (3,2) ▲
Spain	502 (2,1)
TIMSS Scale Centerpoint	
Armenia	498 (2,5)
Albania	494 (3,4)
New Zealand	487 (2,6) ▼
France	485 (3,0) ▼
Georgia	482 (3,/9 ▼
UAE	481 (1,7) ▼
Bahrain	480 (2,6) ▼
North Macedonia	472 (5,3) ▼
Montenegro	453 (2,0) ▼
Bosnia and Herzegovina	452 (2,4) ▼
Qatar	449 (3,4) ▼
Kosovo	444 (3,0) ▼
Islamic Republic of Iran	443 (3,9) ▼
Chile	441 (2,7) ▼
Oman	431 (431)▼
Saudi Arabia	398 (3,6) ▼
Morocco	383 (4,3) ▼
Kuwait	383 (4,7) ▼
South Africa	374 (3,6) ▼
Pakistan	328 (12,0) ▼
Filipini	297 (6,4) ▼
Benchmarking Participants	
City of Moscow, Russian Federation	593 (2,2) ▲
Dubai, UAE	544 (1,6) ▲
Quebec, Canada	532 (2,3) ▲
Madrid, Hotel Spain	518 (2,2) ▲
Ontario, Canada	512 (3,3) ▲
Abu Dhabi, UAE	441 (2,3) ▼

Note: The TIMSS Achievement Scale was established in 1995 based on a combined distribution of achievements of all countries participating in TIMSS 1995. To provide a reference point for comparing countries, this central point on a scale of 500 was located in the middle of the combined distributions of achievements. The units of the scale are selected so that 100 scale score corresponds to the standard deviation of the distribution.

The standard error is shown in parentheses. Due to rounding, some results may be inconsistent.

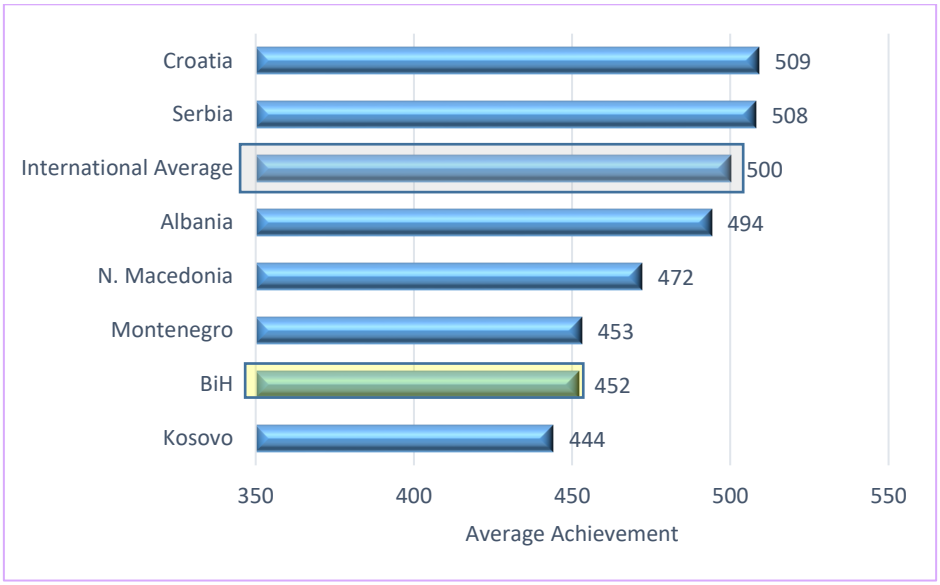
▲ *The average is significantly higher than the TIMSS average*

▼ *The average is significantly lower than the TIMSS average*

Source: IEA's Trends in International Science and Science Study - TIMSS 2019

As in the TIMSS 2015 survey, best results in mathematics were achieved by the countries of the Far East: Singapore, Hong Kong, and Republic Korea. They are followed by Japan, the Russian Federation and Northern Ireland. Exhibit 2.1 shows average achievement in mathematics of fourth grade students in the countries of the region.

Exhibit 2.1 Mathematics achievement in regional countries



In science, also, best results were achieved by the countries of the Asian region: Singapore and Republic Korea. In addition, Japan, the Russian Federation, Chinese Taipei and Finland have achieved extremely high achievements. There is a significant difference between the success of these countries and the countries that are placed at the bottom of the TIMSS scale, where mostly Arab countries are grouped. In science, BiH, with 459 scale score, scored better result than in mathematics.

In BiH, the average achievements of students from different parts (cantons, Republika Srpska, Brčko District) in mathematics are at the level of low benchmark. Students from three cantons achieved average score that is above BiH average, as is the case with RS students, having statistically significantly better score than the national average. Regarding the differences in average achievement between the cantons, there is statistically significant differences only between Zenica-Doboj Canton and Sarajevo Canton in favor of students from Sarajevo Canton.

Table 2.2 TIMSS 2019 fourth grade average science achievement

Country	Average Scale Score
Singapore	595 (3,4) ▲
Korea, Rep. of	588 (2,1) ▲
Russian Federation	567 (3,0) ▲
Japan	562 (1,8) ▲
Chinese Taipei	558 (1,8) ▲
Finland	555 (2,6) ▲
Latvia	542 (2,4) ▲
Norway	539 (2,2) ▲
USA	539 (2,7) ▲
Lithuania	538 (2,5) ▲
Sweden	537 (3,3) ▲
England	537 (2,7) ▲
Czech Republic	534 (2,6) ▲
Australia	533 (2,4) ▲
Hong Kong SAR	531 (3,3) ▲
Poland	531 (2,6) ▲
Hungary	529 (2,7) ▲
Ireland	528 (3,2) ▲
Turkey	526 (4,2) ▲
Croatia	524 (2,2) ▲
Canada	523 (1,9) ▲
Denmark	522 (2,4) ▲
Austria	522 (2,6) ▲
Bulgaria	521 (4,9)▲
Slovak Republic	521 (3,1) ▲
Northern Ireland	518 (2,3) ▲
The Netherlands	518 (2,9) ▲
Germany	518 (2,2) ▲
Serbia	517 (3,59)▲
Cyprus	511 (3,0) ▲
Spain	511 (2,0) ▲
Italy	510 (3,0) ▲
Portugal	504 (2,6)
New Zealand	503 (2,3)
Belgium (Flemish)	501 (2,19
TIMSS Scale Centerpoint	
Malta	496 (1,3) ▼
Kazakhstan	494 (3,1)
Bahrain	493 (3,4) ▼
Albania	489 (3,5) ▼
France	488 (3,0) ▼
UAE	473 (2,1) ▼
Chile	469 (2,6) ▼
Armenia	466 (3,4) ▼
Bosnia and Herzegovina	459 (2,9) ▼
Georgia	454 (3,9) ▼
Montenegro	453 (2,5) ▼
Qatar	449 (3,9) ▼
Iran	441 (4,1) ▼
Oman	435 (4,1) ▼
Azerbaijan	427 (3,3) ▼
North Macedonia	426 (6,2) ▼
Kosovo	413 (3,7) ▼
Saudi Arabia	402 (4,1) ▼
Kuwait	392 (6,1) ▼
Morocco	374 (5,8) ▼
South Africa	324 (4,9) ▼
Pakistan	290 (13,4) ▼
Philippines	249 (7,5) ▼
Benchmarking Participants	
City of Moscow, Russian Federation	595 (2,2) ▲
Dubai, UAE	545 (1,7) ▲
Ontario, Canada	524 (3,2) ▲
Madrid, Hotel Spain	523 (2,0) ▲
Quebec, Canada	522 (2,5) ▲
Abu Dhabi, UEA	418 (2,8) ▼

Note: The TIMSS Achievement Scale was established in 1995 based on a combined distribution of achievements of all countries participating in TIMSS 1995. To provide a reference point for comparing countries, this central point on a scale of 500 was located in the middle of the combined distributions of achievements. The units of the scale are selected so that 100 scale score corresponds to the standard deviation of the distribution.

The standard error is shown in parentheses. Due to rounding, some results may be inconsistent.

▲ *The average is significantly higher than the TIMSS average*

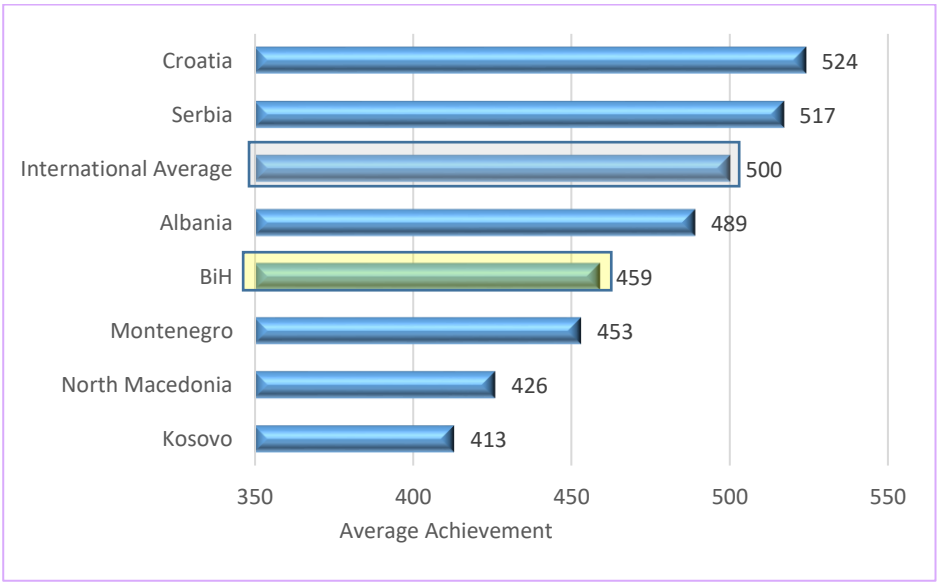
▼ *The average is significantly lower than the TIMSS average*

Source: IEA's Trends in International Science and Science Study - TIMSS 2019

In BiH, the average achievement of students from different parts (cantons, Republika Srpska, Brčko District) in science are at the level of low benchmark. Students from five cantons had average score that is above BiH average, which is the case with students from RS and Brčko District, but these differences in relation to the average score in BiH are not statistically significant. Regarding the differences in average achievement between the cantons, there is statistically significantly lower achievement among students of Zenica-Doboj Canton compared to students of Sarajevo Canton and Posavina Canton.

Exhibit 2.2 shows the average performance of students in BiH in science in relation to the international average, as well as their relative position among the neighbouring countries with valid and comparable results of TIMSS 2019.

Exhibit 2.2 Science achievement in regional countries



2.2 Achievement in Mathematics and Science in BiH by International Benchmark Levels

Based on the achievements of students from all countries participating in the TIMSS survey, constructed are international benchmarks, and in the reports, prepared by the IEA, the achievement is presented and interpreted in relation to them. There are four benchmarks – i.e. four levels of achievement:

- Advanced international level (625 scale score)
- High international level (550 scale score)
- Intermediate international level (475 scale score)
- Low or basic international level (400 scale score)

These values are defined based on items that a certain category of students successfully solves, which spans from the most demanding items, solved by students whose competencies are in the advanced category, to the simplest items, solved by students who achieve low achievement.

It is assumed that students who achieve e.g. high benchmark level, can also solve tasks that determine the middle and low reference levels. This assumption forms the basis of reporting according to benchmarks, which is why the number of students achieving higher benchmarks is always lower than the number of students achieving inferior benchmarks. Also, international reports based on four benchmark levels or, as we call them four international levels of achievement, also provide data on the percentage of students in one country that did not reach even the lowest international level of achievement (Mullis et al., 2016; Martin et al., 2016).

Table 2.3 describes mathematical competencies of students whose achievement is within a certain benchmark level (IEA's Trends in International Mathematics and Science Study - TIMSS 2019).

Table 2.3 Description of TIMSS 2019 fourth grade international benchmarks in mathematics

Benchmark/ International level	Description of achievement
Advanced International Benchmark (625)	Students can apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning. Students can solve a variety of multistep word problems involving whole numbers and show an understanding of fractions and decimals. They can apply knowledge of two- and three-dimensional shapes in a variety of situations. Students can interpret and represent data to solve multistep problems. Students at this level can solve a variety of multistep word problems involving whole numbers. They can find more than one solution to a problem. Students can solve problems that show an understanding of fractions, including those with different denominators. They can order, add, and subtract one- and two-place decimals. Students can apply knowledge of two- and three-dimensional shapes in a variety of situations. They can draw parallel lines and solve problems involving area and perimeter of shapes. They can use a ruler to measure lengths of objects beginning or ending at a half-unit and read other measurement scales. Students can interpret and represent data to solve multistep problems. They can give a mathematical argument to support their solutions.
High International Benchmark (550)	Students apply conceptual understanding to solve problems. They can apply conceptual understanding of whole numbers to solve two-step word problems. They show understanding of the number line, multiples, factors, and rounding numbers, and operations with fractions and decimals. Students can solve simple measurement problems. They demonstrate understanding of geometric properties of shapes and angles. Students can interpret and use data in tables and a variety of graphs to solve problems. Students at this level apply conceptual understanding of whole numbers to solve two-step word problems. They can multiply two-digit numbers and solve problems based on the number line, fractions, and decimals. They can find multiples of one-digit numbers and factors of numbers up to 30 and can round numbers. Students can identify an expression that represents a situation and can identify and use relationships in a well-defined pattern. Students can solve a variety of one-step measurement problems. They can classify and compare a variety of shapes and angles based on their properties. They demonstrate understanding of line symmetry and can recognize relationships between two- and three-dimensional shapes. Students can solve problems by interpreting data presented in tables, pie charts, pictographs, and line and bar graphs. They can compare data from two representations to draw conclusions.

Intermediate International Benchmark (475)	Students can apply basic mathematical knowledge *in simple situations.* They can compute with three- and four-digit whole numbers in a variety of situations. They have some understanding of decimals and fractions. Students can identify and draw shapes with simple properties. They can read, label, and interpret information in graphs and tables. Students at this level demonstrate an understanding of four-digit whole numbers. They can add and subtract four-digit numbers in a variety of situations, including problems involving two steps. Students can multiply and divide three-digit numbers by a one-digit number. They can identify expressions representing simple situations. Students at this level can add and order decimals and work with non-unit fractions. Students can solve simple measurement problems such as identifying the appropriate metric unit for linear objects and volume. Students can solve addition and subtraction problems involving hours and minutes. They can identify and draw shapes with simple properties and relate two- and three-dimensional shapes. Students can read, label, and interpret information in graphs and tables.
Law International Benchmark (400)	Students have some basic mathematical knowledge. They can add, subtract, multiply, and divide one- and two-digit whole numbers. They can solve simple word problems. They have some knowledge of simple fractions and common geometric shapes. Students can read and complete simple bar graphs and tables. Students at this level are familiar with numbers into the thousands. They can order, add, and subtract whole numbers. They have some knowledge of multiplication and division involving two-digit numbers. They can solve one-step word problems and number sentences. They can recognize pictorial representations of simple fractions. Students can recognize basic measurement ideas. They can recognize and visualize common two- and three-dimensional geometric shapes. Students can read and complete simple bar graphs and tables.

In the table above, differences in mathematical competencies between student achievement at the level of two adjacent reference values can be observed and understood. It is concluded that the TIMSS achievement scale is discriminatory, allowing the measurement of significantly different levels of knowledge.

Table 2.4 Description of TIMSS 2019 fourth grade international benchmarks in science

Benchmark/ International level	Description of achievement
Advanced International Benchmark (625)	Students communicate their understanding of life, physical, and Earth sciences and demonstrate some knowledge of the process of scientific inquiry. Students demonstrate knowledge of characteristics and life processes of a variety of organisms. They can communicate understanding of relationships in ecosystems and interactions between organisms and their environment. They communicate understanding of properties and states of matter and physical and chemical changes. Students communicate understanding of Earth's physical characteristics, processes, and history and show knowledge of Earth's revolution and rotation. Students demonstrate knowledge of characteristics and life processes of a variety of organisms. Students communicate understanding of relationships in ecosystems and interactions between organisms and their environment, such as explaining adaptations and identifying animals that compete for food. They can evaluate experimental designs to test how light and water affect the growth of plants. Students communicate understanding of properties and states of matter and of physical and chemical changes. In the context of investigations, students can explain what makes a solid dissolve faster in water, can evaluate methods for separating mixtures of solids, and understand what is important when designing a fair test. Students communicate understanding of Earth's physical characteristics, processes, and history. For example, they can relate two different environments to the weathering of rocks and recognize how fish fossils are formed. Students show knowledge of Earth's revolution and can describe how the Earth's rotation causes day and night. Students demonstrate basic knowledge and skills related to scientific inquiry and can recognize how to set up a simple experiment. They can draw conclusions from descriptions and diagrams and from results of experiments.
High International Benchmark (550)	Students communicate and apply knowledge of life, physical, and Earth science. Students communicate knowledge of characteristics of plants, animals, and their life cycles, and apply knowledge of ecosystems and of humans' and organisms' interactions with their environment. Students demonstrate knowledge of states and properties of matter and of energy transfer in practical contexts, and show some understanding of forces and motion. Students know various facts about the Earth's physical characteristics and show basic understanding of the Earth-Moon-Sun system. Students communicate knowledge of characteristics of plants and animals. For example, they can distinguish living things from nonliving things and demonstrate some knowledge of life cycles of plants and animals. Students can apply knowledge of ecosystems and of organisms' interactions with their environment. They can complete food chains and recognize some plant and animal features that provide advantages in a given environment. Students demonstrate an understanding of how germs spread. Students demonstrate knowledge of states and properties of matter. They understand basic properties of magnets, including the forces between two magnets. Students show some elementary knowledge about how shadows are formed. They apply knowledge of energy transfer in practical contexts and show some understanding of forces and motion, including gravity and air resistance. Students know various facts about the Earth's physical characteristics and climates, and show basic understanding of the Earth-Moon-Sun system. Students can make simple inferences using models, tables, and diagrams.

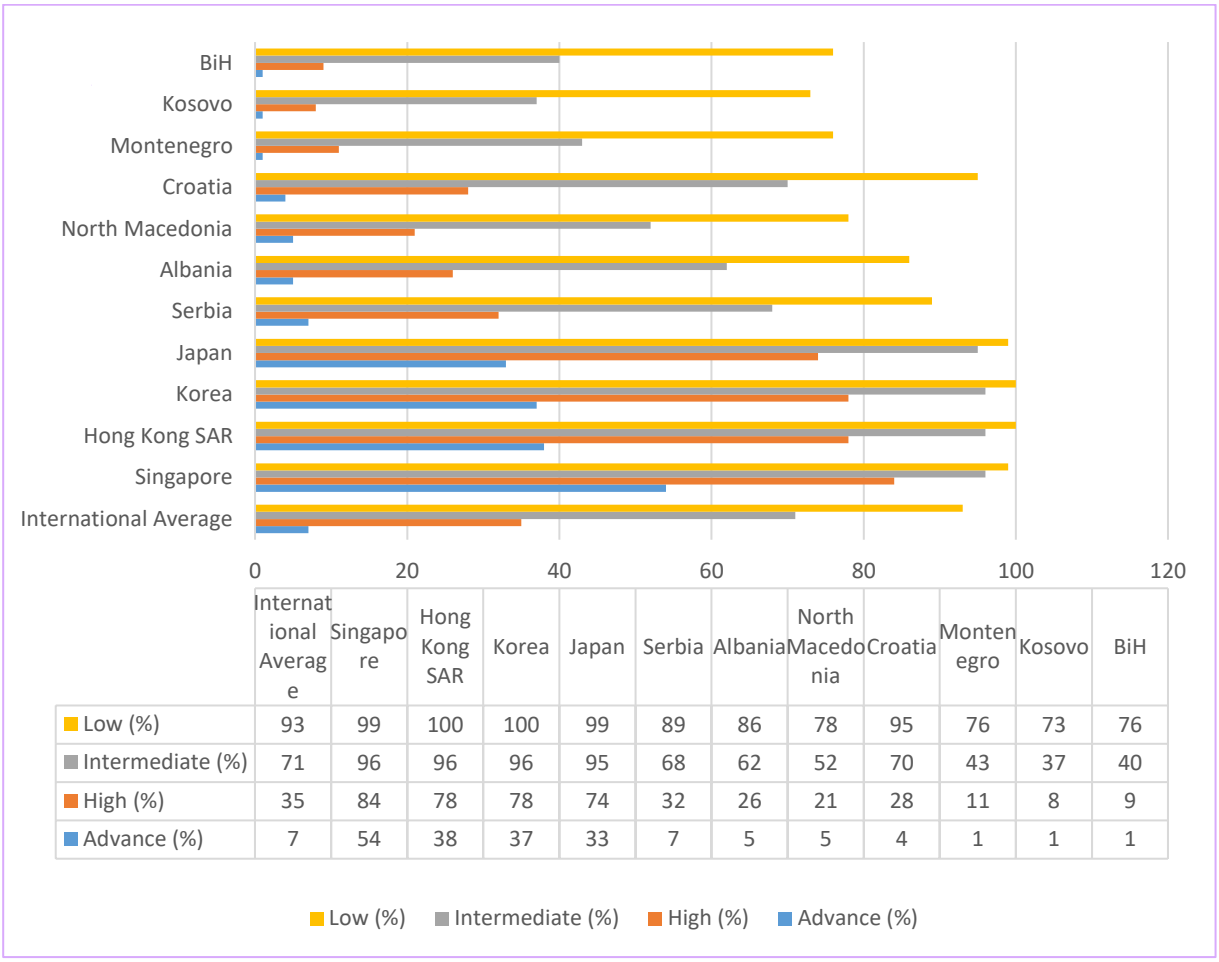
Intermediate International Benchmark (475)	Students show knowledge and understanding of some aspects of science. Students demonstrate some basic knowledge of plants and animals. They demonstrate knowledge about some properties of matter and some facts related to electricity, and can apply elementary knowledge of forces and motion. They show some understanding of Earth's physical characteristics. Students show basic knowledge of what plants and animals need to survive as well as some knowledge of the characteristics of animals. Students can recognize different properties of matter, demonstrate understanding of simple electrical circuits, and apply elementary knowledge of forces and motion, such as the force between a magnet and different materials. Students show some understanding of Earth's physical characteristics. Students can relate information in diagrams to some basic science concepts**.**
Law International Benchmark (400)	Students show limited understanding of scientific concepts and limited knowledge of foundational science facts. Students at this level can recognize that some animals have backbones, that some materials conduct heat better than others, and that water and soil are natural resources.

Table 2.4 shows that with the decline of the particular benchmark value, decreases the level of competencies the students have and the complexity of items that can be successfully solved. Also, the level of cognitive domains in which he successfully operates changes: from reasoning - inference, evaluation, argumentation and differentiation of scientific research processes- at an advanced level, to the knowledge and limited application of the cognitive domains represented in the low benchmark level.

Another significant benchmark value that we rely on when interpreting student achievement is the TIMSS scale centerpoint. Achievement scales are constructed so that their average is 500 scale score and the standard deviation is 100. This allows comparing the obtained scores with the scale average, which remains the same from cycle to cycle, instead of using the empirically calculated international average, which would constantly change, making the comparison of data, obtained in different cycles of the study, difficult.

Exhibit 2.3 shows the percentage distribution of students by levels of achievement/ international benchmarks in mathematics for BiH, neighboring countries, and countries with best achievement in TIMSS 2019.

Exhibit 2.3 Student distribution by international benchmarks in mathematics



	International Average	Singapore	Hong Kong SAR	Korea	Japan	Serbia	Albania	North Macedonia	Croatia	Montenegro	Kosovo	BiH
Low (%)	93	99	100	100	99	89	86	78	95	76	73	76
Intermediate (%)	71	96	96	96	95	68	62	52	70	43	37	40
High (%)	35	84	78	78	74	32	26	21	28	11	8	9
Advance (%)	7	54	38	37	33	7	5	5	4	1	1	1

Note: The numbers in the table represent the percentage of students who reach each of the benchmark. Due to rounding, some results may be inconsistent.

Source: IEA's Trends in International Science and Science Study - TIMSS 2019

Presented are achievements in mathematics across countries according to international benchmarks. Selected were the four most successful countries and the neighbouring countries for comparison.

Students at advanced level in mathematics are able to apply knowledge and cognitive operations in versatile and relatively complex situations. We can see that only 1% of students in BiH, or every hundredth student, reached the advanced benchmark. This percentage of students who solve the most demanding tasks is lower by 6% than the international average, and even by 53% than Singapore, and by 36% and 37% than Hong Kong or Korea results. With this data, we wonder, to what extent do schools pay attention to students who successfully solve high-demanding tasks.

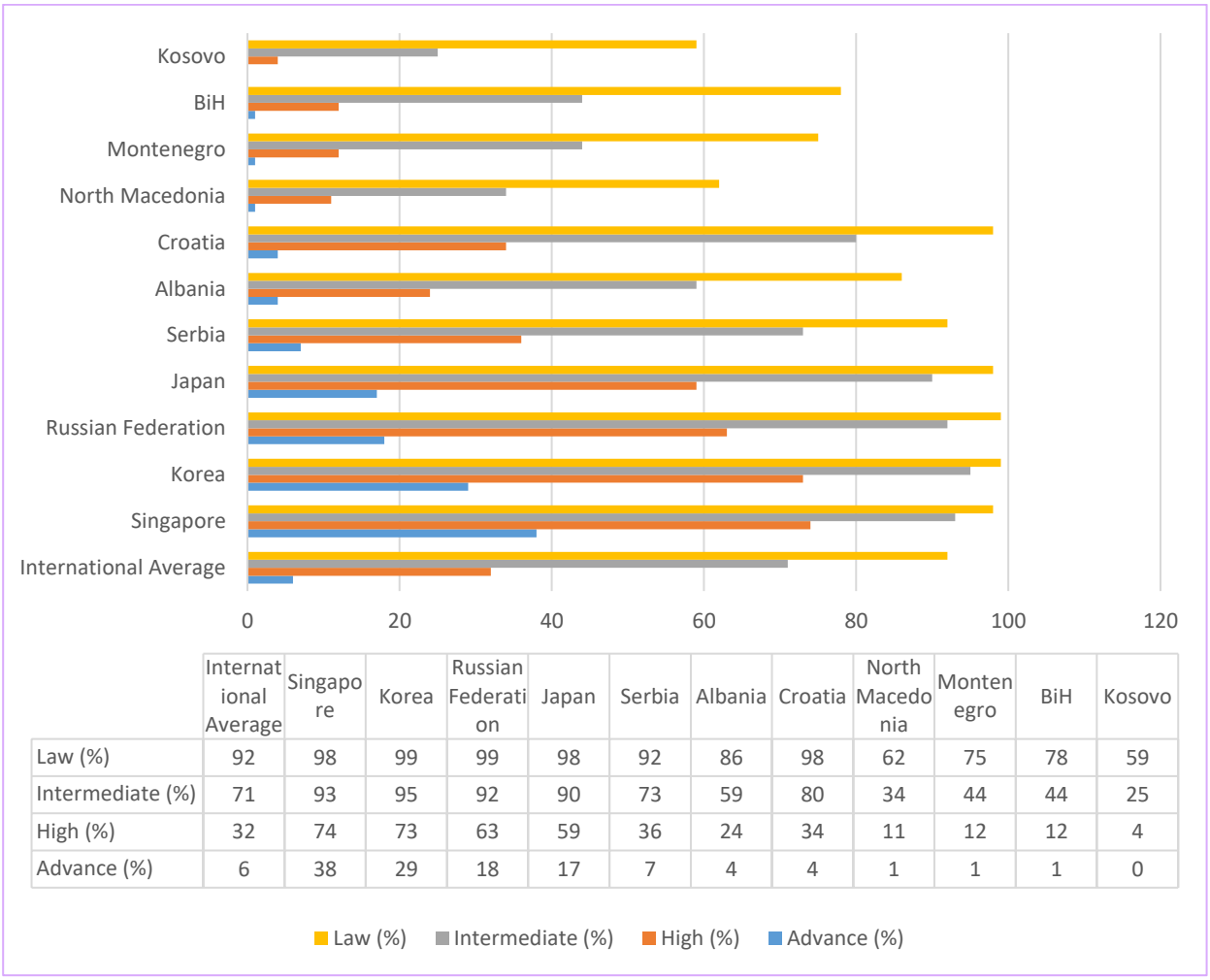
Arround 9% of students reach or exceed high benchmark, and 40% of students solve items used to measure intermediate benchmark. Arround 76% of students meet and exceed the requirements associated with low benchmark. Thus, 24% of students, about a quarter of students or every fourth student, cannot achieve low benchmark, which, in fourth grade mathematics means that the students is not able to apply addition and subtraction operations in a set of natural numbers and that the student

has difficulties with multiplication and measurement, copying with simple tables or graphs. These students fail to acquire basic mathematical competencies, which deserves additional research as well as additional efforts and investments towards significantly reducing the percentage of students in this category in the future.

As for the neighbouring countries, Serbia has highest percentage of students 7%, who achieve or exceed advanced benchmark while in Croatia 95% of students can meet requirements of the low benchmark.

Exhibit 2.4 shows the percentage distribution of students by international benchmarks in science for BiH, neighbouring countries, and countries with best achievement in TIMSS 2019.

Exhibit 2.4 Student distribution by international benchmarks in science



	International Average	Singapore	Korea	Russian Federation	Japan	Serbia	Albania	Croatia	North Macedonia	Montenegro	BiH	Kosovo
Law (%)	92	98	99	99	98	92	86	98	62	75	78	59
Intermediate (%)	71	93	95	92	90	73	59	80	34	44	44	25
High (%)	32	74	73	63	59	36	24	34	11	12	12	4
Advance (%)	6	38	29	18	17	7	4	4	1	1	1	0

Note: The numbers in the table represent the percentage of students who reach each of the benchmark.
Due to rounding, some results may be inconsistent.

Source: IEA's Trends in International Science and Science Study - TIMSS 2019

Presented are are the achievements in science across the countries according to the international benchmarks. The most successful four countries and the neighbouring countries were selected for comparison. We can see the science achievement is similar to mathematics achievement in BiH. Only 1% of students can meet highest requirements in science. These students are able to apply knowledge and understanding of Life Science, Physical Science and Earth Science, demonstarting basic knowledge and skills needed for scientific research. They are able to interpret research results and draw

conclusions based on a description or diagram. These knowledge and skills are the essence of scientific literacy.

Here differences in percentages are somewhat smaller in relation to best-performing countries than in mathematics. When we look at the countries that achieved best results, we notice that 38% of students from Singapore or 29% of students from Korea achieve or exceed the advanced level. This means that about a third of students from these countries achieve the highest level of scientific literacy, for their age.

In BiH, about 12% of students reach or exceed high benchmark, and 44% of students solve items at intermediate benchmark. A total of 78% of students meet, and exceed, the requirements associated with the low benchmark, which means that students have acquired the minimum level of competencies in science i.e. they are to some extent familiar with the characteristics of plants and animals, they can apply knowledge on facts of human health, explain simple graphical representations and give short written answers based on the facts. On the other hand, about 22% of students have very limited knowledge of scientific facts, because they do not even reach low level of achievement. The category of students who fail to reach low benchmark deserves attention, so it is necessary to further examine why teaching for these students is insufficiently effective and what are the deciding factors to consider when it comes to changes that need to be introduced in order to have less students who do not acquire basic scientific competencies.

As for the neighbouring countries, Serbia has the highest percentage of students who achieve or exceed the advanced benchmark 7% while in Croatia 98% of students can meet the requirements of low benchmark.

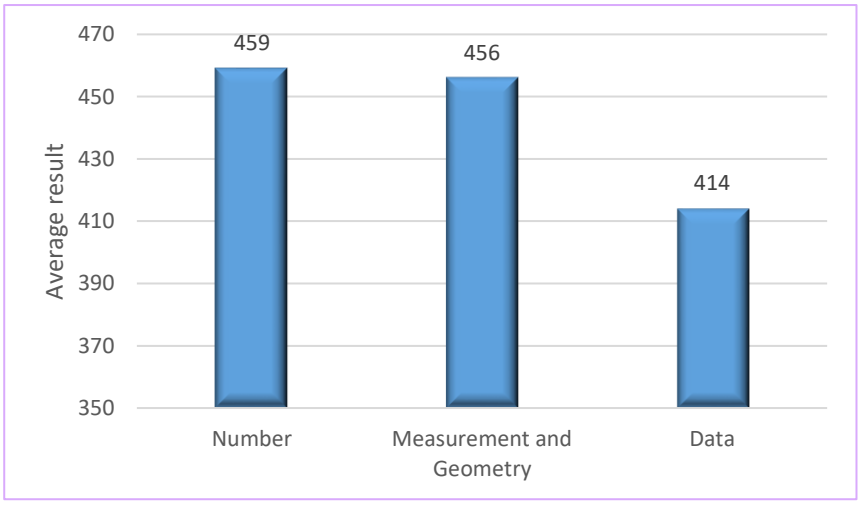
2.3 Student Achievement in Mathematics and Science by Content and Cognitive Domains

TIMSS 2019 survey uses Knowing, Applying and Reasoning as an appropriate range of cognitive skills across different content domains in mathematics and science.

2.3.1 Student Achievement in Mathematics and Science by Content Domain

In mathematics in TIMSS 2019 survey, examined were three content domains: Number, Measurement and Geometry, and Data. Basic data on BiH student achievement by content domain are presented in Exhibit 2.5.

Exhibit 2.5 BiH student achievement in three content domains in mathematics



In Number domain, students from BiH scored 459 scale score, which is significantly more than total average for BiH in mathematics; in Measurement and Geometry they scored 456 scale score, which is significantly higher than overall average for BiH in this domain. In Data domain, average is 414 scale score and it is significantly lower than overall average for BiH. There is a relative inequality of the knowledge in three domains in TIMSS survey, because the achievement in Measurement and Geometry and in Data is worse than in Number.

An overview of the fourth grade achievement in mathematics in the four top achieving countries and in the countries of the region is given in Table 2.5.

Table 2.5 Student achievement by content domains in mathematics

Country	Mathematics Average	Number (83 items)		Measurement and Geometry (52 items)		Data (37 items)	
		average	deviation from country average	average	deviation from country average	average	deviation from country average
Singapore	625	635	10	620	-5	613	-12
Hong Kong SAR	602	598	-4	608	6	607	5
Korea, Rep. of	600	593	-6	608	8	602	3
Chinese Taipei	599	500	0	607	8	590	-9
Japan	593	586	-7	601	8	606	13
Croatia	509	512	2	518	8	494	-15
Serbia	508	518	10	499	-9	489	-1
Albania	494	495	1	496	2	490	-4
N. Macedonia	472	472	1	475	3	464	-7
Montenegro	453	454	1	459	7	439	-14
BiH	452	459	7	458	6	414	-39
Kosovo	444	447	3	450	6	423	-21

Note: Due to rounding, some results may be inconsistent.
Source: IEA's Trends in International Science and Science Study - TIMSS 2019

Regarding the achievement of the countries in the region, it is noticeable the achievement in BiH is similar to the achievement in Montenegro. Namely, the difference in average result in mathematics is only 1 scale score in favor of peers in Montenegro, which is not statistically significant while the biggest difference in average achievement is in the Data domain, which is 26 scale score in favor of students in Montenegro, and this difference is statistically significant.

The achievement in Measurement and Geometry, as well as in Number, is significantly worse than the achievement of the countries of the region e.g. the difference in relation to Serbia is 41 scale score i.e. 59 scale score for both domains, and in relation to Croatia 60 scale score i.e. 53 scale score for both domains.

By comparing the fourth grade mathematics curricula in BiH we notice the Data and their presentation is not included. Nevertheless, achievement shows that students can cope with these requirements and that this domain is represented to some extent in the teaching practice. The importance of this domain for the development of mathematical and scientific competencies should be emphasized. TIMSS and PISA have been examining the domain of Data Presentation for some time now, what contributes to the domain considered important. Therefore, it is very important for the Data domain to be included in the curricula/syllabus, and become widely represented in the teaching practice and test booklets.

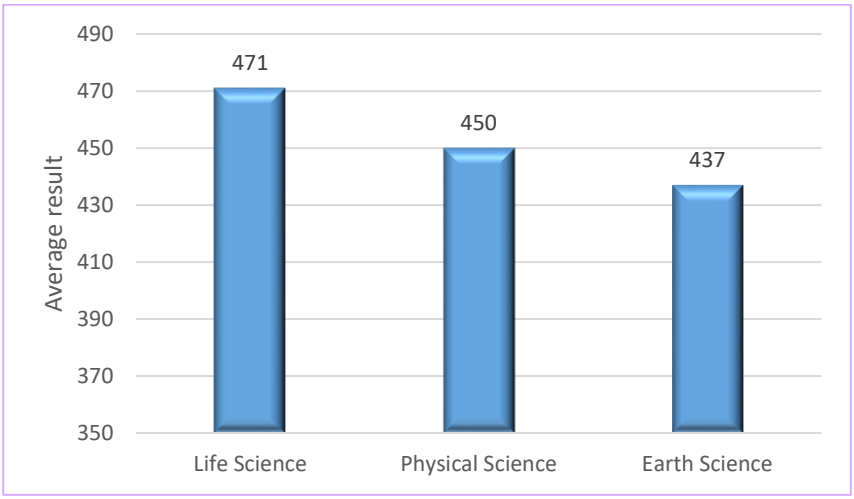
In BiH fourth grade mathematics curricula, the Measurement and Geometry domain is not given enough space in visually perceiving space or coincidence, the axis of symmetry, translation or rotation, the area of rectangles, squares, and the like. This indicates the curricula and the way of teaching should be improved, because one of the important factors influencing student achievement is the level of teacher preparedness to implement topics and contents in certain areas.

The achievement in the Data domain is the worst, taking into account the overall score in mathematics. This area is not explicitly covered in the curricula, however, some elements of data and data processing are contained in them and represented in teaching practice. On the other hand, students appear to cope in unfamiliar situations, which can be attributed to their general cognitive and logical-mathematical abilities.

It is believed the success of East Asian countries in mathematics is due to the high appriciation and investment of resources into the development of mathematical competencies, which make the basis for development and progress in technical and economic fields. It should be noted that more classes dedicated to the topic do not provide better achievement and that the content of teaching is more important than the time of its duration (Haahr, Kibak Nielsen, Eggert Hansen & Teglgaard Jakobsen, 2005; Jones, 2005, according to: Gašić-Pavišić, 2011).

In TIMSS 2019, examined were three content domains in science: Life Science, Physical Science and Earth Science. Each of these domains covers a large number of topics. Items are designed to represent a specific content area, yet an item can cover multiple topics, so students are asked to connect knowledge from various fields. Exhibit 2.6 gives student achievement in BiH in three content domains in science.

Exhibit 2.6 Student achievement in BiH in three content domains in science



Students from BiH achieved significantly better results in Life Science domain, 471 scale score, compared to overall average achievement in science. BiH students achieved 450 scale score in Physical Science and 437 scale score in Earth Science, significantly lower than overall achievement. This difference in achievement can be related to the differences that exist between the TIMSS program and the science curriculum in BiH.

An overview of the fourth grade achievement in mathematics in four top achieving countries and in the countries of the region by content domains is given in Table 2.6.

Table 2.6 Student achievement in science by content domains

Country	Science Average	Life Science (73 items)		Physical Science (61 items)		Earth Science (35 items)	
		average	deviation from country average	average	deviation from country average	average	deviation from country average
Singapore	595 (3,4)	603	8	613	19	557	-38
Korea, Rep. of	588	574	-13	607	19	587	-1
Russian Federation	567	570	3	572	5	554	-13
Japan	562	550	-11	579	17	559	-2
Croatia	524	520	-4	528	4	522	-1
Serbia	517	521	4	524	7	494	-23
Albania	489	488	-1	493	4	475	-15
BiH	459	471	13	450	-8	437	-22
Montenegro	453	464	11	446	-7	434	-20
N. Macedonia	426	422	-4	432	6	409	-17
Kosovo	413	408	-5	415	2	410	-3

Note: Due to rounding, some results may be inconsistent.
Source: IEA's Trends in International Science and Science Study - TIMSS 2019

BiH student achievement is similar to the achievement of peers from Montenegro. Unlike the achievement in mathematics, students from BiH achieve slightly better results in science than students from Montenegro. Thus, the difference in the overall average score is 6 scale score in favor of students from BiH while the smallest difference is in Earth Science 3 scale score and the largest in wildlife 7 scale score, in both cases in favor of students from BiH.

Achievement in Physical Science and Earth Science in BiH is significantly worse than in the countries of the region. Thus, in relation to the achievement in Croatia in these two domains, the difference is 78 and 85 scale score respectively, in favor of students from Croatia. Regarding the countries of the region that have similar structure of education i.e. 9 years long primary education and similar enrollment policy we can say that BiH has better achievements, compared to North Macedonia and Kosovo statistically significantly better results.

2.3.2 Student Achievement in Mathematics and Science by Cognitive Domains

Different types of knowledge are examined in TIMSS survey. Items are designed to assess different cognitive processes by three domains: Knowing, Applying, and Reasoning. Items of Knowing domain require students to demonstrate simple cognitive skills, yet this domain makes the basis for higher-level domains where knowledge should be applied in known, unknown, simple and complex situations and tasks. It is especially important to monitor student achievement in cognitive domains of high level.

An overview of the fourth grade achievement in mathematics in four top achieving countries and in the countries of the region by cognitive domains is given in Table 2.7.

Table 2.7 Student achievement in mathematics by cognitive domains

Country	Average in Mathematics	Knowing (59 items)		Applying (74 items)		Reasoning (38 items)	
		average	deviation from country average	average	deviation from country average	average	deviation from country average
Singapore	625	640	15	626	0	614	-11
Korea, Rep. of	602	600	-2	606	5	596	-6
Russian Federation	600	612	13	594	-5	596	-3
Japan	599	622	22	600	1	576	-23
Croatia	509	508	-2	509	0	510	0
Serbia	508	504	-4	509	1	503	-5
Albania	494	492	-2	498	4	490	-4
BiH	472	470	-2	477	5	470	-2
Montenegro	453	445	-8	454	1	463	10
N. Macedonia	452	444	-8	452	0	461	10
Kosovo	444	445	0	445	1	441	-3

Note: Due to rounding, some results may be inconsistent.
Source: IEA's Trends in International Science and Science Study - TIMSS 2019

Based on the indicators, the achievement of BiH students in cognitive domains is best in the domain of Reasoning 461 scale score, which is statistically significantly higher result than the average result in mathematics for BiH. In items that measure Applying, students achieved the same result as the average score in mathematics. We can say the result is satisfactory, although the average result is below the average on the TIMSS scale. The fact that students can reason and apply the knowledge they have acquired is encouraging, thus confirming the purposefulness of teaching and learning mathematics. It is interesting that for almost all observed countries, students achieve lower results in the cognitive domain of Reasoning. In Japan, Singapore and Serbia, the result is statistically significantly lower than their average, while in BiH the result in this domain is statistically significantly higher than the BiH average.

An overview of the fourth grade achievement in science in four top achieving countries and in the countries of the region by cognitive domains is given in Table 2.8.

Table 2.8 Student achievement in science by cognitive domains

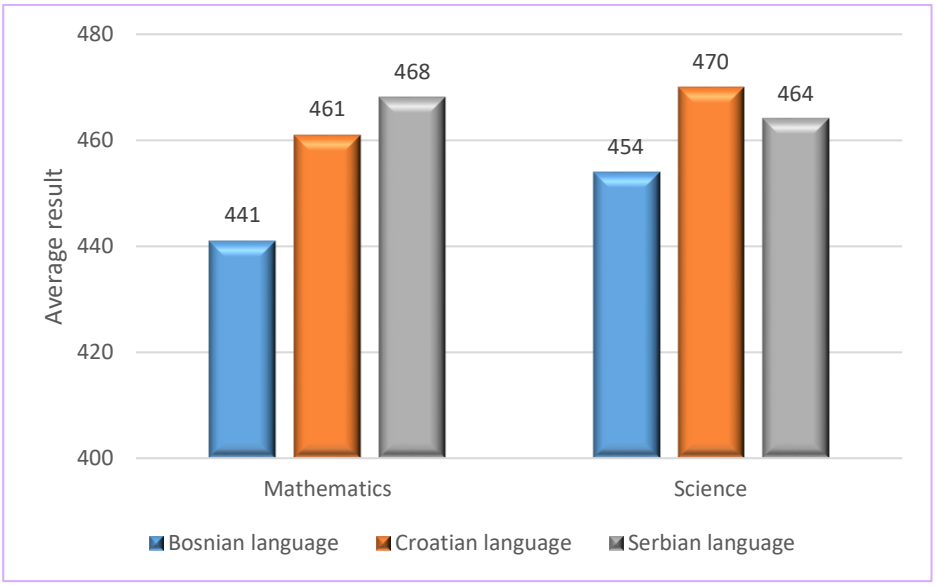
Country	Average in science	Knowing (69 items)		Applying (64 items)		Reasoning (36 items)	
		average	deviation from country average	average	deviation from country average	average	deviation from country average
Singapore	595	588	-7	595	1	604	9
Korea, Rep. of	588	584	-3	596	8	581	-6
Russian Federation	567	562	-5	572	5	569	2
Japan	562	535	-27	576	15	580	18
Croatia	524	526	3	521	-3	522	-2
Serbia	517	506	-11	526	9	518	1
Albania	489	494	4	485	-4	487	-2
BiH	459	451	-7	459	0	469	10
Montenegro	453	451	-2	454	0	451	-2
N. Macedonia	426	423	-3	423	-3	425	-1
Kosovo	413	419	6	406	-7	402	-11

Note: Due to rounding, some results may be inconsistent.
Source: IEA's Trends in International Science and Science Study - TIMSS 2019

As per observed science data, the distribution of student achievement in BiH by cognitive domains in science is similar to the distribution of some highly positioned countries, where students achieve statistically significantly better result with items measuring Reasoning, and significantly weaker results when it comes to knowing the facts. It should not be neglected that students in BiH also have low scores at the level of reasoning, and that this result cannot be directly related to the efforts of educational policy makers moving towards education that emphasizes functional knowledge, as is the case with developed countries. Anyway, it is promising that in science there is such a distribution that indicates the importance of applying scientific knowledge and skills in solving problem situations.

TIMSS study analyzes the achievement among different groups of students according to the language of assessment, which is also the language of instruction. In BiH, TIMSS 2019 assessment was conducted in Bosnian language, Croatian language and Serbian language. About 59% of students in BiH answered test items and completed student questionnaire in Bosnian language, about 10% in Croatian language and about 31% in Serbian language. Exhibit 2.7 presents average results in mathematics and science of students in BiH by language of assessment.

Exhibit 2.7 Average achievement in mathematics and science by language of assessment



The difference in achievement in mathematics by the language of the test is statistically significant between the students who took the test in Serbian and Bosnian, in favor of the teaching in Serbian language. The difference, statistically significant, was also found between the achievement of students who took the test in Croatian and Bosnian, in favor of the teaching in Croatian language. In science, there is differences in achievement in all three languages, but not statistically significant.

TIMSS survey strives to make fair comparison of student achievement in all participating countries. The TIMSS 2019 Assessment Frameworks is designed to identify important aspects of mathematics and science that participating countries have agreed should be at the heart of the international evaluation of mathematics and science achievements. Although assessment has been developed to present agreed frameworks, the intention is to have the common core in all countries, and it is inevitable that the match between assessment (or tests) in TIMSS 2019 and countries' mathematics and science curricula will not be the same for all countries. To restrict test items to just those topics, which are included in the curriculum and covered in the same order in all participating countries, would severely limit test coverage and limit the research questions for which the study is intended. Therefore, tests inevitably have some items that measure topics unknown to some students in other countries. A Test-Curriculum Matching Analysis (TCMA) was conducted to examine the extent to which TIMSS 2019 matches the mathematical and scientific curriculum of each country. The TCMA also investigates the impact on country's performance by including only items considered relevant to the particular curriculum.

In order to collect data for TIMSS 2019 assessment to match the curricula of the participating countries, the NRC (TIMSS Country Coordinator) was asked to examine each TIMSS item and indicate whether certain knowledge and skills, which are the subject of TIMSS assessment, are taught by curriculum in their country for the tested grade (fourth or eighth grade). The biggest differences in mathematics was found in the Russian Federation (16 scale score Bulgaria (11 scale score Croatia (11 scale score) and BiH (10 scale score).

Even when countries performed better, on items found to fit their curriculum, than they did overall, their performance vis-à-vis other participants changed very little. For example, students in Korea had a higher average achievement based on items covering the national curriculum (604) than on the entire test (588). However, most other countries have also achieved better performance based on this subset of items selected by Korea. Also, Singapore and Japan achieved better performance based on selected items in Korea compared to their average performance based on all items. In science in BiH, average achievement is higher by 6 scale score.

The TCMA results show that item selection does not have a large impact on the relative performance of countries. Participating countries that had relatively high or low achievement in mathematics or science based on all items also had relatively high or low achievement based on each of the different sets of items selected for TCMA. Although there are some changes in the order of countries based on the items selected for TCMA, most of these differences are within the limits of standard error.

2.4 Examples of Items in Mathematics and Science

Below given are the examples of mathematics items for fourth grade by international benchmark levels. For some math items, used in the international report as good examples of benchmarks, there is no data for BiH, for, they were not included in the assessment with the less difficult math items. Anyway, IEA reserves the right to distribute the test items in the public.

MATHEMATICS

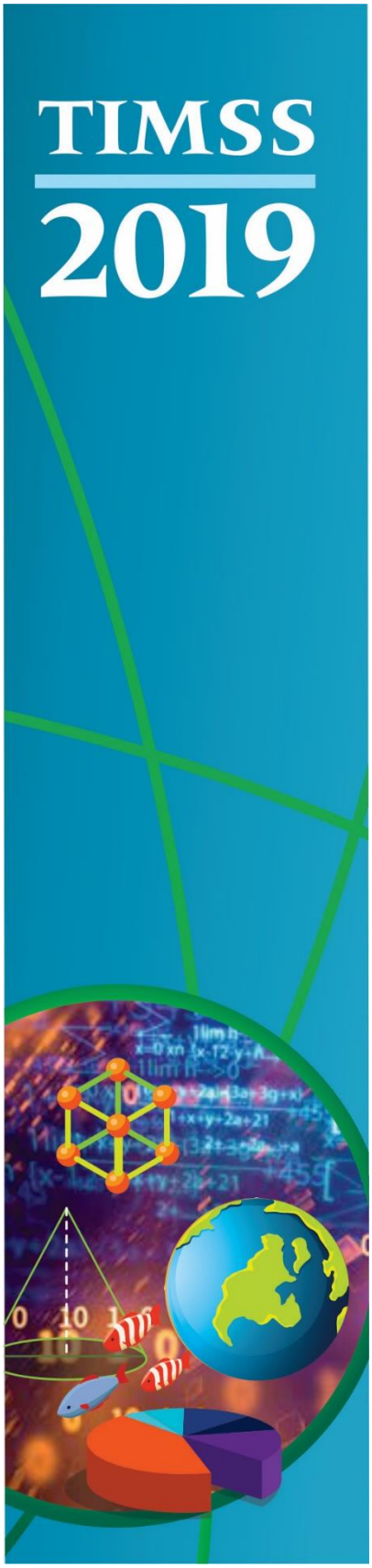


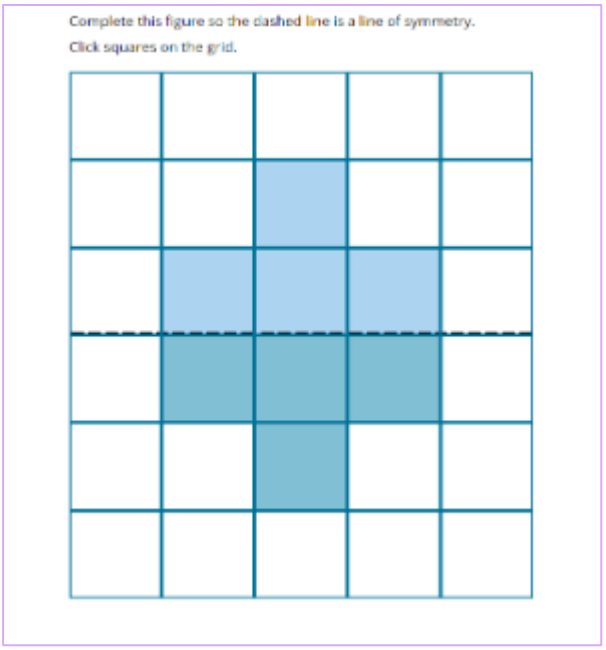
Exhibit 1. Intermediate International Benchmark of Mathematics Achievement – Example Item 1

Country	Percentages		
Singapore	97	(0.7)	▲
Cyprus	93	(1.2)	▲
Ireland	92	(1.4)	▲
Northern Ireland	91	(1.6)	▲
Denmark	91	(1.5)	▲
Hong Kong SAR	90	(1.9)	▲
The Netherlands	90	(1.3)	▲
Malta	90	(1.4)	▲
Albania	90	(1.8)	▲
Poland	90	(1.2)	▲
Belgium (Flemish part)	89	(1.5)	▲
Latvia	89	(1.6)	▲
England	88	(1.8)	▲
Norway (5)	88	(1.9)	▲
Australia	86	(1.8)	▲
Lithuania	86	(1.7)	▲
Kosovo	86	(1.9)	▲
Germany	85	(1.8)	▲
Kazakhstan	84	(1.7)	▲
Portugal	84	(2.0)	▲
Finland	82	(1.8)	▲
Hungary	81	(1.7)	▲
Morocco	81	(1.9)	▲
Azerbaijan	79	(2.0)	▲
New Zealand	79	(1.9)	▲
Bulgaria	78	(2.4)	▲
North Macedonia	77	(2.4)	▲
Russian Federation	77	(2.3)	▲
Austria	77	(1.9)	▲
Sweden	76	(2.2)	▲
Italy	73	(2.5)	
Canada	72	(1.8)	
France	72	(2.4)	
International Average	70	(0.3)	
Oman	70	(2.0)	
Korea, Rep. of	69	(2.3)	
Iran	68	(2.2)	
Turkey (5)	67	(2.7)	
Czech Republic	66	(2.6)	
Spain	65	(2.5)	▽
Slovak Republic	62	(2.8)	▽
USA	60	(1.5)	▽
Chinese Taipei	59	(2.4)	▽
Serbia	58	(2.5)	▽
Bahrain	57	(2.4)	▽
Japan	56	(2.5)	▽
UAE	55	(1.2)	▽
Croatia	54	(2.9)	▽
South Africa (5)	54	(1.9)	▽
Kuwait	52	(2.6)	▽
Montenegro	52	(2.0)	▽
Chile	51	(2.6)	▽
Armenia	49	(2.5)	▽
Qatar	41	(2.6)	▽
Saudi Arabia	40	(1.9)	▽
Georgia	31	(2.7)	▽
Bosnia and Herzegovina	30	(2.0)	▽
Pakistan	18	(4.7)	▽
Philippines	13	(1.9)	▽
Benchmarking Participants			
City of Moscow, Russian	90	(1.6)	▲
Quebec, Canada	83	(2.2)	▲
Ontario, Canada	74	(3.1)	
Dubai, UAE	73	(1.5)	
Madrid, Hotel Spain	65	(3.1)	
Abu Dhabi, UAE	45	(2.1)	▽

Content Domain: Measurement and Geometry

Cognitive Domain: Applying

Description: Completes a symmetric figure on a square grid given half the shape and the line of symmetry



Source: IEA's Trends in International Mathematics and Science Study - TIMSS 2019 Downloaded from http://timss2019.org/download

Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

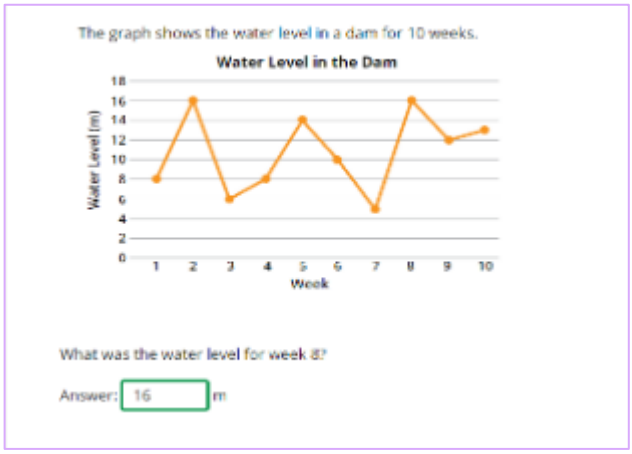
Exhibit 2. Intermediate International Benchmark of Mathematics Achievement – Example Item 2

Country	Percentages		
Japan	95	(0.9)	▲
Singapore	92	(0.9)	▲
Chinese Taipei	92	(1.3)	▲
Korea, Rep. of	91	(1.3)	▲
England	91	(1.5)	▲
The Netherlands	91	(1.4)	▲
Hong Kong SAR	91	(1.5)	▲
Norway (5)	88	(1.7)	▲
Northern Ireland	87	(1.8)	▲
Russian Federation	87	(1.5)	▲
Sweden	86	(1.9)	▲
Finland	86	(1.6)	▲
Belgium (Flemish part)	86	(1.6)	▲
Lithuania	84	(1.7)	▲
Denmark	84	(1.7)	▲
Australia	84	(1.6)	▲
Portugal	82	(1.6)	▲
Latvia	81	(2.0)	▲
Ireland	80	(1.6)	▲
Azerbaijan	79	(2.0)	▲
USA	79	(1.4)	▲
Spain	78	(2.5)	▲
New Zealand	77	(1.7)	▲
Hungary	76	(1.9)	▲
Canada	76	(1.3)	▲
Cyprus	75	(1.7)	▲
Malta	74	(2.0)	▲
Czech Republic	73	(2.2)	▲
Germany	71	(2.0)	
Austria	70	(2.4)	
Slovak Republic	70	(2.2)	
Italy	69	(2.5)	
Turkey (5)	69	(2.4)	
France	68	(2.6)	
International Average	**68**	**(0.3)**	
Albania	68	(2.2)	
Serbia	66	(2.7)	
Poland	65	(2.2)	
Kazakhstan	64	(2.2)	
Bahrein	63	(1.8)	▽
UAE	62	(0.8)	▽
Bulgaria	62	(2.8)	▽
Chile	61	(2.2)	▽
Qatar	60	(2.3)	▽
Croatia	59	(3.2)	▽
North Macedonia	52	(2.8)	▽
South Africa (5)	52	(1.8)	▽
Iran	50	(2.4)	▽
Georgia	48	(2.9)	▽
Oman	45	(2.0)	▽
Kosovo	43	(2.8)	▽
Armenia	42	(2.1)	▽
Montenegro	41	(1.8)	▽
Kuwait	40	(2.6)	▽
Saudi Arabia	34	(1.8)	▽
Marroco	32	(2.5)	▽
Bosnia and Herzegovina	32	(1.8)	▽
Philippines	28	(2.1)	▽
Pakistan	21	(4.2)	▽
Benchmarking Participants			
City of Moscow, Russian	95	(1.1)	▲
Quebec, Canada	84	(1.9)	▲
Dubai, UAE	81	(1.2)	▲
Madrid, Hotel Spain	80	(2.1)	▲
Ontario, Canada	75	(2.1)	▲
Abu Dhabi, UAE	52	(1.2)	▽

Content Domain: Data

Cognitive Domain: Knowing

Description: Reads data from a line graph



Source: IEA's Trends in International Mathematics and Science Study - TIMSS 2019 Downloaded from http://timss2019.org/download

Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

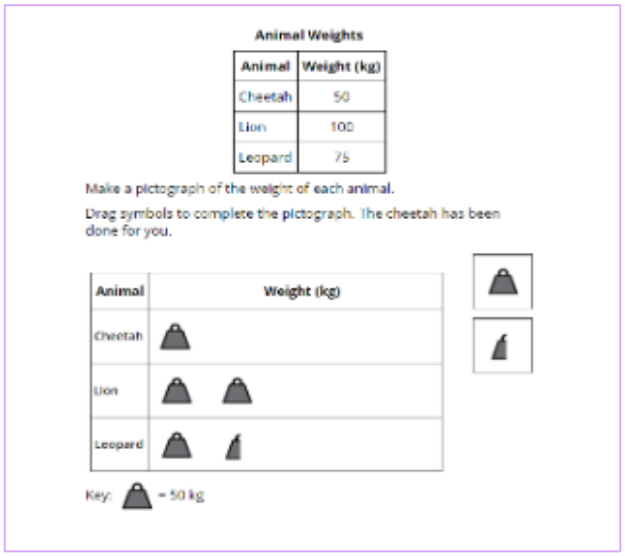
Exhibit 3. High International Benchmark of Mathematics Achievement – Example Item 3

Country	Percentages		
Hong Kong SAR	88	(2.0)	▲
Singapore	86	(1.4)	▲
Japan	84	(1.5)	▲
Korea, Rep. of	83	(1.7)	▲
Chinese Taipei	81	(1.8)	▲
England	81	(2.1)	▲
Northern Ireland	80	(2.1)	▲
Latvia	80	(2.4)	▲
Belgium (Flemish part)	78	(1.6)	▲
The Netherlands	78	(2.1)	▲
Ireland	77	(2.0)	▲
Lithuania	77	(1.9)	▲
Norway (5)	77	(2.4)	▲
Poland	77	(1.6)	▲
Finland	74	(2.0)	▲
Russian Federation	74	(2.5)	▲
Kazakhstan	74	(2.2)	▲
Denmark	72	(2.4)	▲
Cyprus	72	(1.9)	▲
Sweden	71	(2.2)	▲
Malta	71	(2.0)	▲
Australia	70	(1.9)	▲
Hungary	69	(1.9)	▲
Austria	68	(2.5)	▲
Germany	68	(1.9)	▲
Portugal	67	(1.7)	▲
Azerbaijan	67	(2.1)	▲
Turkey (5)	67	(2.7)	▲
New Zealand	65	(2.0)	▲
Czech Republic	65	(2.1)	
USA	65	(1.5)	▲
Canada	65	(1.6)	▲
Serbia	62	(2.5)	
International Average	61	(0.3)	
Bulgaria	61	(2.5)	
Croatia	61	(2.8)	
Albania	59	(2.5)	
Slovak Republic	58	(2.4)	
Spain	56	(2.2)	▽
Bahrain	56	(1.7)	▽
Italy	56	(2.6)	▽
Georgia	53	(2.9)	▽
North Macedonia	52	(3.0)	▽
France	50	(2.3)	▽
UAE	50	(1.0)	▽
Montenegro	48	(2.1)	▽
Iran	48	(2.7)	▽
Kosovo	48	(2.8)	▽
Armenia	46	(2.4)	▽
Qatar	45	(2.4)	▽
Bosnia and Herzegovina	43	(1.9)	▽
Oman	41	(2.0)	▽
Chile	38	(2.3)	▽
Saudi Arabia	38	(2.1)	▽
Morocco	34	(2.2)	▽
Kuwait	30	(2.1)	▽
South Africa (5)	29	(1.4)	▽
Philippines	17	(1.9)	▽
Pakistan	10	(2.1)	▽
Benchmarking Participants			
City of Moscow, Russian	91	(1.4)	▲
Dubai, UAE	72	(1.4)	▲
Ontario, Canada	68	(2.7)	▲
Quebec, Canada	65	(2.4)	
Madrid, Hotel Spain	58	(3.0)	
Abu Dhabi, UAE	37	(1.5)	▽

Content Domain: Data

Cognitive Domain: Reasoning

Description: Represents data from a table in a pictograph



Source: IEA's Trends in International Mathematics and Science Study - TIMSS 2019 Downloaded from http://timss2019.org/download

Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

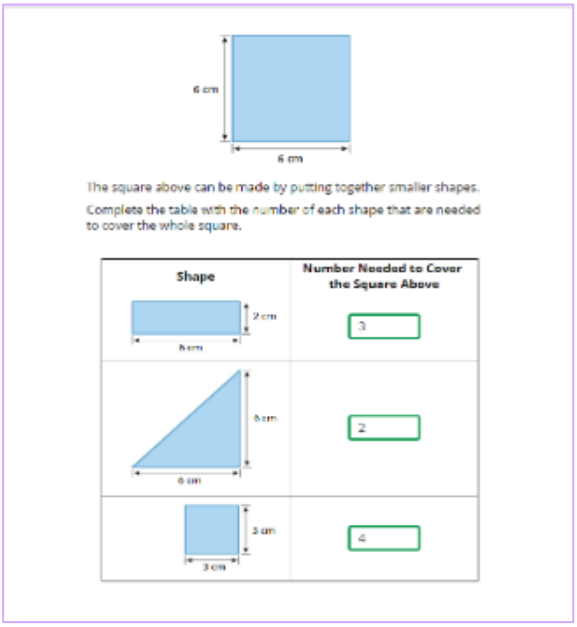
Exhibit 4. Advanced International Benchmark of Mathematics Achievement – Example Item 2

Country	Percentages		
Korea, Rep. of	54	(2.0)	▲
Hong Kong SAR	53	(3.2)	▲
Russia	47	(2.3)	▲
Singapore	45	(2.1)	▲
Japan	41	(2.3)	▲
Chinese Taipei	40	(2.6)	▲
The Netherlands	36	(2.3)	▲
Czech Republic	35	(2.2)	▲
Finland	34	(2.1)	▲
Poland	34	(1.9)	▲
Hungary	31	(2.4)	▲
Lithuania	31	(2.2)	▲
Latvia	31	(2.1)	▲
Azerbaijan	30	(1.6)	▲
Armenia	28	(2.3)	▲
Norway (5)	27	(2.7)	▲
Bulgaria	27	(2.7)	▲
Denmark	26	(2.0)	▲
Sweden	26	(2.1)	▲
Northern Ireland	26	(2.2)	▲
Albania	25	(2.6)	
Ireland	24	(2.1)	
England	24	(2.1)	
Belgium (Flemish part)	24	(1.9)	
Austria	24	(1.8)	
Australia	23	(1.7)	
Italy	22	(1.9)	
Portugal	21	(1.8)	
Germany	21	(2.2)	
International Average	**21**	**(0.2)**	
Cyprus	21	(2.3)	
Serbia	20	(2.3)	
Canada	19	(1.9)	
Kazakhstan	19	(2.2)	
USA	17	(1.4)	▽
New Zealand	16	(1.5)	▽
Turkey (5)	16	(1.6)	▽
Slovak Republic	16	(1.8)	▽
France	15	(1.5)	▽
UAE	14	(0.7)	▽
North Macedonia	14	(2.0)	▽
Malta	12	(1.4)	▽
Georgia	12	(1.5)	▽
Montenegro	12	(1.3)	▽
Spain	11	(1.3)	▽
Bahrain	11	(1.3)	▽
Iran	11	(1.5)	▽
Oman	10	(1.8)	▽
Croatia	10	(1.5)	▽
Bosnia and Herzegovina	9	(1.4)	▽
Saudi Arabia	8	(1.0)	▽
Morocco	6	(1.4)	▽
Chile	6	(1.0)	▽
Qatar	6	(1.1)	▽
Kosovo	3	(0.8)	▽
Kuwait	3	(0.9)	▽
South Africa (5)	2	(0.5)	▽
Pakistan	1	(0.3)	▽
Philippines	1	(0.3)	▽
Benchmarking Participants			
City of Moscow, Russian Fed.	53	(2.9)	▲
Dubai, UAE	23	(1.5)	
Quebec, Canada	21	(2.0)	
Ontario, Canada	19	(3.6)	
Madrid, Hotel Spain	13	(1.6)	▽
Abu Dhabi, UAE	8	(0.8)	▽

Content domain: Measurement and Geometry

Cognitive Domain: Reasoning

Description: Determines the number of three different shapes that cover the area of a square (2 of 2 scale score)



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Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

SCIENCE

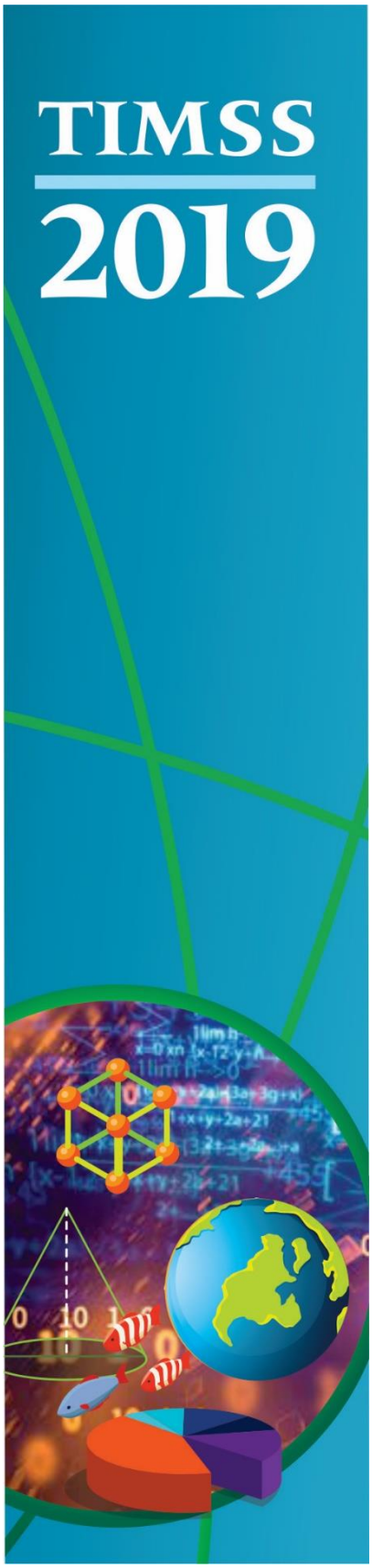


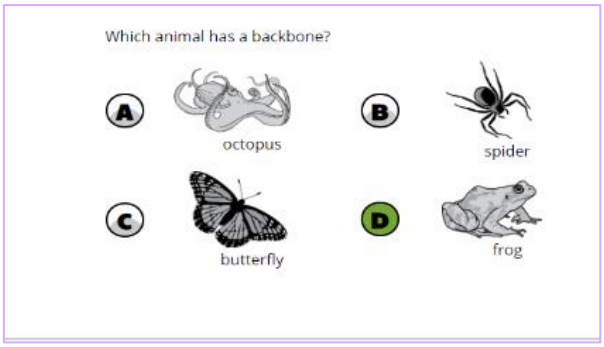
Exhibit 1. Low International Benchmark of Science Achievement

Country	Percentages		
Hungary	89	(1.6)	▲
Latvia	88	(1.6)	▲
Croatia	87	(1.6)	▲
Korea, Rep. of	87	(1.6)	▲
Albania	86	(2.5)	▲
Armenia	85	(1.7)	▲
Chinese Taipei	85	(1.4)	▲
Slovak Republic	84	(1.7)	▲
Norway (5)	83	(2.0)	▲
Georgia	83	(1.8)	▲
Bulgaria	83	(2.1)	▲
USA	82	(1.2)	▲
Serbia	82	(1.9)	▲
Poland	81	(1.6)	▲
Bosnia and Herzegovina	81	(1.7)	▲
Turkey (5)	81	(1.8)	▲
Czech Republic	81	(1.9)	▲
North Macedonia	81	(2.1)	▲
Russia	80	(1.9)	▲
Japan	80	(1.5)	▲
Denmark	79	(2.0)	▲
Malta	79	(1.7)	▲
Finland	79	(1.7)	▲
Sweden	79	(1.9)	▲
Australia	78	(1.7)	▲
New Zealand	78	(1.8)	▲
Canada	78	(1.5)	▲
Kazakhstan	77	(1.8)	
England	77	(2.4)	
France	76	(2.0)	
Azerbaijan	76	(2.0)	
Northern Ireland	76	(2.0)	
Ireland	76	(2.1)	
Montenegro	75	(1.7)	
Cyprus	75	(1.8)	
Lithuania	74	(2.0)	
International Average	**74**	**(0.3)**	
Morocco	74	(1.7)	
Kosovo	74	(1.8)	
Hong Kong SAR	74	(2.3)	
Germany	73	(2.0)	
Italy	73	(2.2)	
Oman	73	(2.0)	
Austria	72	(2.2)	
UAE	72	(1.0)	▽
Singapore	72	(1.5)	
Spain	71	(2.7)	
Qatar	70	(2.2)	▽
Chile	67	(2.1)	▽
Bahrain	67	(1.8)	▽
Iran	64	(2.1)	▽
Kuwait	61	(2.6)	▽
Pakistan	61	(3.2)	▽
Saudi Arabia	61	(1.8)	▽
Portugal	60	(2.3)	▽
South Africa (5)	58	(1.6)	▽
Philippines	56	(2.5)	▽
Belgium (Flemish part)	35	(2.1)	▽
The Netherlands	27	(2.4)	▽
Benchmarking Participants			
City of Moscow, Russian	79	(1.7)	▲
Ontario, Canada	79	(2.1)	▲
Dubai, UAE	78	(1.9)	▲
Quebec, Canada	73	(2.6)	
Madrid, Hotel Spain	69	(2.4)	▽
Abu Dhabi, UAE	66	(1.6)	▽
Hungary	89	(1.6)	▲

Content Domain: Life Science

Cognitive Domain: Knowing

Description: Recognizes an animal that has a backbone



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Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

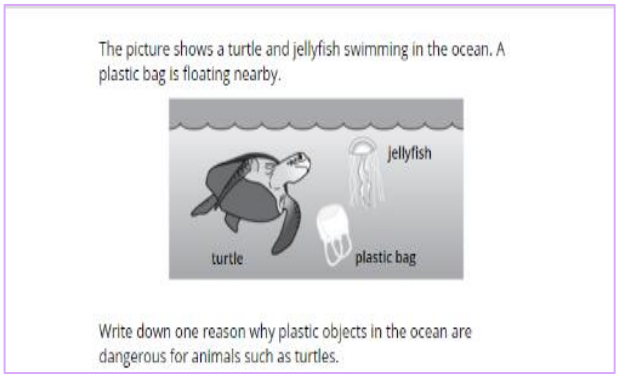
Exhibit 2. Intermediate International Benchmark of Science Achievement - Example Item 1

Country	Percentages		
Sweden	86	(1.8)	▯
Finland	85	(1.4)	▯
Norway (5)	85	(1.9)	▯
Australia	84	(1.6)	▯
Japan	83	(1.6)	▯
The Netherlands	83	(1.8)	▯
Singapore	83	(1.2)	▯
Cyprus	83	(1.7)	▯
England	81	(2.1)	▯
Ireland	81	(1.9)	▯
USA	79	(1.2)	▯
Denmark	78	(2.2)	▯
Belgium (Flemish part)	78	(2.1)	▯
Northern Ireland	76	(2.5)	▯
Malta	76	(1.8)	▯
Chinese Taipei	75	(2.2)	▯
Canada	75	(1.6)	▯
Russia	74	(2.3)	▯
Czech Republic	73	(1.9)	▯
Germany	73	(2.1)	▯
Korea, Rep. of	73	(2.1)	▯
Lithuania	71	(1.9)	▯
Spain	70	(2.0)	▯
New Zealand	70	(1.7)	▯
Portugal	70	(2.2)	▯
Austria	70	(2.2)	▯
Hungary	68	(2.0)	▯
Poland	67	(1.9)	▯
Italy	65	(2.1)	▯
Slovak Republic	63	(2.4)	▯
France	62	(2.6)	▯
Hong Kong SAR	62	(3.0)	
Chile	61	(2.1)	
Latvia	60	(2.2)	
Turkey (5)	58	(2.4)	
International Average	**57**	**(0.3)**	
Serbia	54	(2.7)	
Croatia	51	(2.3)	▯
Bahrain	48	(2.2)	▯
Armenia	45	(2.4)	▯
Qatar	45	(2.6)	▯
UAE	44	(1.0)	▯
Bulgaria	42	(3.1)	▯
Albania	40	(2.9)	▯
Bosnia and Herzegovina	39	(2.5)	▯
Georgia	36	(2.8)	▯
Montenegro	35	(2.1)	▯
Oman	34	(2.1)	▯
Kazakhstan	33	(2.0)	▯
South Africa (5)	28	(1.5)	▯
Kuwait	28	(2.0)	▯
Iran	21	(1.8)	▯
Morocco	21	(1.9)	▯
Azerbaijan	20	(1.9)	▯
North Macedonia	19	(2.3)	▯
Kosovo	17	(1.9)	▯
Saudi Arabia	14	(1.4)	▯
Philippines	11	(1.5)	▯
Pakistan	7	(1.9)	▯
Benchmarking Participants			
City of Moscow, Russian	78	(2.0)	▯
Madrid, Hotel Spain	76	(2.6)	▯
Ontario, Canada	76	(2.7)	▯
Quebec, Canada	73	(2.4)	▯
Dubai, UAE	60	(2.1)	
Abu Dhabi, UAE	34	(1.4)	▯

Content Domain: Life Science

Cognitive Domain: Knowing

Description: States one reason why plastic objects in the ocean are dangerous for sea animals



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Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

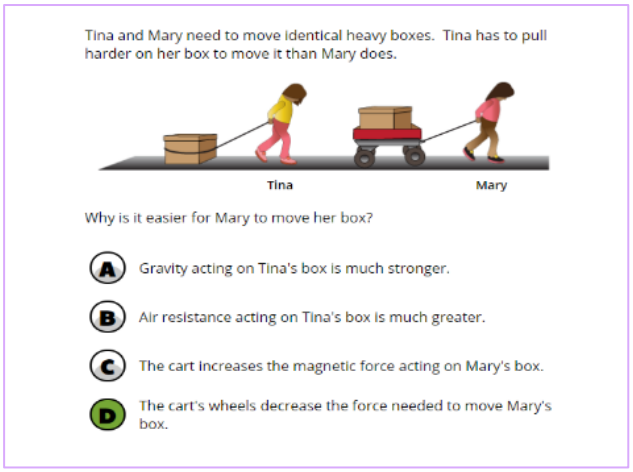
Exhibit 3. Intermediate International Benchmark of Science Achievement – Example Item 2

Country	Percentages		
Finland	88	(1.4)	▲
Korea, Rep. of	87	(1.6)	▲
Singapore	85	(1.2)	▲
Chinese Taipei	85	(1.5)	▲
Hong Kong SAR	83	(2.1)	▲
Russia	82	(2.1)	▲
Lithuania	82	(1.9)	▲
Sweden	81	(1.7)	▲
Ireland	80	(1.9)	▲
Latvia	80	(2.0)	▲
England	77	(2.1)	▲
Northern Ireland	76	(2.0)	▲
Serbia	76	(2.3)	▲
Australia	76	(2.1)	▲
Hungary	75	(1.9)	▲
Belgium (Flemish part)	74	(2.2)	▲
Denmark	73	(2.0)	▲
Poland	72	(1.8)	▲
Italy	72	(2.6)	▲
Germany	72	(2.2)	▲
New Zealand	72	(2.0)	▲
Canada	72	(2.1)	▲
USA	71	(1.4)	▲
Norway (5)	71	(2.2)	▲
Slovak Republic	70	(2.1)	▲
Croatia	70	(2.8)	
The Netherlands	70	(2.4)	
Czech Republic	69	(2.2)	
Kazakhstan	68	(1.9)	
Cyprus	68	(1.8)	
Austria	67	(2.2)	
Spain	67	(2.1)	
International Average	**66**	**(0.3)**	
Malta	66	(2.2)	
Japan	66	(2.2)	
Bulgaria	65	(2.8)	
Albania	64	(2.3)	
Bahrain	63	(1.8)	
Portugal	62	(1.9)	▽
Iran	61	(2.3)	▽
UAE	61	(0.8)	▽
Turkey (5)	60	(2.6)	▽
Azerbaijan	60	(2.2)	▽
Bosnia and Herzegovina	58	(2.1)	▽
France	58	(2.1)	▽
Georgia	55	(2.7)	▽
Qatar	54	(2.2)	▽
Kosovo	54	(2.2)	▽
Montenegro	53	(2.1)	▽
Oman	53	(1.8)	▽
North Macedonia	51	(3.0)	▽
Chile	50	(2.1)	▽
Saudi Arabia	49	(2.3)	▽
Armenia	48	(2.4)	▽
South Africa (5)	47	(1.5)	▽
Kuwait	45	(2.1)	▽
Morocco	41	(2.0)	▽
Pakistan	39	(4.7)	▽
Philippines	36	(2.0)	▽
Benchmarking Participants			
City of Moscow, Russian Fed.	88	(1.7)	▲
Dubai, UAE	77	(1.6)	▲
Madrid, Hotel Spain	73	(2.6)	▲
Ontario, Canada	72	(3.7)	
Quebec, Canada	68	(2.4)	
Abu Dhabi, UAE	52	(1.4)	▽

Content Domain: Physical Science

Cognitive Domain: Applying

Description: Recognizes the best explanation for why a box on a cart is easier to pull than a box resting directly on the floor



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Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average e

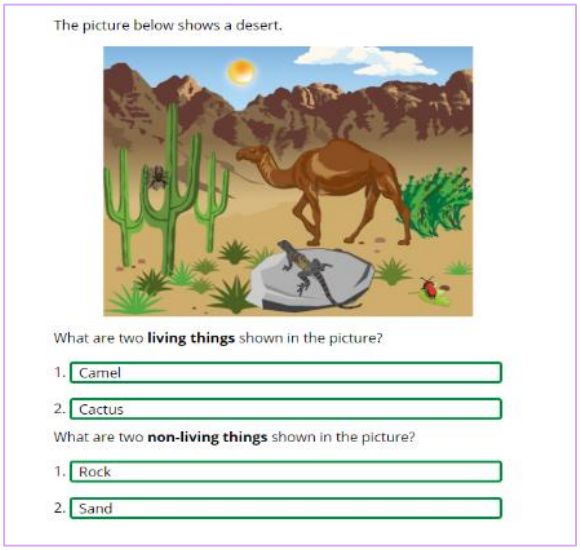
Exhibit 4. High International Benchmark of Science Achievement – Example Item 1

Country	Percentages		
Singapore	84	(1.4)	▲
Armenia	79	(1.8)	▲
Kazakhstan	71	(2.6)	▲
Cyprus	67	(2.4)	▲
Russia	67	(2.2)	▲
Turkey (5)	67	(2.6)	▲
Serbia	66	(2.7)	▲
Czech Republic	64	(1.7)	▲
Italy	63	(2.6)	▲
Slovak Republic	62	(2.3)	▲
Hungary	62	(2.3)	▲
Croatia	62	(2.6)	▲
Bahrain	60	(1.5)	▲
UAE	58	(1.1)	▲
Bulgaria	57	(2.6)	▲
Oman	56	(2.1)	▲
Montenegro	55	(1.9)	▲
Norway (5)	55	(3.0)	▲
Kosovo	55	(2.6)	▲
Malta	52	(2.2)	▲
USA	52	(1.6)	▲
Australia	51	(2.2)	▲
Qatar	51	(3.0)	▲
Sweden	50	(2.4)	
Poland	50	(2.6)	
Finland	49	(2.0)	▲
Portugal	48	(2.3)	
Latvia	47	(2.3)	
Lithuania	47	(2.7)	
Saudi Arabia	46	(2.0)	
Canada	46	(1.3)	
Kuwait	46	(2.3)	
International Average	**45**	**(0.3)**	
Albania	39	(2.8)	▽
England	38	(2.6)	▽
North Macedonia	38	(3.3)	▽
Bosnia and Herzegovina	38	(2.4)	▽
France	37	(2.2)	▽
Japan	37	(2.3)	▽
Korea, Rep. of	37	(2.4)	▽
Iran	35	(2.5)	▽
Ireland	34	(2.1)	▽
Denmark	34	(2.4)	▽
Pakistan	34	(3.6)	▽
Azerbaijan	33	(2.0)	▽
New Zealand	32	(2.0)	▽
Spain	32	(2.2)	▽
Georgia	31	(2.7)	▽
The Netherlands	30	(2.3)	▽
Northern Ireland	29	(2.4)	▽
Austria	27	(2.4)	▽
South Africa (5)	27	(1.6)	▽
Morocco	27	(2.0)	▽
Germany	23	(1.9)	▽
Hong Kong SAR	23	(2.3)	▽
Chile	20	(2.0)	▽
Belgium (Flemish part)	18	(1.7)	▽
Philippines	15	(1.5)	▽
Chinese Taipei	10	(1.2)	
Benchmarking Participants			
City of Moscow, Russian	76	(1.9)	▲
Dubai, UAE	72	(1.5)	▲
Ontario, Canada	52	(2.1)	▲
Abu Dhabi, UAE	42	(1.3)	▽
Quebec, Canada	31	(2.0)	▽
Madrid, Hotel Spain	23	(1.9)	▽

Content Domain: Life Science

Cognitive Domain: Knowing

Description: Lists two living things and two nonliving things shown in a picture of a desert ecosystem



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Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

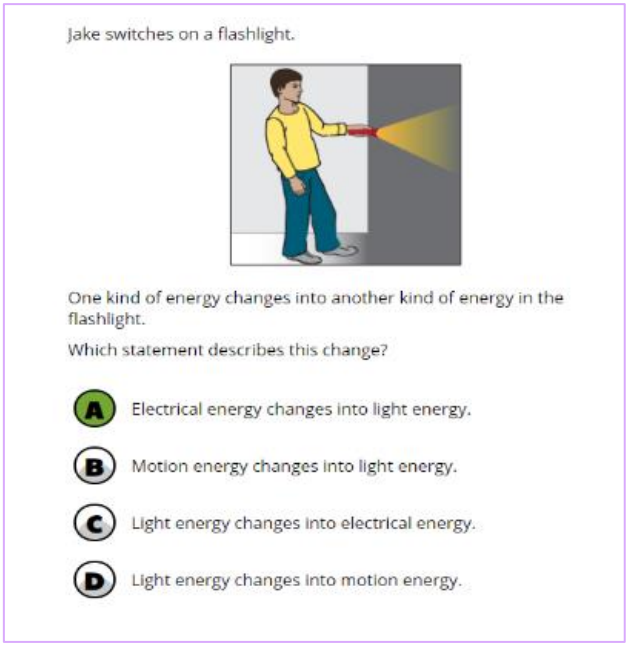
Exhibit 5. High International Benchmark of Science Achievement – Example Item 2

Country	Percentages		
Chinese Taipei	82	(1.8)	▲
Korea, Rep. of	81	(2.0)	▲
Hong Kong SAR	80	(1.9)	▲
Sweden	77	(2.1)	▲
Croatia	75	(2.8)	▲
Finland	74	(2.0)	▲
Japan	74	(1.9)	▲
Lithuania	74	(2.1)	▲
Iran	73	(1.8)	▲
Poland	73	(2.0)	▲
Bulgaria	72	(2.5)	▲
Singapore	72	(1.6)	▲
Belgium (Flemish part)	71	(1.7)	▲
Slovak Republic	70	(2.3)	▲
Serbia	69	(2.1)	▲
Norway (5)	69	(2.4)	▲
Russia	69	(2.0)	▲
Spain	68	(2.0)	▲
Czech Republic	68	(2.2)	▲
Denmark	67	(2.2)	
Australia	67	(2.0)	
Latvia	67	(2.6)	
France	66	(2.3)	
Bahrain	66	(1.8)	
Germany	66	(2.0)	
England	66	(2.3)	
Bosnia and Herzegovina	66	(1.8)	
Italy	65	(2.5)	
Canada	65	(1.4)	
USA	65	(1.6)	
Austria	64	(2.1)	
New Zealand	64	(2.1)	
International Average	**64**	**(0.3)**	
Hungary	64	(2.0)	
Northern Ireland	63	(2.6)	
Ireland	62	(2.5)	
The Netherlands	62	(2.3)	
UAE	62	(1.1)	
Georgia	62	(2.8)	
Qatar	61	(2.4)	
Turkey (5)	60	(2.4)	
Portugal	60	(2.1)	▽
Cyprus	59	(1.8)	▽
North Macedonia	59	(2.9)	
Malta	59	(2.0)	▽
Saudi Arabia	58	(2.1)	▽
Oman	57	(2.0)	▽
Kuwait	57	(2.2)	▽
Albania	56	(2.8)	▽
Kazakhstan	56	(2.1)	▽
Montenegro	56	(1.6)	▽
Kosovo	54	(2.5)	▽
Chile	52	(2.3)	▽
Azerbaijan	51	(2.4)	▽
Morocco	50	(1.9)	▽
South Africa (5)	50	(1.6)	▽
Armenia	49	(2.3)	▽
Philippines	42	(2.1)	▽
Pakistan	32	(3.3)	▽
Benchmarking Participants			
City of Moscow, Russian	88	(1.4)	▲
Dubai, UAE	73	(1.5)	▲
Quebec, Canada	72	(2.2)	
Madrid, Hotel Spain	66	(2.5)	
Ontario, Canada	61	(2.3)	▽
Abu Dhabi, UAE	51	(1.7)	▲

Content Domain: Physical Science

Cognitive Domain: Knowing

Description: Recognizes the energy change that occurs when a flashlight is turned on



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Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

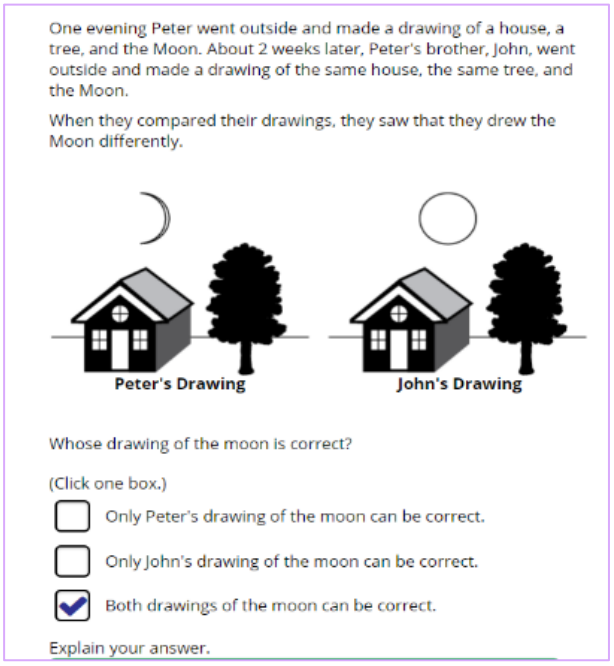
Exhibit 6. High International Benchmark of Science Achievement – Example Item 3

Country	Percentages		
Finland	61	(2.0)	▲
Norway (5)	58	(2.5)	▲
Australia	58	(2.0)	▲
Lithuania	56	(2.4)	▲
USA	55	(1.7)	▲
Korea, Rep. of	54	(2.1)	▲
Turkey (5)	53	(2.4)	▲
Russia	53	(2.4)	▲
Portugal	52	(2.3)	▲
Sweden	52	(2.5)	▲
Japan	51	(2.1)	▲
Singapore	51	(1.8)	▲
Austria	50	(2.3)	▲
Germany	50	(2.3)	▲
Hungary	49	(2.4)	▲
Malta	49	(2.3)	▲
Belgium (Flemish part)	48	(2.1)	▲
Croatia	46	(3.3)	▲
Spain	46	(2.2)	▲
Chinese Taipei	44	(2.3)	▲
New Zealand	44	(2.5)	▲
Latvia	43	(2.2)	▲
Kazakhstan	43	(2.5)	▲
Canada	43	(1.6)	▲
Slovak Republic	42	(2.3)	▲
The Netherlands	41	(2.6)	
Serbia	41	(2.2)	
Bahrain	40	(1.7)	
Ireland	40	(2.4)	
Cyprus	40	(2.2)	
Northern Ireland	39	(2.2)	
France	37	(2.4)	
Italy	37	(2.4)	
Czech Republic	37	(2.5)	
International Average	**37**	**(0.3)**	
England	36	(2.6)	
Poland	34	(2.2)	
Denmark	34	(2.4)	
Armenia	33	(2.2)	
UAE	30	(1.0)	▽
Bulgaria	30	(2.4)	▽
Chile	30	(1.8)	▽
Montenegro	28	(1.8)	▽
Albania	28	(2.3)	▽
Georgia	27	(2.1)	▽
Bosnia and Herzegovina	26	(1.8)	▽
Qatar	25	(2.0)	▽
Hong Kong SAR	24	(2.0)	▽
Saudi Arabia	20	(1.7)	▽
Oman	19	(1.5)	▽
Azerbaijan	18	(1.6)	▽
South Africa (5)	17	(1.3)	▽
North Macedonia	17	(2.4)	▽
Kosovo	15	(1.4)	▽
Morocco	15	(1.8)	▽
Kuwait	15	(1.6)	▽
Iran	15	(1.6)	▽
Pakistan	8	(1.7)	▽
Philippines	4	(1.1)	▽
Benchmarking Participants			
City of Moscow, Russian Fed.	58	(2.1)	▲
Madrid, Hotel Spain	53	(2.5)	▲
Quebec, Canada	48	(2.5)	▲
Dubai, UAE	46	(1.8)	▲
Ontario, Canada	40	(3.0)	
Abu Dhabi, UAE	23	(1.5)	▽

Content Domain: Earth Science

Cognitive Domain: Applying

Description: Using two pictures of the same location, explains that the Moon can look different at different times



Source: IEA's Trends in International Mathematics and Science Study - TIMSS 2019 Downloaded from http://timss2019.org/download

Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

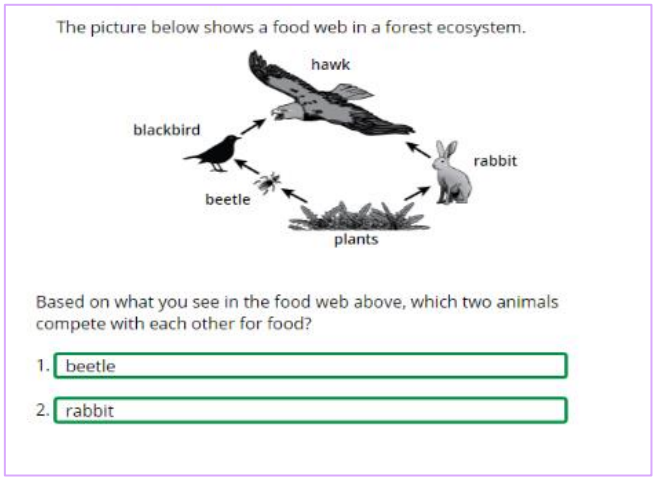
Exhibit 7. Advanced International Benchmark of Science Achievement – Example Item 1

Country	Percentages		
Bulgaria	69	(2.3)	▲
Korea, Rep. of	56	(2.3)	▲
Singapore	54	(2.0)	▲
Chinese Taipei	45	(2.2)	▲
Sweden	45	(2.6)	▲
Norway (5)	44	(2.2)	▲
Finland	43	(1.7)	▲
Slovak Republic	42	(2.3)	▲
Serbia	40	(2.7)	▲
USA	40	(1.8)	▲
Hong Kong SAR	40	(2.6)	▲
Denmark	40	(2.4)	▲
Northern Ireland	39	(2.8)	▲
Austria	38	(2.9)	▲
Germany	38	(2.3)	▲
Australia	37	(2.3)	▲
England	37	(2.7)	▲
Japan	37	(1.9)	▲
Russia	37	(2.4)	▲
Poland	37	(2.2)	▲
France	36	(2.8)	▲
Bahrain	35	(1.8)	▲
Ireland	35	(2.1)	▲
Czech Republic	34	(2.2)	
Spain	34	(1.7)	▲
Malta	33	(2.1)	
Italy	31	(2.6)	
Hungary	31	(2.0)	
New Zealand	31	(1.6)	
Portugal	31	(2.2)	
Canada	31	(1.9)	
International Average	**30**	**(0.3)**	
Cyprus	30	(2.5)	
Belgium (Flemish part)	29	(2.2)	
UAE	28	(1.1)	▽
The Netherlands	27	(2.1)	
Latvia	27	(2.1)	
Montenegro	26	(2.1)	▽
Croatia	26	(2.0)	▽
Lithuania	26	(2.3)	▽
Chile	24	(2.0)	▽
Albania	22	(2.4)	▽
Armenia	22	(1.8)	▽
Oman	22	(2.0)	▽
Iran	22	(1.8)	▽
Turkey (5)	20	(1.7)	▽
Saudi Arabia	20	(1.4)	▽
Qatar	19	(2.1)	▽
Morocco	16	(2.0)	▽
Georgia	16	(2.2)	▽
Bosnia and Herzegovina	15	(1.5)	▽
Kuwait	15	(1.9)	▽
South Africa (5)	15	(1.1)	▽
Azerbaijan	14	(1.4)	▽
Kazakhstan	13	(1.6)	▽
North Macedonia	13	(1.8)	▽
Pakistan	10	(2.3)	▽
Philippines	6	(0.9)	▽
Kosovo	5	(1.3)	▽
Benchmarking Participant			
City of Moscow, Russian	52	(2.7)	▲
Dubai, UAE	41	(2.0)	▲
Madrid, Hotel Spain	36	(2.3)	▲
Ontario, Canada	32	(3.6)	
Quebec, Canada	30	(2.2)	
Abu Dhabi, UAE	19	(1.3)	▽

Content Domain: Life Science

Cognitive Domain: Applying

Description: Uses a food web to determine which animals are competitors



Source: IEA's Trends in International Mathematics and Science Study - TIMSS 2019 Downloaded from http://timss2019.org/download

Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

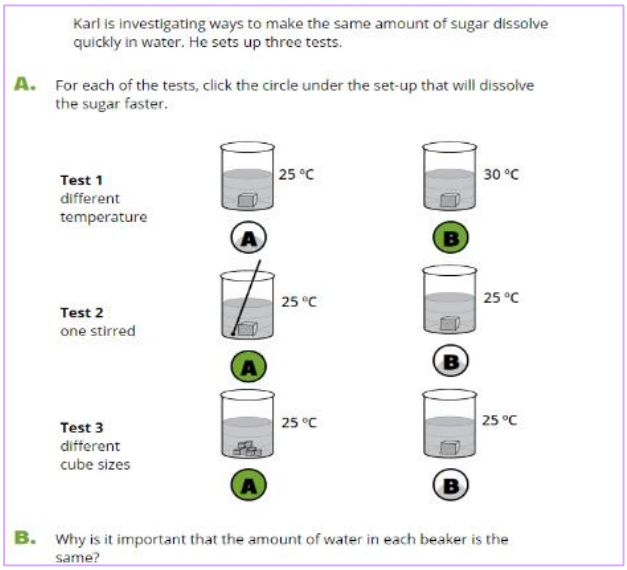
Exhibit 8. Advanced International Benchmark of Science Achievement – Example Item 2

Country	Percentages		
Latvia	74	(2.0)	▲
Chinese Taipei	69	(2.0)	▲
Poland	61	(2.1)	▲
Japan	59	(1.9)	▲
Korea, Rep. of	57	(2.1)	▲
Serbia	55	(2.6)	▲
Finland	54	(2.2)	▲
Russia	52	(2.0)	▲
Lithuania	52	(2.5)	▲
Belgium (Flemish part)	50	(2.0)	▲
Slovak Republic	49	(2.7)	▲
Singapore	48	(1.8)	▲
Sweden	46	(2.6)	▲
Hong Kong SAR	45	(2.6)	▲
Czech Republic	44	(2.3)	▲
Ireland	44	(2.5)	▲
Hungary	44	(2.3)	▲
The Netherlands	43	(2.6)	▲
Bulgaria	43	(2.4)	▲
Norway (5)	43	(2.6)	▲
Denmark	42	(2.4)	▲
Canada	42	(1.6)	▲
Croatia	41	(2.2)	
Germany	41	(2.0)	▲
Australia	41	(1.8)	▲
Northern Ireland	41	(2.6)	
Italy	40	(2.3)	
Cyprus	40	(2.3)	
Portugal	38	(2.2)	
New Zealand	37	(1.9)	
International Average	**37**	**(0.3)**	
Austria	37	(2.1)	
Albania	36	(2.6)	
England	36	(2.6)	
Malta	34	(2.2)	
France	32	(2.5)	▽
Spain	32	(2.4)	▽
Armenia	32	(2.0)	▽
USA	31	(1.6)	▽
Turkey (5)	30	(1.8)	▽
Bahrain	30	(2.1)	▽
Chile	29	(2.0)	▽
Azerbaijan	28	(2.1)	▽
North Macedonia	28	(2.9)	▽
Kazakhstan	28	(2.0)	▽
UAE	27	(0.8)	▽
Bosnia and Herzegovina	27	(1.8)	▽
Montenegro	26	(1.9)	▽
Georgia	25	(2.5)	▽
Qatar	24	(1.7)	▽
Oman	22	(1.8)	▽
Kuwait	21	(1.7)	▽
Philippines	19	(1.6)	▽
Saudi Arabia	18	(1.4)	▽
Kosovo	17	(1.7)	▽
Morocco	15	(2.2)	▽
South Africa (5)	14	(1.2)	▽
Iran	13	(1.5)	▽
Pakistan	9	(1.9)	▽
Benchmarking Participants			
City of Moscow, Russian	58	(2.2)	▲
Quebec, Canada	43	(2.5)	▲
Madrid, Hotel Spain	43	(2.8)	▲
Ontario, Canada	42	(2.9)	
Dubai, UAE	36	(1.8)	
Abu Dhabi, UAE	21	(1.4)	▽

Content Domain: Physical Science

Cognitive Domain: Reasoning

Description: Part A - Recognizes set-ups that will more quickly dissolve a solid in water



Source: IEA's Trends in International Mathematics and Science Study - TIMSS 2019 Downloaded from http://timss2019.org/download

Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

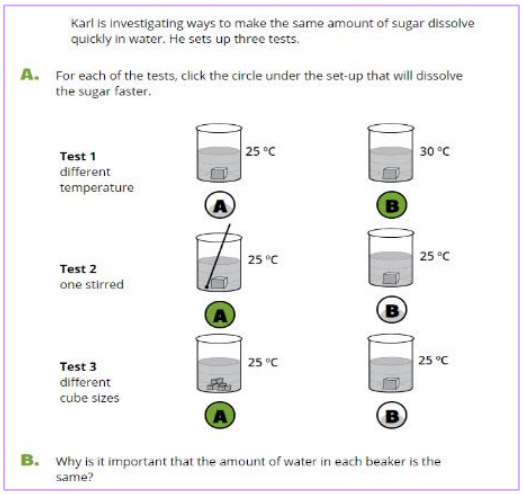
Exhibit 9. Advanced International Benchmark of Science Achievement – Example Item 3

Country	Percentages		
Singapore	66	(1.7)	▲
England	53	(3.3)	▲
Japan	49	(2.0)	▲
Korea, Rep. of	48	(2.3)	▲
Russia	40	(2.5)	▲
Australia	38	(1.5)	▲
Ireland	35	(2.5)	▲
Finland	34	(2.1)	▲
Northern Ireland	32	(2.3)	▲
Chinese Taipei	30	(2.5)	▲
Cyprus	30	(1.9)	▲
Armenia	29	(2.3)	▲
The Netherlands	28	(2.4)	▲
Oman	28	(2.0)	▲
Serbia	27	(2.4)	▲
Turkey (5)	27	(1.8)	▲
Poland	25	(1.7)	▲
Albania	25	(2.2)	
Belgium (Flemish part)	24	(1.7)	
Canada	24	(1.5)	
Czech Republic	23	(1.7)	
Malta	23	(1.7)	
Lithuania	23	(1.9)	
Germany	22	(1.9)	
Bahrain	22	(1.8)	
Spain	21	(2.2)	
Croatia	21	(1.9)	
International Average	**21**	**(0.2)**	
Hungary	21	(1.7)	
Hong Kong SAR	20	(2.6)	
Latvia	20	(1.8)	
France	20	(1.7)	
Kazakhstan	20	(1.9)	
Slovak Republic	19	(1.6)	
USA	19	(1.2)	
Denmark	18	(1.9)	
Bulgaria	18	(1.6)	
Austria	18	(1.9)	
New Zealand	16	(1.5)	▽
UAE	16	(0.6)	▽
Portugal	14	(1.6)	▽
Sweden	14	(1.8)	▽
Iran	13	(1.7)	▽
Qatar	12	(1.6)	▽
Norway (5)	11	(1.6)	▽
Italy	10	(1.5)	▽
Bosnia and Herzegovina	10	(1.3)	▽
Azerbaijan	9	(1.1)	▽
North Macedonia	8	(1.4)	▽
Chile	8	(1.0)	▽
Kuwait	6	(1.1)	▽
Montenegro	6	(0.9)	▽
Pakistan	5	(1.6)	▽
Georgia	5	(1.2)	▽
South Africa (5)	5	(1.0)	▽
Saudi Arabia	4	(0.8)	▽
Kosovo	4	(0.9)	▽
Morocco	4	(0.8)	▽
Philippines	1	(0.3)	▽
Benchmarking Participants			
Dubai, UAE	35	(1.9)	▲
Madrid, Hotel Spain	27	(2.1)	▲
Ontario, Canada	24	(2.5)	
City of Moscow, Russian Fed.	20	(2.2)	
Quebec, Canada	19	(2.0)	
Abu Dhabi, UAE	7	(0.7)	▽

Content Domain: Physical Science

Cognitive Domain: Reasoning

Description: Explains the importance of controlling a variable in an experiment



Source: IEA's Trends in International Mathematics and Science Study - TIMSS 2019 Downloaded from http://timss2019.org/download

Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

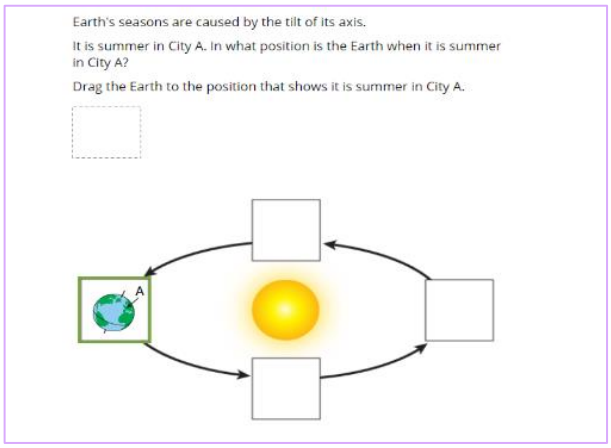
Exhibit 10. Advanced International Benchmark of Science Achievement – Example Item 4

Country	Percentages		
Chinese Taipei	59	(2.6)	▲
Sweden	55	(2.7)	▲
Russia	54	(2.4)	▲
Singapore	53	(2.3)	▲
Norway (5)	52	(2.4)	▲
England	48	(2.4)	▲
Latvia	47	(2.2)	▲
Finland	47	(2.5)	▲
Lithuania	47	(2.1)	▲
Korea, Rep. of	46	(2.4)	▲
Slovak Republic	45	(2.4)	▲
Ireland	44	(2.5)	▲
USA	44	(1.5)	▲
Germany	43	(2.2)	▲
Australia	43	(2.7)	▲
Denmark	42	(2.6)	▲
Poland	41	(2.4)	▲
Croatia	41	(3.2)	
UAE	41	(1.1)	▲
Hungary	40	(2.5)	
Hong Kong SAR	40	(2.1)	
Czech Republic	40	(2.6)	
Turkey (5)	40	(2.4)	
Bulgaria	40	(2.3)	
France	39	(2.2)	
Canada	39	(1.4)	
Austria	39	(2.4)	
Belgium (Flemish part)	38	(2.5)	
New Zealand	38	(1.8)	
Northern Ireland	37	(2.6)	
The Netherlands	37	(2.5)	
Japan	37	(2.0)	
Portugal	36	(2.2)	
International Average	36	(0.3)	
Kazakhstan	36	(2.3)	
Serbia	35	(2.3)	
Georgia	35	(2.6)	
Italy	33	(2.3)	
Qatar	32	(2.3)	
Malta	31	(2.2)	▽
Spain	30	(2.0)	▽
Chile	28	(2.0)	▽
Albania	27	(2.7)	▽
Armenia	27	(2.1)	▽
Oman	27	(1.8)	▽
Saudi Arabia	27	(1.7)	▽
Bahrain	27	(1.7)	▽
Kuwait	26	(2.1)	▽
Bosnia and Herzegovina	26	(1.6)	▽
Azerbaijan	26	(1.8)	▽
Cyprus	26	(2.2)	▽
South Africa (5)	26	(1.3)	▽
Morocco	24	(2.0)	▽
Kosovo	23	(2.3)	▽
Pakistan	22	(2.4)	▽
North Macedonia	21	(2.2)	▽
Philippines	21	(1.9)	▽
Montenegro	18	(1.6)	▽
Iran	15	(1.7)	▽
Benchmarking Participants			
City of Moscow, Russian	69	(2.6)	▲
Dubai, UAE	53	(1.8)	▲
Quebec, Canada	42	(2.5)	▲
Ontario, Canada	36	(2.6)	
Madrid, Hotel Spain	35	(2.3)	
Abu Dhabi, UAE	33	(2.0)	

Content Domain: Earth Science

Cognitive Domain: Applying

Description: Places the Earth in a model to show its position relative to the Sun when a labeled city is experiencing summer



Source: IEA's Trends in International Mathematics and Science Study - TIMSS 2019 Downloaded from http://timss2019.org/download

Note: () Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

▲ Percent significantly higher than international average
▽ Percent significantly lower than international average

3. FACTORS OF STUDENT ACHIEVEMENT IN BOSNIA AND HERZEGOVINA IN MATHEMATICS AND SCIENCE IN TIMSS 2019 ASSESSMENT

By participating in the TIMSS study and in other international assessments such as PIRLS and PISA a society demonstrates an interest to improve students' achievements and their competencies and identify a wide range of factors important to advance the quality of education. Based on the information on relevant achievement factors, decision makers can easily identify strengths and weaknesses of education systems and develop the evidence-based recommendations for the improvement.

Researchers and society are equally interested in identifying the factors that influence achievements in mathematics and science and to understand the processes underlying these factors. The society is interested in improving student competencies in mathematics since the quality of mathematics education enables pursuing the academic and career choices. The knowledge of mathematics is basic in seeking a number of prestigious occupations in science, engineering and information technology (Bleyer, Pedersen & Elmor, 1981; Sells, 1978). Also, mathematics achievement is a predictor of the country's economic development.

Science and technology are becoming increasingly important in modern society. The concept of scientific literacy is very complex, there are different definitions, but it is unquestionable that understanding of science is necessary in making decisions about the world we live in. The attitudes towards science have an important impact on the acquisition of knowledge and skills in science and technology, their application in life and career decisions in science field.

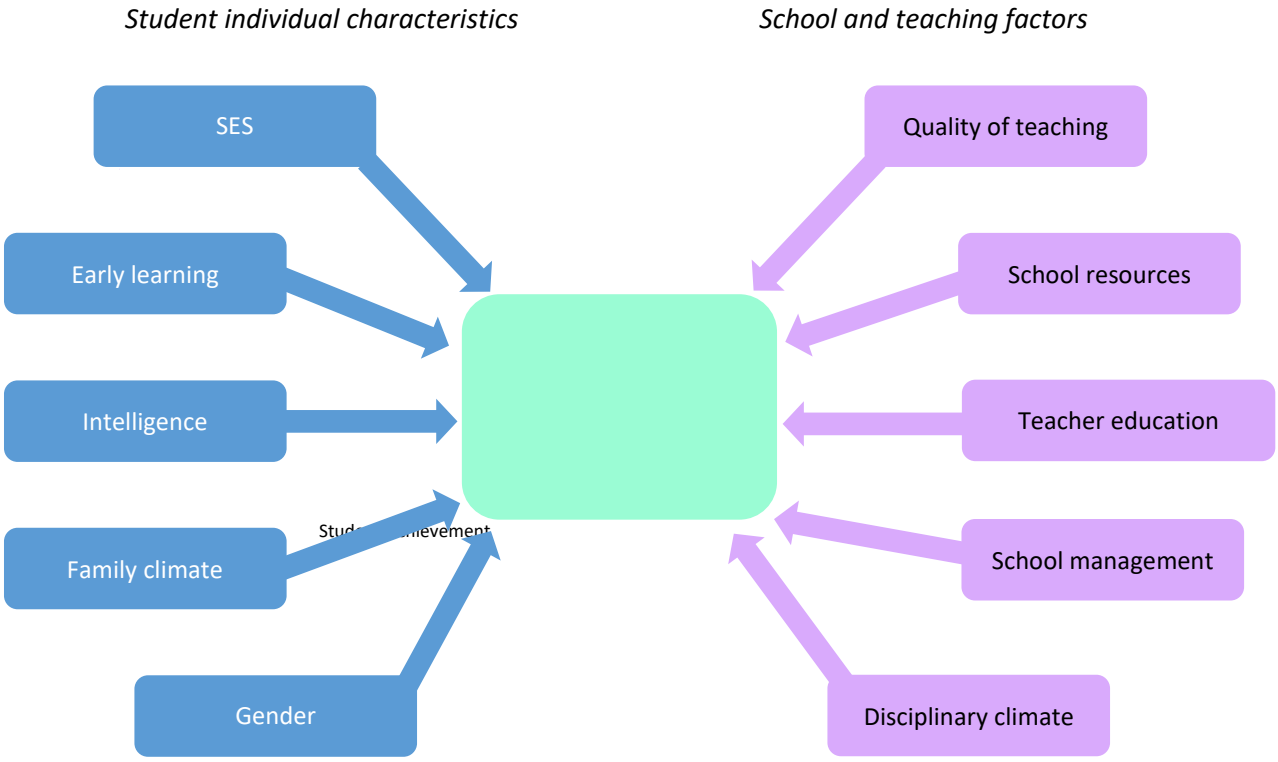
Experts on the learning procesess have been studying factors influencing student achievement for decades. Since the process of learning and teaching, as well as their interaction, is complex, it is not possible to formulate a model that can unite all the factors and fully explain the differences among students. Many studies have been conducted using different methods in different educational systems, and it has been found that a set of factors related to student characteristics, and to the family, school, and teaching contexts in which learning occurs, have a significant impact.

Academic achievement is a complex phenomenon influenced by numerous factors, from the personality characteristics of students to the environment and conditions in which that achievement is achieved. There are many causes of student success or failure, and they are most often classified into three groups:

- family and peers (family relations, socio-economic status, family structure, expectations of parents and peers, peer relations),
- school (curriculum, teacher training, student-teacher relations, teacher expectations, method of student assessment) and
- personal resources of students (intelligence, values, self-esteem, expectations, self-efficacy assessment) (Gutwein, 2009).

TIMSS collects information from school principals, students, students' parents and teachers, and since differences in student achievement stem from the individual, teaching, classroom, school level, this research examines the entire school classroom that allows for separation of variance from different levels of influence.

Exhibit 3.1 Student achievement factors



Students begin primary education with various prior knowledge acquired in the family and / or in some form of preschool education. They originate from different family and social conditions, so student characteristics and attitudes are one of the sets of contextual characteristics whose influence was recorded in the TIMSS research.

Early learning activities in numerical (mathematical) competencies stimulate interest in mathematics and further development of mathematical skills, and research shows that they have moderate to strong influence on mathematics achievements in later schooling while the quantitative and numerical knowledge developed in pre-primary education is a stronger predictor of mathematical achievement in later schooling than an intelligence or memory skill test (Melhuish et al., 2008; Sarama & Clements, 2009).

The attitudes toward mathematics are a significant predictor of different outcomes in mathematics, such as engagement or achievement as well as of academic success in mathematics and science, and success and persistence in learning mathematics. Three types of concepts are often discussed in literature when it comes to the attitudes toward mathematics (Vandecandelaere, Speybroeck, Vanlaar, De Fraine, Van Damme, 2012), the concept of mathematical academic confidence, enjoyment of mathematics, and perceived value of mathematics. The first concept refers to the perception of one's own abilities to master mathematics materials, and the perception of success in mathematics. The following concept implies a positive attitude towards mathematics, and contains an affective and behavioral component. Seeing the value of mathematics for functioning and everyday life is the third concept related to achievements in mathematics.

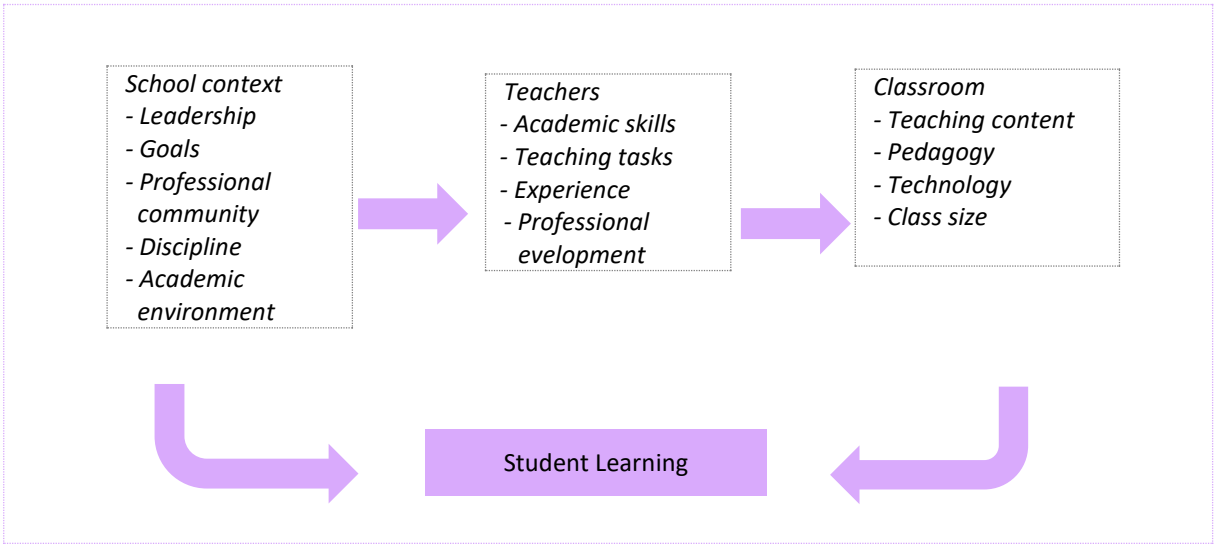
Researchers found the student achievement depends on individual characteristics - gender, SES, motivation, but also depends on the quality of teaching, school leadership, and the resources available to the school (Creemers & Kyriakides, 2008; Muijs et al., 2014; Scheerens et al., 2007, according to Todorović 2016). During the 1990s and the following decade, researchers of efficiency in education

identified various teaching and school factors. Since these are factors that can be systematically influenced through educational policies and teacher education, their analysis is needed.

In TIMSS study, different teaching variables and their impact on student achievement are examined. Teacher characteristics such as education, experience, attitudes, and the use of certain teaching practices have been found to be relevant to student success in school.

According to Mayer, Mullens & Moore (2000) school quality influences student achievement through trained and skilled teachers, activities in the classroom, and the general climate and atmosphere that prevails in school. The quality of the school improves when teachers have high academic skills, teach in the field for which they are educated, have more than a few years of experience and participate in high quality professional development programs. The effectiveness of the classroom is best explained if the content of the curriculum, pedagogical aspects, materials and equipment used are understood. The effects of characteristics at the school level are more difficult to determine than the effects of the context of the teacher and the classroom.

Exhibit 3.2 School quality indicators vs student learning



Source: Mayer, Mullens & Moore, Monitoring school quality, An inndicator Report, December 2000

Well-trained, motivated and self-confident teachers are an important factor in student achievement, but if some of the organizational factors are not satisfied, e.g. the size of the class or the time devoted to a particular teaching topic, the quality of teaching may suffer. Oversized classes as well as an uninspiring peer group and time in class that is not related to set goals (Brophy & Good, 1986) can negatively affect student achievement. When using various teaching resources, e.g. digitrons, computers, teaching aids, it is crucial to train teachers to use them according to the set goals of the class (Manalo, Bunnell & Stillman, 2000; Witzel, Mercer & Miller, 2003).

Any teaching practice that motivates and engages student is considered a good teaching effect. The teaching practice that is appropriate to students' abilities, which includes active learning of new content and student involvement, connecting what is learned with everyday life, continuously asking for and giving feedback, linking test content and teaching content, teacher preparation, individualized and differentiated teaching, applying different ways of monitoring and evaluating of student achievement, is a practice that has the characteristics of effective practice. The homework has inconsistent findings. Namely, homework should be an opportunity to enrich the learning experience, but the policies of different countries regarding the reasons for assignments are different.

School characteristics are factors that affect or make teaching and learning difficult. School influences student in two ways - as an educational institution with its organization, and through the realized social relations within it with an emphasis on peer relations that students have within the class (Bilić, 2001: 98). In an effective school, effective factors are integrated with quality management. By understanding a range of effectiveness factors, we can observe which factors exist in a particular school and which, if adopted, could facilitate effectiveness given a particular school context. Schools in urban and economically more stable environments often have better achievements. This is related to better opportunities for hiring better teaching staff, better resources of the community in which the school is located. Students are usually of better SES, and parents of higher level of education. The issue of school resources is not consistently related, as there are studies that confirm that they do not strongly or consistently affect student success in school (Hansushek, 1997), but there are authors who believe that the amount of money invested per student is a strong predictor of achievement (Hedges, Laine). & Greenwald, 1994).

One of the most significant factors of achievement is the extent to which the school places emphasis on student achievement. Setting high, achievable goals for academic student achievement leads to an environment that is focused on achieving better results. When school leaders work with their teachers to build the whole school, at the classroom level and personal goals, they become guides in a powerful transformation process, enabling teachers to elevate their practice, encourage progress in their work and better manage professional life. Many studies suggest that the school climate is positively associated with academic achievement, so aspects of safety, teaching, and learning, the school environment encourage student achievement when properly cultivated (Cohen, Mccabe, Michelli & Pickeral, 2009). The issues of discipline, being late, absenteeism or safety at school are issues that affect learning difficulties in schools.

It is very important to identify key achievement factors, both for decision makers in education and for practitioners involved in improving education.

3.1 BiH Student Achievement Factors in Mathematics and Science

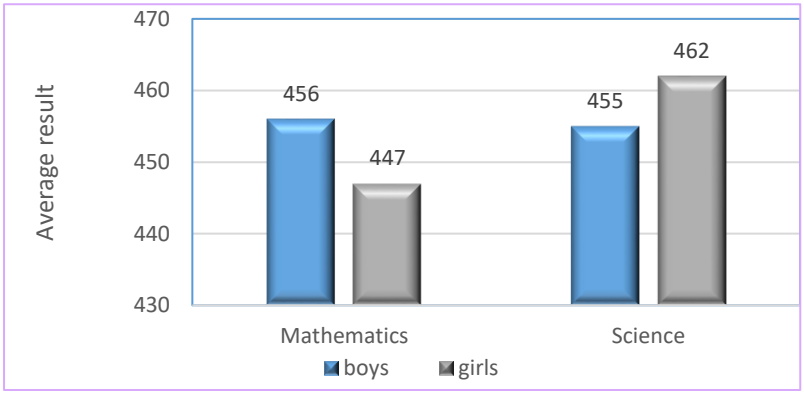
In addition to examining student achievement, TIMSS 2019 also includes examining a range of contextual variables that can affect cognitive and non-cognitive outcomes. The importance of individual variables has been confirmed by previous TIMSS research. This report provides data based on an analysis of the impact of factors associated with:

- Gender of students
- Characteristics and attitudes of students
- Family context
- Teaching factors
- School factors

3.1.1 Assessment of Student Achievement in Mathematics and Science by Gender, Home Learning Resources, and Environment Where School is Located (Rural-Urban)

Every education system should strive for a fair system; it should also strive for student achievement to be the result of their efforts and will, and not the result of contextual factors such as gender, socio-economic status, family structure or place of residence. Figure 3.3 presents the differences in achievements of boys and girls in the TIMSS 2019 survey in BiH.

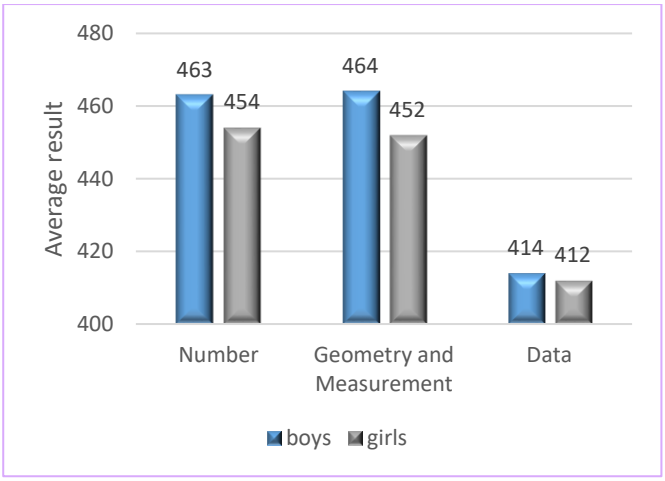
Exhibit 3.3 Gender gap in average achievement in mathematics and science

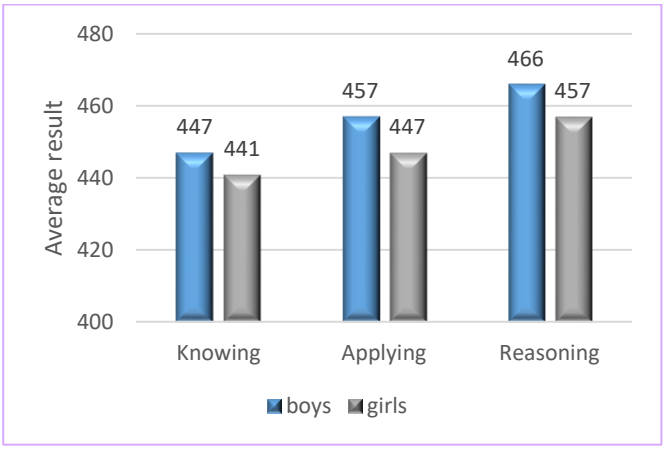


The difference of student achievement in BiH by gender in mathematics is 9 scale score in favor of boys and it is statistically significant. In science, the difference in achievement is 7 scale score in favor of girls, which is statistically significant. The international average in mathematics is 499 scale score for girls and 503 scale score for boys, and in science 493 scale score for girls and 489 scale score for boys. In neighbouring countries, the biggest gender gap in mathematics is in Croatia, 12 scale score, in favor of boys while in science there is a gender gap of 13 scale score in Kosovo and 14 scale score in North Macedonia in favor of girls, which is statistically significant.

In the following exhibits, presented is a gender gap in average achievement by content and cognitive domains.

Figure 3.4 Gender gap in average achievement in mathematics by content and cognitive domains





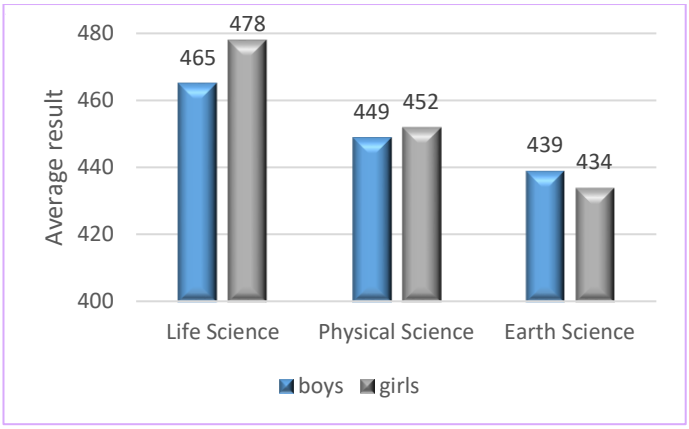
In Number and Geometry and Measurement domains, gender gap is in favor of boys and the gap is statistically significant in both domains, which is also the case at the international level. In Data domain the difference is small. In mathematics, across cognitive domains there is a difference in achievement between boys and girls, and it is statistically significant in Applying and Reasoning domains in favor of boys. At the international level, the difference is statistically significant across all three cognitive domains in favor of boys.

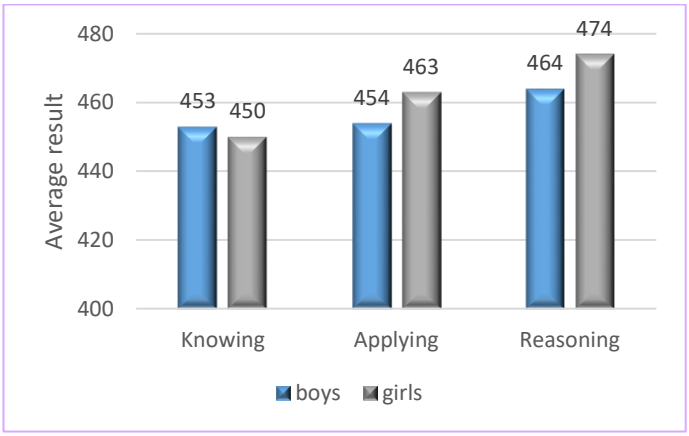
The distribution of boys and girls in mathematics by achievement levels does not show any significant gap. Namely, the biggest difference is at intermediate level, where there are 6% more boys than girls, and at the high level where there are 3% more boys than girls.

Exhibit 3.5 presents the gender gap in science achievements by content and cognitive domains. The average score of boys in science by content domains is lower than girls' score in two domains: Life Science and Physical Science, yet the difference is statistically significant only in Life Science. The gender gap in science by content domains is similar to those in neighbouring countries. Thus, in Serbia, Montenegro, North Macedonia, girls achieve statistically significantly better results in Life Science domain. At the international level, girls scored better in Life Science domain than boys, where the average score for girls is 498 scale score and for boys 489 scale score, while the situation is reversed in the domain of Earth Science, with an average score of 486 for girls and 489 for boys.

The distribution of boys and girls in science by achievement levels does not show any significant gap. The biggest difference is at the low level, where there are 3% more girls than boys, and at intermediate level, where there are 2% more girls than boys.

Exhibit 3.5 Gender gap in average achievement in science by content and cognitive domains





Average scores by gender across cognitive domains indicate the girls perform better in the domains of *Applying and Reasoning*, and it is statistically significant. At the international level, the situation is similar, in both domains girls achieve better results, but the score difference is smaller than among students in BiH. The average score of girls in the domains of *Applying* and *Reasoning* is 506 and 509 scale score, respectively, and for boys 503 scale score in both domains. In both cognitive domains, the difference was statistically significant in favor of girls.

TIMSS 2019 collected data on student urbanity in two ways. The first is based on the data that TIMSS takes as stratification variables for school selection, thus ensuring representativeness for schools as a whole, as well as for schools in rural and urban areas. Each country defines rural and urban areas according to its own criteria. In addition, TIMSS offers the following definitions to school principals to describe the area in which the school is located:

Urban - densely populated; Suburbs - on the edge or suburbs of an urban area; Medium or large city; Small town or village; Remote rural area.

Rural schools in BiH are those selected by the principal as a small town, village or remote rural area, while urban schools are those selected as other categories.

Exhibit 3.6 Gender gap in average achievement in mathematics and science in urban and rural schools

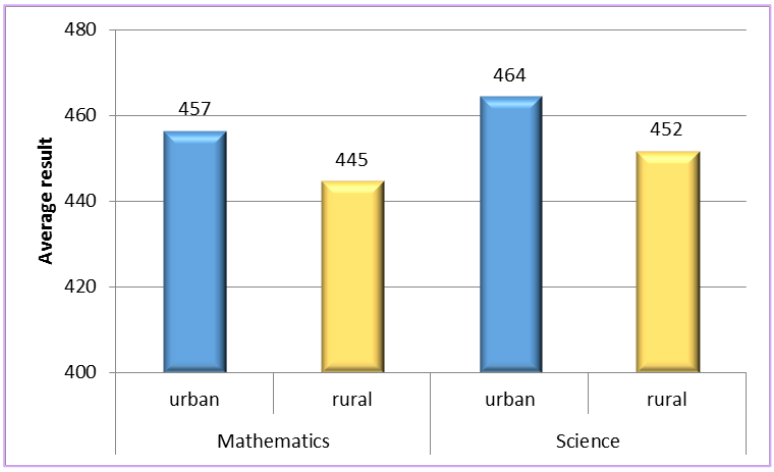
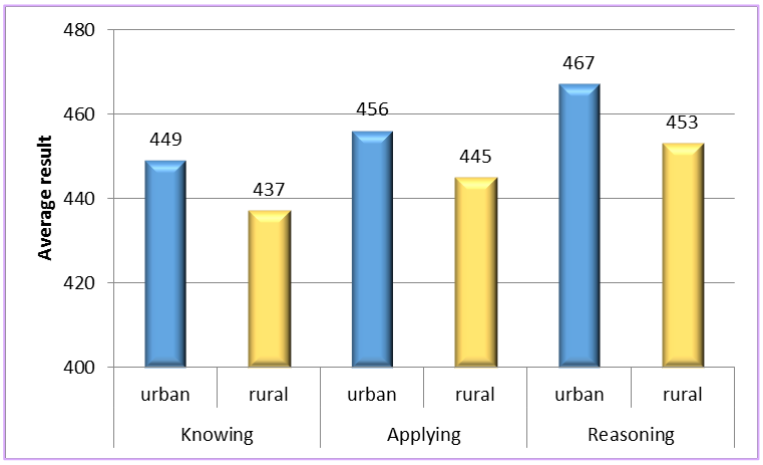


Exhibit 3.6 presents the difference between student average achievement in urban and rural schools. In BiH, the difference between the achievements of students in *urban* and *rural* schools in mathematics and science is 12 scale score in favor of students in urban schools, which is statistically significant.

It is worth mentioning that in Zenica-Doboj Canton, there is a significant difference in mathematics achievement, 23 scale score, in favor of students in *urban* schools. The situation is similar in schools of these categories in RS, and the difference is 15 scale score in favor of students in *urban* schools. In science noted is similar, only the difference is bigger. In Zenica-Doboj Canton, the difference in achievement of students from *urban* and *rural* schools is 28 scale score, and in RS that difference is 17 scale score, in favor of students from *urban* schools.

Exhibit 3.7 Average achievement in mathematics and science by cognitive domains in urban and rural schools



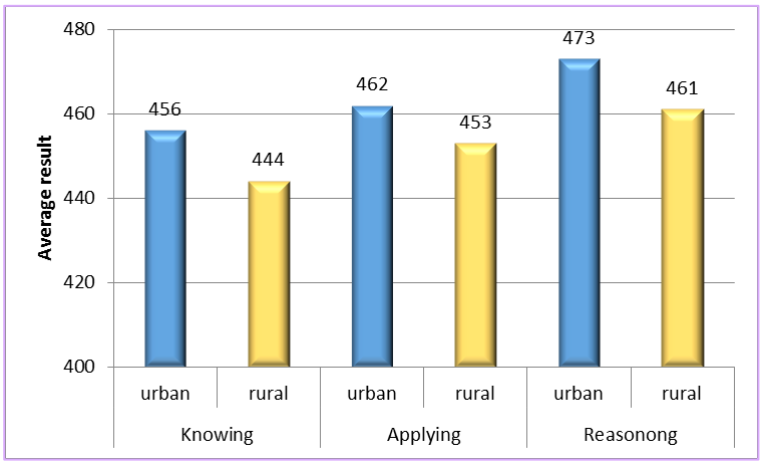
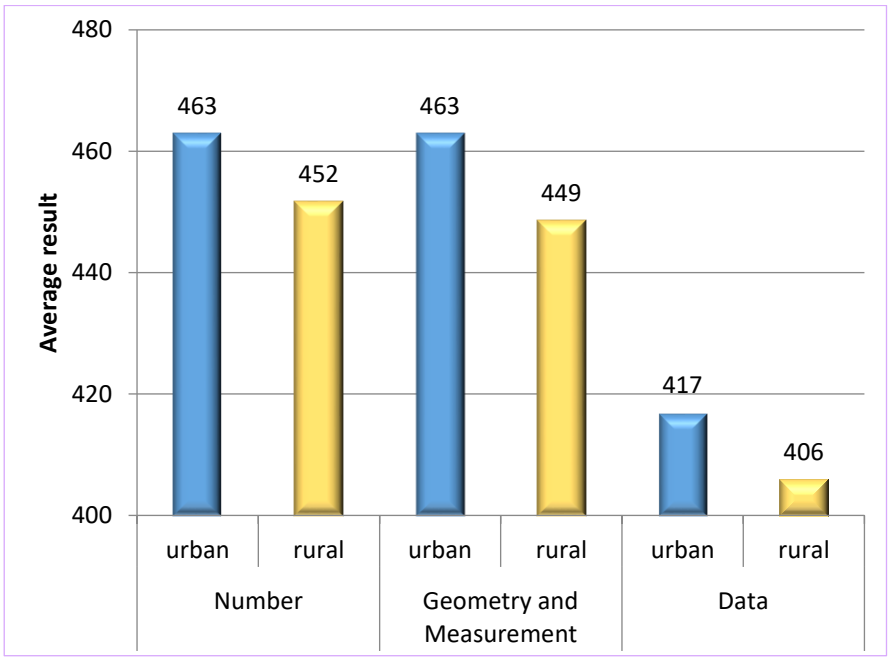
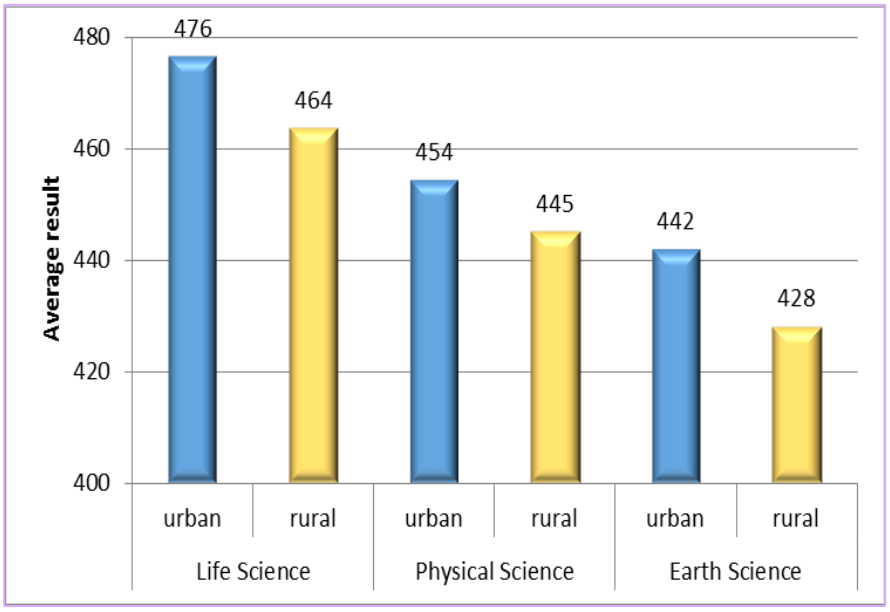


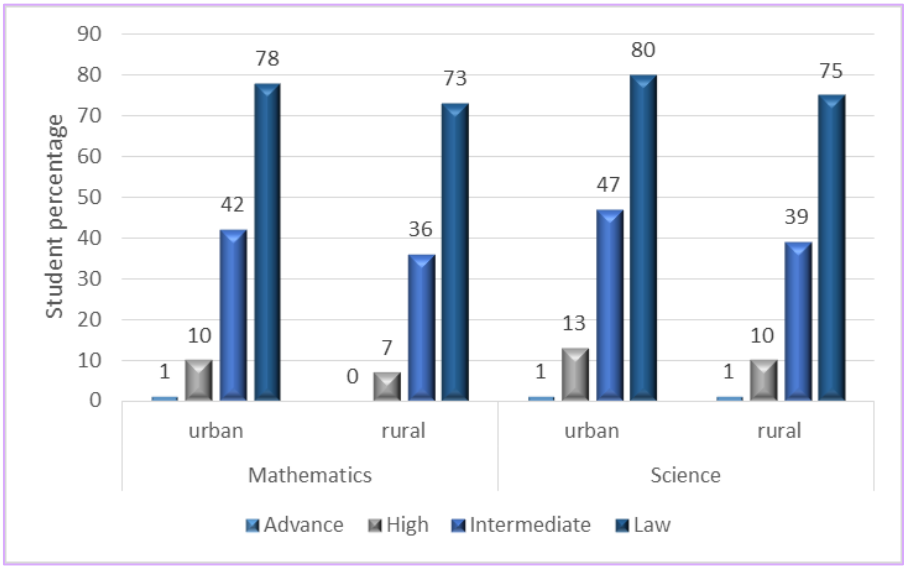
Exhibit 3.8a Average achievement in mathematics and science by content domains in urban and rural schools





The differences in student achievement in BiH in rural and urban schools by content and cognitive domains in mathematics and science are statistically significant in favor of urban school students.

Exhibit 3.8b Student distribution by international benchmarks in mathemathics and science in urban and rural schools



Fourth grade students in urban schools achieve better results at all benchmark levels and the achievemnts are higher, on average, for each benchmark than the average for BiH, except for the advance level in mathematics.

3.1.2 Student Characteristics and Attitudes

Student achievement factors are analyzed in relation to the students' characteristics and attitudes, by following variables:

- Preschool education and early learning
- Literacy and numeracy competencies before starting the first grade of primary school
- Attitude towards mathematics and science
- Mathematical self-confidence and science self-confidence

Preschool education and early learning

In BiH, there about 81% of students whose parents stated their children attended a preschool program for children older than 3 years. Knowing the enrollment rate of children in preschool programs from 3 to 6 years is the lowest in Europe, 25%, (UNICEF, Situation Analysis of Children in Bosnia and Herzegovina, 2020) and that there is a positive trend of enrollment of children in pre-school preparatory programs, which in 2018/2019 was 78%, we can say that a high percentage of children who attended the preschool, according to the statements of their parents, is actually attributed to the percentage that refers to the preschool in a year before starting the school. The average score in mathematics of these students is 456 scale score, while the average score of students who did not attend preschool programs for children older than 3 years is 447 scale score and the difference is statistically significant. In science, the average score of students who attended preschool programs for children older than 3 years is 462 scale score, and it is only 1 scale score higher than for students who did not attend these programs, which is not statistically significant. About 79% of children, whose parents gave negative answer to question related to attending the preschool program for children under 3, achieved an average math score of 455 scale score and it is 4 scale score lower than is the case of students who attended this program, which is not statistically significant. In science, average score of students who attended the program for children

under 3 years is 468 scale score and is better result for seven scale score than for students who did not attend this program, but the difference is not statistically significant.

The following exhibit shows percentage of students by total number of years in preschool programs.

Exhibit 3.9 Student percentage by total number of years in preschool programs

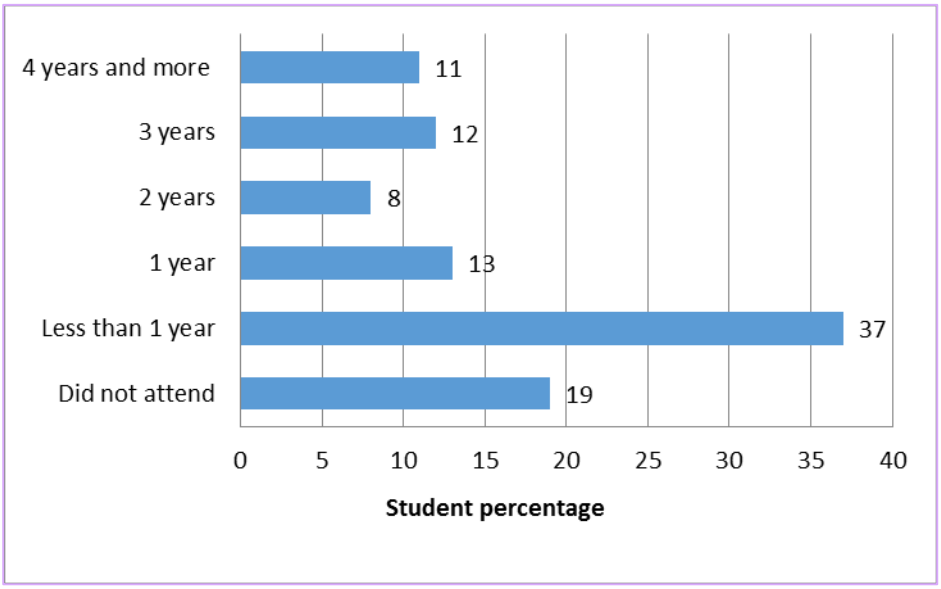
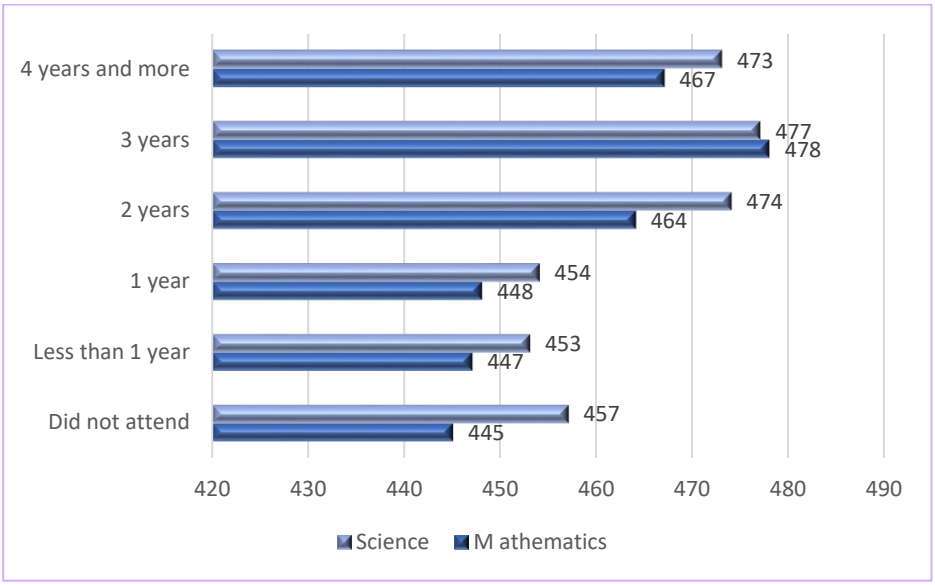


Exhibit 3.10 shows differences in student achievement in relation to the length of preschool attendance.

Exhibit 3.10 Student achievement in mathematics and science by length of preschool attendance



It can be seen that in mathematics every year contributes positively, except for category *4 years and more*. The difference between students who *did not attend* preschool program and those who attended for *3 years* is 32 scale score, in favor of students who attended the program for *3 years*. It is interesting that in category *4 years and more* there is no positive contribution compared to category 3, meaning the nursery period does not contribute significantly to cognitive dimensions in terms of success in mathematics in further education. This information should be examined further. In science, the

situation is somewhat different. Students who *did not attend* preschool education programs have statistically significantly lower achievement than students in the categories of *2, 3, 4 years and more*. Positive contribution of the length of attending preschool program is for the categories of students *less than 1 year, 2 year, 3 year.* This also signals for additional research, and seeing into the quality of science literacy programs and motivating environment in preschool institutions.

Literacy and *Numeracy* Competencies *Before Starting the First Grade of Primary School*

The influence of the family on school achievement has been a topic of scientific research for a long time. There is no doubt family environment is important for acquiring first knowledge and experiences; children enter first interpersonal and emotional connections, forms values for future inclusion and functioning in wider community (Zukić, 2012 according to: Slijepcevic, Zukovic Kopunovic, 2017). Many studies indicate the impact of family variables on academic achievement and student progress. There is need for finding solutions and models for early learning in the family, since in BiH there is a large number of preschool children who do not attend any preschool institutional form of education. According to UNICEF survey (Situation Analysis of Children in Bosnia and Herzegovina, March 2019) the enrollment rate of children aged 3 to 6 in preschool education in BiH is the lowest in Europe, amounting to 25%. In 2018/2019 there was increased number of children in the compulsory preschool program one year before starting primary school, amounting to 78%. In the surrounding countries, the enrollment rate in preschool education is much higher, in Croatia about 83%, Montenegro about 70%, Serbia about 69%, and in North Macedonia about 40%.

Family influence on early learning is largely marked by attitudes that parents have about early learning. However, the importance of parents in early learning process cannot be compensated, and active support of parents, development of their competencies and adoption of appropriate methods are needed to become an integral part of educational process. How parents will treat their child depends largely on the attitudes they have toward early learning. A research in Croatia shows that socio-demographic characteristics are important for the formation of parental behavior towards preschool children. The number of children in the family proved to be an important predictor of parental positive/ negative behavior towards children, which also applies to the age of mother (Štironja Borić, Roščić, Sedmak, Šepčević & Keresteš, 2011 - according to Travar, Spasojević, 2018). The same research confirms the existence of differences in parental attitudes and behavior towards children in relation to gender and that parental support is important for socio-emotional development of the child. Another research shows that poor support, especially from mothers, can have negative effects on socio-emotional development of the child (Cooper, Masi & Wick, 2009 - according to Travar, Spasojevic, 2018).

Analysis of the international research data, such as TIMSS, is a way of obtaining reliable information on important factors of the home environment that are vital for later success in school (Martin, Mullis, Foy & Stanco, 2012; Mullis, Martin, Foy & Arora, 2012a; Mullis, Martin, Foy & Drucker, 2012b; OECD, 2010, 2012).

Parental assessment of their children's knowledge and skills in terms of literacy and mathematical competences is an important predictor of achievement in mathematics. In TIMSS 2019, parents were asked to assess their child's early literacy before the first grade of primary school using a scale with four categories: *very good, good, not very good* and *not good at all*. Parents assessed proficiency based on seven statements: a) Recognizes most letters of the alphabet, b) Reads some words, c) Reads sentences, d) Reads a story, e) Writes letters of the alphabet, f) Writes his/her name, d) Writes other words except for his/her name.

To assess numeracy, parents answered questions: a) Count by himself/herself, b) Recognize written numbers, c) Write numbers, in the following categories: *not at all*, *up to 10*, u*p to 20*, *up to 100 or more*, and the questions: e) Perform simple addition, e) Perform simple subtraction, in the categories: *yes* or n*o*. Students were scored according to their parents 'statements of how well their children were able to do 12 requirements within Early Literacy and Numeracy competencies before starting school.

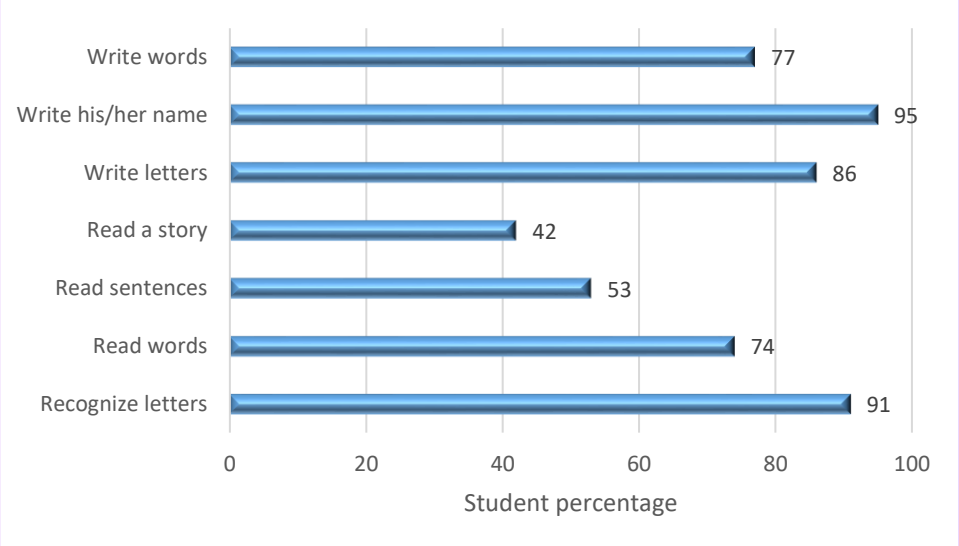
Students were divided into three categories: v*ery well, moderately well* and *not well*. Students who solve the tasks in the field of literacy and numeracy *Very well* were awarded at least 11.2 scale score (source: IEA's Trends in International Mathematics and Science Study - TIMSS 2019), which corresponds to the parents' answers that the child was able to do all 12 tasks (five at the highest level, 5 at the intermediate level and simple addition and subtraction tasks), on average. Students who could gain more than 8.6 scale score on the scale found themselves in the category *not well*, which means that their parents reported that they could not do 12 tasks at a satisfactory level (five tasks at least at the minimum level, five at least at the medium level and without simple addition or subtraction), on average. All other students belong to the category *moderately well*.

Table 3.1 Student percentage and average result in mathematics by child's competencies before starting school

Country	Very well			Moderately well			Not well		
	percen-tage	average result		percen-tage	average result		percen-tage	average result	
		mathe-matics	science		mathe-matics	science		mathe-matics	science
BiH	23	480	482	56	451	458	21	425	435
International average	25	532	518	51	498	488	24	468	461

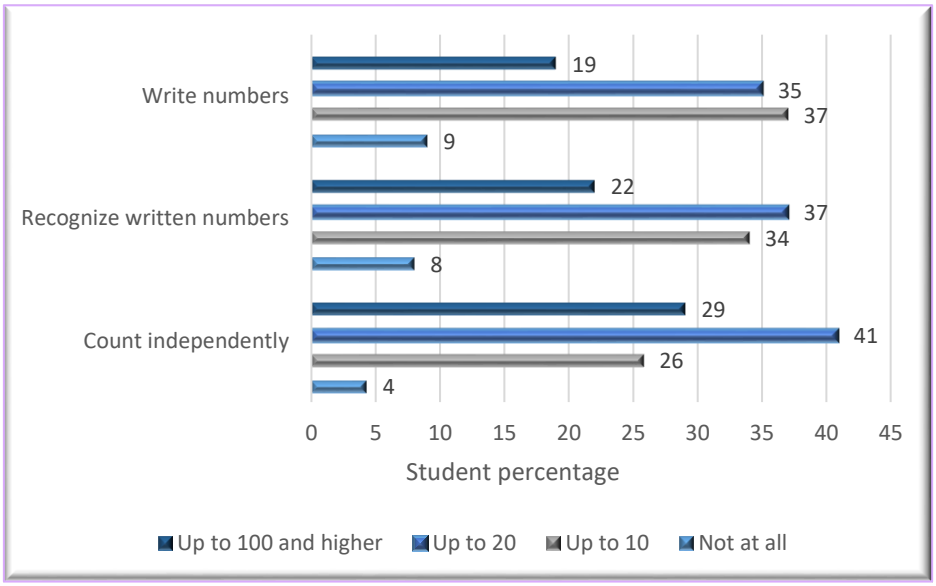
In BiH, for 23% of students, parents say that they were able to do tasks in literacy and numeracy *very well*, 56% m*oderately well*, and 21% could not cope with these requirements. It can be seen that students who are classified in the category *very well* have best achievement in mathematics and there is a big difference of average result compared to students in the category *not well*, 55 scale score. It is similar in in science, so it is obvious there is a positive contribution when it comes to students' competencies before starting school and achievements in mathematics and science.

Exhibit 3.11 Percentage of students assessed by their parents to be very well and moderately well trained in the following activities



The results indicate that for the largest percentage of students their parents estimated they know how to write their name very well or moderately well. Then comes the percentage of students who *recognize letters* and the lowest percentage is for students who *can read a story*. It is understandable students have mastered the skills of *reading a story* or words less, because the age of 4 to 5 years is the age when they develop pre-reading skills of recognizing syllables and the first and last phoneme in a word (Čudina - Obradović, 2002b). Then, writing gets similar to real letters bearing characteristics of the writing phase. This is the age when children do not actually write, but draw letters; they perceive the whole, recognize a picture, but not the written words and letters. This finding refers to the parents' perception of their children they had 4 years ago, that is, when their children were about 6 years old, and sometimes it is difficult to put the trait of your child in the appropriate moment. Parents' assessments in BiH regarding development of early literacy skills are obviously subject to socially desirable responses and cultural aspect of the parents' role in working with their children on elements of early literacy development. Parents expect their child should be able to read and write before starting the school, and their activities at home are focused on exercising early literacy.

Exhibit 3.12 Percentage of students whose parents stated their child could to do the following requirements before starting school



Most children, according to their parent assessment, *count independently* before going to school, and most of them can count up to 20. The same is with the requirement to *recognize written numbers and write numbers.* Interestingly, according to parents, *recognizing written numbers* was more difficult to their children before starting the school than adding numbers (Exhibit 3.12). It is clear that this is not really about addition, in which the child understands the relationships between numbers, as well as an explicit understanding of the meaning of cardinality. Children do not actually add up, they memorize and repeat the content like a poem learned by heart. Parental activities are traditionally focused on memorizing the patterns, rather than learning and understanding the concepts behind these skills.

Exhibit 3.13 Percentage of students whose parents reported their child could do the following tasks

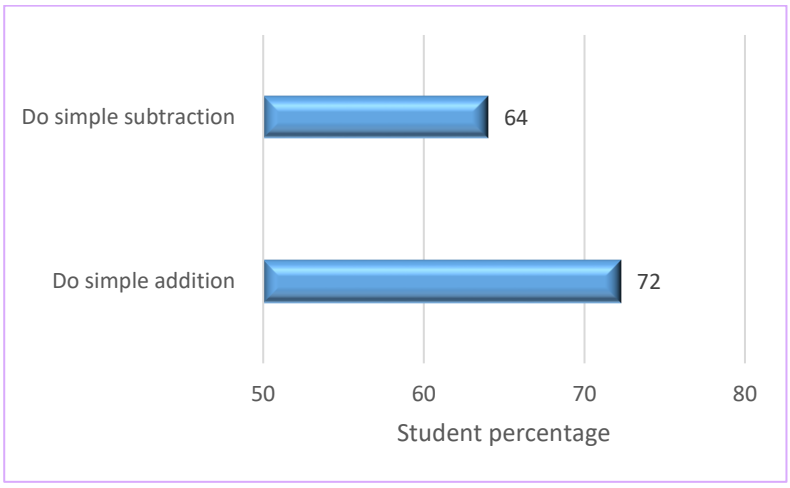


Table 3. 2 Correlation of the early literacy and numeracy competencies with the achievements in mathematics and science

	Mathematics	Science
Early literacy competencies	0.19	0.17
Early numeracy competencies	0.29	0.21
Early literacy and numeracy competencies	0.27	0.22

Data in Table 3.2 indicate positive correlation between early literacy and mathematical competences before starting the school with the achievements in mathematics and science in TIMSS 2019, and the correlation is statistically significant at the level of $p < 0.05$ for all three variables - early literacy and numeracy competencies and a combined variable of these literacy. It should be emphasized that the obtained correlations are low, which indicates that, although parents reported that their children read, write and count, these skills are not developed lliteracy and numeracy competencies, but more mechanical skills.

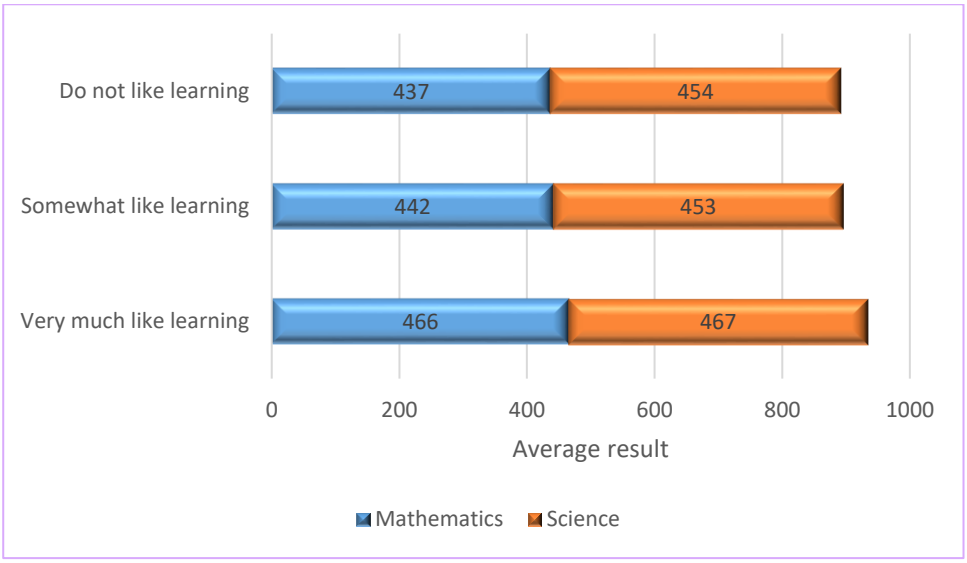
Attitude Towards Mathematics and Science

In terms of student beliefs, students' attitudes toward mathematics and science, as well as mathematical and scientific self-confidence, were examined. The variables of students' attitudes towards mathematics and science are operationalized by a scale consisting of nine statements:

a) I enjoy learning mathematics /science, b) I wish I didn't have to study mathematics / science, c) mathematics / science is boring, d) I learn many interesting things in mathematics /science e) I like mathematics / science, f) I like any schoolwork that involves numbers / I look forward to learning science in school, d) I I like to solve mathematics problems / science teaches me how things in the world work, h) I look forward to mathematics lessons / I like to conduct scientific experiments i) Mathematics is one of my favorite subjects / Science is one of my favorite subjects, which students answer in the categories: *Agree a lot, Agree a little, Disagree a little, Disagree a lot.*

Students are divided into three categories, so students who very much like learning mathematics are given at least 10.2 scale score on the scale, which corresponds to students 'answers *agree a lot* with the five statements and *agree a little* with the next 4 statements, on average. Students who could not score less than 8.4 scale score on the scale were categorized as do not like learning mathematics, which corresponds to students 'answers *disagree a little* with five of the nine statements and *agree a little* with other 4 statements, on average. All other students are in the category somewhat like learning. The same procedure is used for the scale of students' attitudes towards science.

Exhibit 3.14 Student achievement in mathematics and science by students' attitudes towards mathematics and science



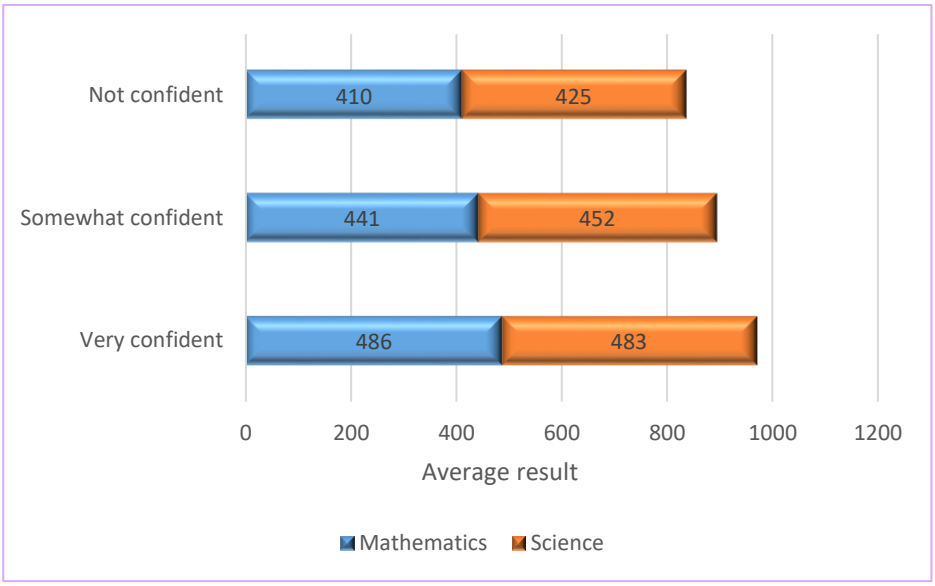
Positive attitude towards mathematics has positive effect on student achievement, and it is similar with science. Namely, 49% of students state they Very much like learning mathematics and these students have the highest average result, which is above the average for BiH, while 20% of students state they do not like learning mathematics and their achievement is 29 scale score lower than of students in the first category. In science, 49% of students are in the category of very much like learning this subject, and 16% of students are in the category of *do not like learning* science and the average result is very similar to the result of *somewhat like learning.* Students who expressed they *very much like learning* science achieved statistically significantly higher result than students in other two categories of statements.

Self-confidence in Mathematics and Science

Mathematical and scientific self-confidence have greater effects on students' achievements in comparison to the attitude towards mathematics and science.

The variable of mathematical and scientific self-confidence is operationalized by a scale consisting of 9 statements for mathematics and 7 for science: a) I usually do well in mathematics / science, b) Mathematics/Science is more difficult for me than for many of my classmates c) Mathematics/Science is not one of my strengths, d) I learn things quickly in mathematics/science, e) Mathematics makes me nervous, f) I am good at working out difficult mathematics problems, d) My teacher tells me I am good at mathematics/science, h) Mathematics/ Science is harder for me than any other subject i) Mathematics/Science makes me confused. Students evaluated these statements with responses: *agree a lot, agree a little, disagree a little, and disagree a lot.*

Exhibit 3.15 Student achievement by mathematical and scientific self-confidence



An average student who is *very confident*, as stated by 42% in mathematics and 46% in science, in both tested areas (Exhibit 3.15), reaches the average level of achievement (lower limit level 475 scale score) while an average student who is *not confident,* 21% in mathematics and 19% in science, belongs to the category of low achievement (lower limit level 400 scale score).

3.1.3 Family Context

Below are some results of the relationship between the characteristics of the family environment and the achievements of BiH fourth grade primary school students in mathematics and science. The focus was on indicators of students' socio-economic status: home resources for learning, education and parental occupation. There are also analyzes of family activities related to the development of early lliteracy and numerical competencies.

The variable on home learning resources was created based on the following: the number of books at home, owning the internet, and owning a room at home. Students are divided into three categories, so students with many resources are awarded 11.8 scale score on the scale, which corresponds to statements that they have more than 100 books, an internet connection and their own room, and their parents report that they have more than 25 books for children at home, at least one parent has completed a university education, and at least one parent has occupations such as a scientist, mathematician, architect, engineer, teacher, etc., on average. Students with few resources earn less than 7.4 scale score and they stated that they have 25 or less books, that they have no internet and their room at home, and their parents report that they have 10 or less books for children, neither parent has post-secondary education, and neither parent owns a smaller business, or is an administrative officer, or an expert in a field, on average. All other students are categorized into the category some resources.

Exhibit 3.16 Student achievement in mathematics by learning resources in regional countries

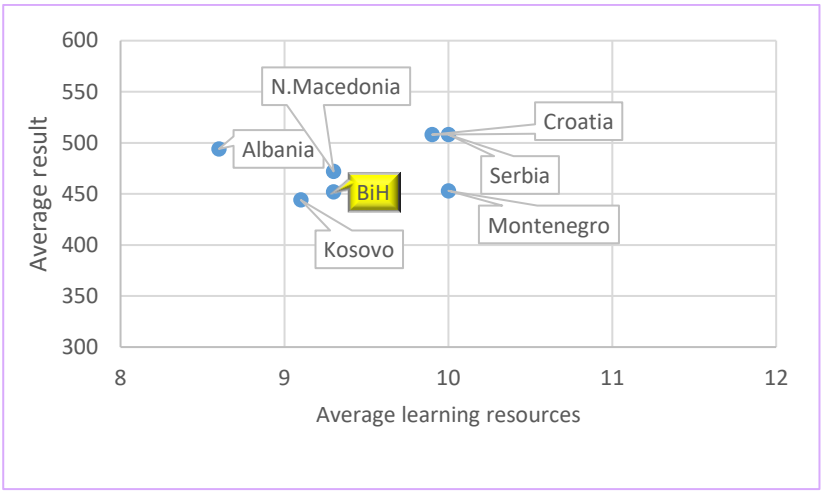
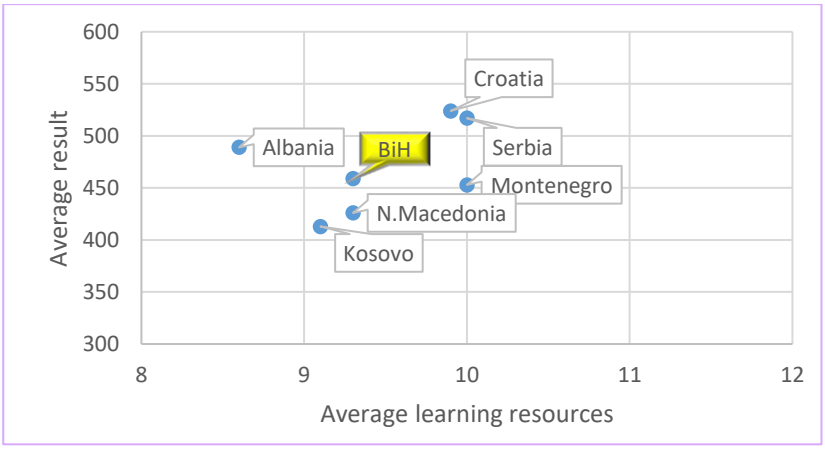


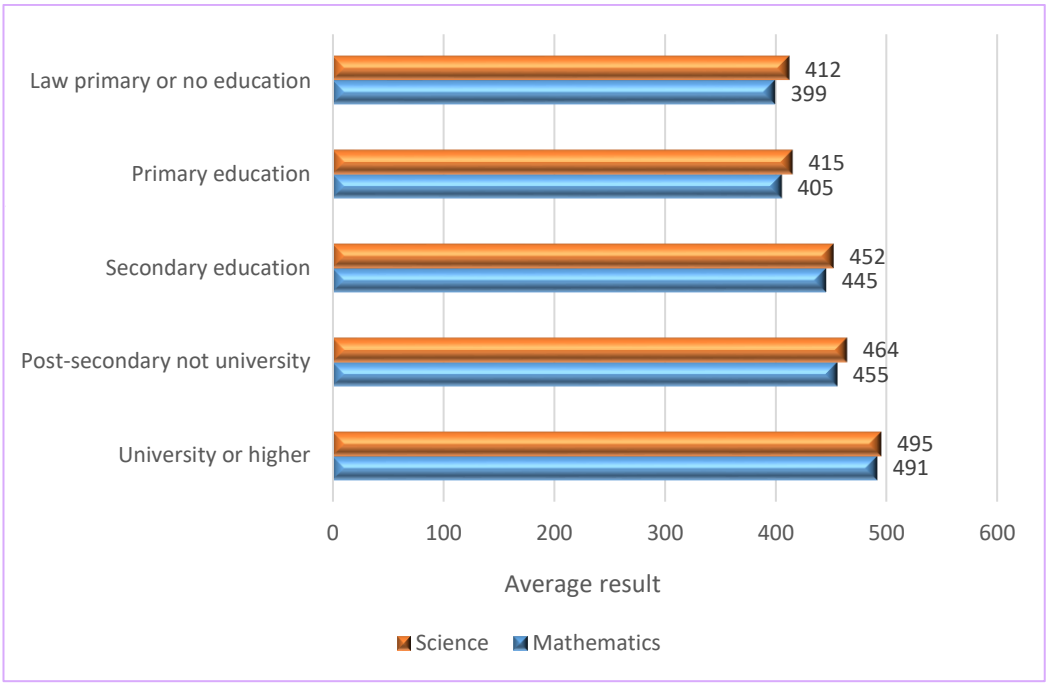
Exhibit 3.17 Student achievement in science by learning resources in regional countries



Exhibits 3.18 - 3.20 present the distribution of student achievement by:

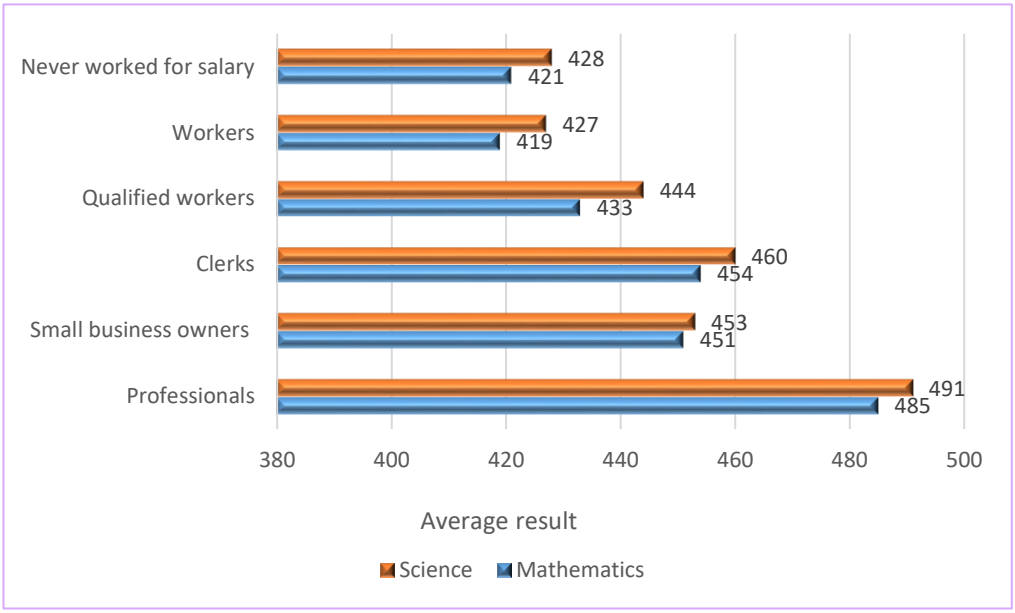
- Parents' education
- Parents' occupation
- Owning home educational resources

Exhibit 3.18 Student achievement in mathematics and science by parent education



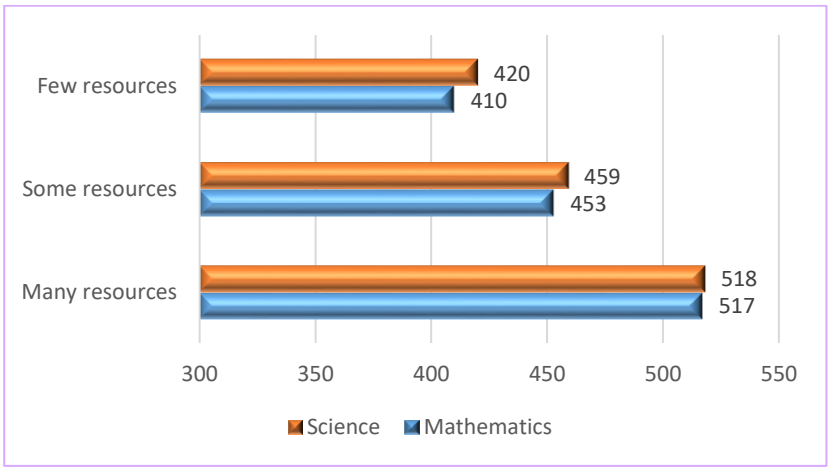
The level of parent education can be taken as statistically significant factor in student achievement in mathematics. The differences are significant so that children whose parents have a higher level of education also have statistically significantly better achievements in mathematics. The same trend applies to science. Thus, average student whose parents have *university education,* or *master's degree, specialist studies* or *doctoral studies* (in the field of science or art) can be classified in the group of students with intermediate achievements in mathematics and science (the lower limit of this level is 475 scale score). The average student whose parents completed the *low grades of primary school* or *have no education*, scored in mathematics below the low benchmark level (below 400 scale score while in science they scored minimum level.

Exhibit 3.19 Student achievement in mathematics and science by parent occupation



The pattern of differences in the achievements in mathematics and sciences by occupation of the parents is similar to the previous differences. If parents have more prestigious occupations, their children achieve better results. The highest achievement in mathematics and science are by children whose parents are *professionals* and these results are statistically significantly higher than of children whose parents have some other occupation. So, children, acoording to their achievement, can be divided into three groups: the first group are children whose parents are *professionals* in a field, then the children of the *clerks* and of *small businesses owners*, and the third group of the *qualified workers, workers* and parents who *never worked for salary*. In science, grouping is somewhat different. Children whose parents have occupation identified as *professionals* have the highest score. They are followed by the group that includes *small business owners*, *clerks* and *qualified workers* not statistically significantly different from each other, but different from the first group and the group of parents who *never worked for salary*. Hence, the occupation of parents is significant factor of student achievement both in math and science.

Exhibit 3.20 Student achievement in mathematics and science by home educational resources



The differences in home educational resources lead to differences in student achievement (Exhibit 3.20). Average student who has *many resources* for learning at home, 5% of them in BiH, scored at average level of achievement in mathematics and science and it is similar with students in the category of *some resources,* but the differences between the first and second category of students is 64 scale score in mathematics and 59 scale score in science in favour of students from the category *many resources*. In both cases there is statistically significant difference. Average student with *few resources* achieves low achievement.

The fourth grade students in BiH stated that about 69% of them have up to 25 books at home. Students who have up to 10 books or 11 to 25 books at home have significantly lower achievements in mathematics and science than students who have more than 25 books at home. About 87% of students stated they have computer or tablet at home as well as desk for personal use and these students achieve significantly better results in math and science than those who did not have these resources. About 82% of students have their own study room, while 89% have internet connection, and as many as 87% of students report owning their own mobile phone. The situation in neighbouring countries is similar; only in Albania and Kosovo there is a smaller percentage of students who have the mobile phone or internet connection in their households. Nevertheless, in the countries with top results the situation is like this: in Singapore 65% of the students have their mobile phone, in Japan, 46% of students, in Hong Kong 67%, and in Chinese Taipei 52% of students. 75% of students in Chinese Taipei, 81% in Hong Kong, 83% in Japan, and 97% in Singapore and 87% in the Russian Federation have a household Internet connection. Only 49% of students in Chinese Taipei say they have their own room, and 55% in Singapore or 67% of students in Japan.

Significant differences in student achievement in terms of family resources were found in most cantons in BiH. Students who have better family opportunities, achieve better results in mathematics and science. When we look at the results separately at the entity level, differences in achievement indicates the same thing, and that is that children who have better learning resources achieve better results in both subjects. Only in Brcko District there are significant differences between students in *few resource* category and the *many resources* category.

Activities Related to Developing Early Literacy and Numeracy

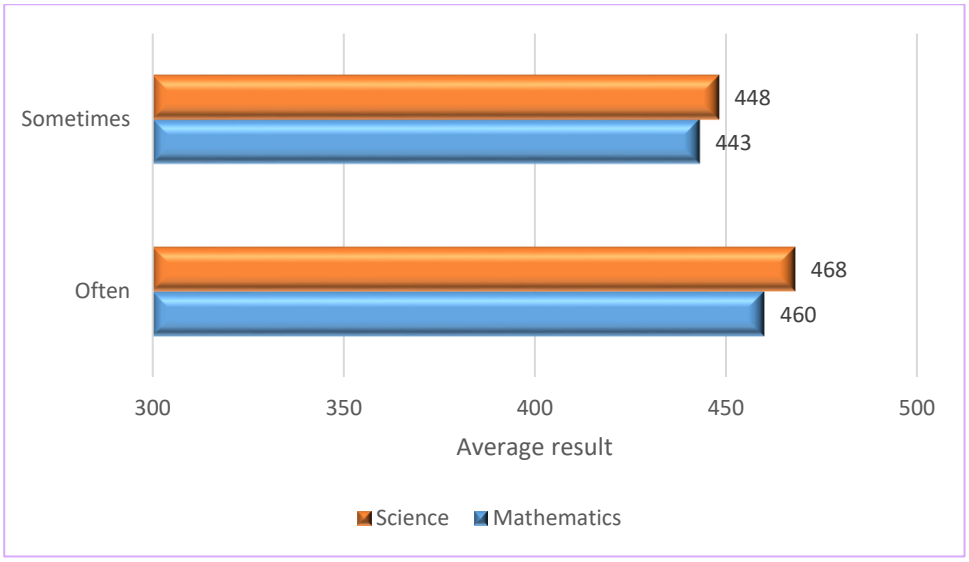
It is important to determine the frequency of children's participation in various activities that are important for the development of early literacy and numeracy in home environment before formal schooling. In TIMSS 2019, frequency is described by three levels: *often, sometimes, never or almost never.* Data on activities related to development of early literacy and numeracy in home environment were collected based on parents' responses. The variable of activities related to the development of early literacy and numeracy contains 18 statements, which are classified into two groups; first for developing literacy:

a) Read books, b) Tell stories, c) Sing songs, d) Play with alphabet toys (e.g., blocs with letters of the alphabet), e) Talk about things you had done, f) Talk about what you read, g) Play word games, h) Write letters or words, i) Read aloud signs and labels, and second for developing numeracy:

j) Say counting rhymes or sing counting songs, k) Play with number toys (e.g., blocks with numbers), l) Count different things, m) Play games involving shapes (e.g., shape puzzles sorting toys, puzzles), n) Play with building blocks or constructiontoys, o) Play board or card games, p) Write numbers, r) Draw shapes, s) Measure or weigh things (e.g., when cooking).

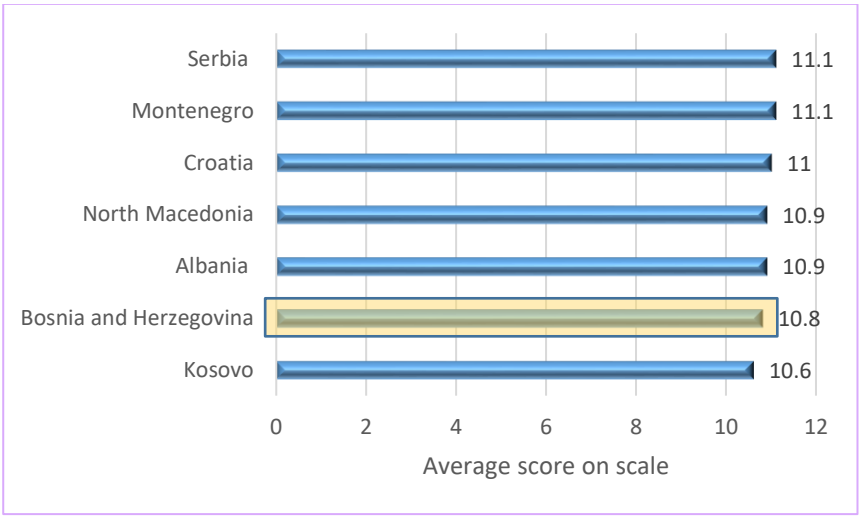
Students were classified into three categories according to parent responses, namely: *often* if the total score on the scale was at least 10.6, which corresponds to parents reporting that they often practiced 9 of 18 activities and *sometimes* the other 9 activities. Students in the category *never or almost never* have a total score that does not exceed 6.5 on the scale, which means that parents reported that they *never* or *almost never* did 9 of 18 activities with the child, and that they practiced only *sometimes* the remaining 9 in period before starting primary school. The remaining students belong to the category *sometimes* (IEA's Trends in International Mathematics and Science Study - TIMSS 2019).

Exhibit 3.21 Activities related to developing early literacy and numeracy



In BiH, there is a very small percentage of students in *never* or *almost never* category, only 1%. All others were categorized *often*, 53% and *sometimes*, 46%. It can be seen the students in the category *often* achieve better results in mathematics and science. The average score on the scale of activities related to the development of literacy and numeracy in BiH is 10.8 scale score, which places BiH in the upper part of the scale of the countries participating in TIMSS 2019 for the fourth grade.

Exhibit 3.22 Activities related to the development of home early literacy and numeracy activities before primary school in regional countries



In the countries of the region, most students, according to their parents, were often exposed to preschool activities that develop literacy and numeracy. In Serbia, there are as many as 60% of students who often did those activities. In BiH, there are 53% of students whose parents stated they *often* did activities with their children to develop literacy and numeracy. The average score of these students in mathematics is 460 scale score, and in science 468 scale score. For all countries in the region, it is noticeable that there is a significant difference in achievement in mathematics and science in the category *often* compared to the category *sometimes*.

3.1.4 Teaching and Learninmg and School Characteristics

For many years there have been debates between teachers and researchers about which variables in school are determinants of student success. As policy makers become more involved in school reforms, so this issue takes on new significance as many of their initiatives are based on presumed relationships between different factors regarding education and learning outcomes (Darling-Hammond, 2000). Some research shows that schools have little impact on student achievement that is independent of their background and general social context (Coleman et al., 1996; Jencks et al., 1972, according to Darling-Hammond, 2000). Some other indicators suggest that factors such as class size (Glass et al., 1982 according to Darling-Hammond, 2000), teacher qualification (Ferguson, 1991 according to Darling-Hammond, 2000), school size (Haller, 1993 according to Darling-Hammond, 2000) as well as some other school variables, can have significant influences on what students learn.

There are several factors that affect teaching and learning. These include parents' expectations regarding communication with teachers, socio-economic conditions and school policies that are associated with school attendance and school discipline. Some factors are more obvious, such as the physical condition of the school building or the presence of technology in classrooms, while some are more related to educational decisions made at school, local community or at a higher level.

There are studies that have empirically confirmed that the quality of teachers 'work contributes to the improvement of students' academic results (Brophy & Good, 1986, darling-Hammod, 2000). Teacher effects are cumulative and generally not compensatory. There are also research studies that have focused research on the contribution of general characteristics of teachers - qualifications, level of initial education, attendance of professional development programs, years of work experience, the effectiveness of their work in teaching and student achievement (Darling-Hammond & Youngs, 2002, Hanushek & Kain, 2000).

Taking this in consideration, the question is what actions and behaviors of teachers affect the quality of student achievement, is it the structure of the class, setting clear goals for the class, setting challenging tasks, asking questions that engage student potential, setting high student expectations, giving comprehensive and timely feedback, and the like.

The international study TIMSS 2019 also deals with the collection of data on the characteristics of teachers, their practices related to learning mathematics and science at the classroom level. These data give us knowledge of how the initial education of teachers stands, how the system works in terms of professional development of teachers, and what pedagogical approaches teachers use in working with students. Based on this information, the quality of teachers work and their impact on students' academic success can be analyzed, and it is possible to make comparisons among the countries participating in the research based on these variables.

TIMSS study examines several teaching variables. Teachers are the creators of the teaching process; they have an impact on the implementation of the curriculum as well as on the circumstances under which the teaching process takes place. The issue of teacher education, motivation, job satisfaction, self-confidence in their teacher competencies, are all factors that can positively affect the motivation of students for better achievements. The quality of teaching can be conditioned e.g. class size, educational resources, as well as training teachers to make the best use of teaching equipment. School characteristics can also be aggravating or facilitating factors in teaching and learning. The location of the school, its size and equipment, emphasizing the importance of students' academic success, school climate, and effective leaders can be factors in student success.

Formal Teacher Education and Years of Work Experience

In BiH, around 67% of fourth-grade primary school students are taught by teachers whose level of formal education is university, and there are 29% of students whose teachers completed Post-Secondary but not Bachelor's Degree, while 4% of students are taught by postgraduate teachers. In the countries of the region, in Croatia and Albania, there is a high percentage of students whose teachers have obtained postgraduate education e.g. completed master's or doctoral studies. Thus, in Croatia, 50%, and in Albania, 59% of students are taught by teachers with postgraduate level of education.

Table 3.3 Years of teaching experience and average achievement

	21 years and more		11 to 20 yaers		6 to 10 years		5 years and less	
	% students	Average achievement mathematics/ science	% students	Average achievement mathematics/ science	% students	Average achievement mathematics/ science	% students	Average achievement mathematics/ science
BiH	50	450/460	33	453/459	14	460/465	8	440/442

Students taught by teachers with more years of teaching experience achieve better average results in science, and it is similar in mathematics. Although there is difference between the achievement in mathematics for students of teachers with *21 or more years of experience* and students of teachers of the next category, in favor of the latter, the difference is not statistically significant. The difference in science between *5 years and less* and other categories is not statistically significant, but the values are very close to the significance, so it is obvious that teachers in category *5 years and less* of teaching experience need more professional help and additional training to be better prepared for achieving educational goals of their students.

Participation in Professional Development and Job Satisfaction

In TIMSS 2019, fourth grade mathematics teachers gave answers on their professional development in: a) Mathematical content, b) Mathematics Pedagogy/ Instruction c) Mathematics Curriculum, e) Integrating Technology into Mathematics Instruction e) Improving students critical thinking or problem-solving skills, f) Mathematics Assessment, g) Addressing Individual Students' Needs in the last two years.

Most students, 21%, whose teachers participated in trainings on individual student needs, 20% on improving critical thinking, equally, 15% on mathematical content and assessment in mathematics, and 12% on the integration of ICT in teaching and 10% on the topic of teaching methodology. When it comes to the needs of teachers for future professional development in mathematics, most students have teachers who stated they need education on ICT integration in teaching (72%), exactly where they had little training. Generally, teachers need the least of additional training in topics related to the curriculum, assessment and methodology of teaching mathematics. There are many more students whose teachers feel they lack competencies related to the individual needs of students (54%) or to the development of critical thinking in students (63%). Although teachers had some forms of training on these topics, it can be concluded they were not sufficient, bearing in mind the quality and teachers' expectations.

Teachers of science provided answers to questions of professional development in the last two years in the following areas: a) Science Content, b) Science Pedagogy/ Instruction, c) Science Curriculum, d) Integrating Technology into Science Instruction, e Improving Students' Critical Thinking or Inquiry Skills, f) Science Assessment, d) Addressing Individual Students' Needs, h) Integrating Science with Other Subjects. According to teachers, the most common training was on the development of critical thinking with students (there are 17% of students whose teachers gave such statements); there were less training on the topic of integration of science into other subjects and teaching of science, 12%, and the least on integration of ICT in teaching, for 10% of students. As in mathematics, teachers of most students express the need for additional education on ICT integration in science teaching, 73%, on integration of science into other subjects, 61%, on development of student critical thinking and problem solving, 60%, and on individual needs of students, for 50% of students.

The teacher questionnaire offered a set of questions related to teacher's job satisfaction: a) I am content with my profession as a teacher, b) I c) I find my work full of meaning and purpose, c) I am enthusiastic about my job, d) My work inspires me, e) I am proud of the work I do, in the categories: *very often, often, sometimes, never or almost never.* A composite variable was created so that students were classified into three categories according to the teacher's answers, namely: *very satisfied* if the total score on the scale was at least 10.1, which corresponds to teacher reporting in the category *very often* on three of five statements and *often* on other two statements, on average. Students in *less than satisfied* category have an overall score that does not exceed 6.5 on the scale, meaning that teachers reported *sometimes* on three of the five statements and *often* on the other two, on average. The remaining students belong to the category of *somewhat satisfied* (IEA's Trends in International Mathematics and Science Study -

TIMSS 2019). According to average score of 10.7 on the job satisfaction scale, BiH is ranked at the top of the scale, with 78% of students taught by teachers who are *very satisfied* with their job, 20% *somewhat satisfied* and only 2% who are *less than satisfied.* Also, student achievement of *very satisfied* teachers is better than those in the category of *somewhat satisfied*, however there is no statistical significance. (Table 3.4). Therefore, job satisfaction among fourth grade teachers in BiH does not contribute significantly to better student achievement in mathematics and science.

Table 3.4 Student achievement vs the level of teacher satisfaction with their work

	Very satisfied		Somewhat satisfied		Less than satisfied	
	% students	Average achievement mathematics/ science	**%** students	Average achievement mathematics/ science	**%** students	Average achievement mathematics/ science
BiH	78	453/461	33	449/453	2	-

Access to Computers in Mathematics and Science Lessons

In TIMSS 2019, teachers answered the question on the use of computers in teaching mathematics and science according to the availability of computers for each student, availability of computers used by all students, and the use of computers in school that can be used only sometimes. Also, teachers reported how often they use computers in math and science classes to support learning for: a) The whole class, b) Students with lower grades, c) Students with better results, d) Students with disabilities in growth and development, and it in categories: *every day or almost every day, once or twice a week, once or twice a month, never or almost never.*

In BiH, 13% of students have computers (including tablets) available in mathematics lessons, and 18% in science lessons. In both tested areas, there is statistically significant difference in achievement when students have or do not have computers available in the classroom. In math, that difference is 29 scale score and in science 16 scale score in favor of students with computers. Only 4% of students have computers for every student in math lessons while in science teaching there are 5% of students who have lessons in a classroom where every student has a computer. The situation is similar in the surrounding countries. Regarding the situation in top achieving countries, they are not at the top of the scale by the percentage of computer availability in mathematics and science lessons, nor there is a significant difference in student achievement in these two categories of students.

In BiH, only 1%, ie 2% of students have the opportunity to be thought by teachers who are using computers for teaching purposes during mathematics, ie science instructions *every day* or *almost every day.* As many as 88% of students in mathematics and 84% of students in science classes are taught by teachers who *never* or *almost never* use computers to support learning of their students. The performance of these students is significantly worse than of students whose teachers use computers *once* or *twice a month.*

Engaging Instruction

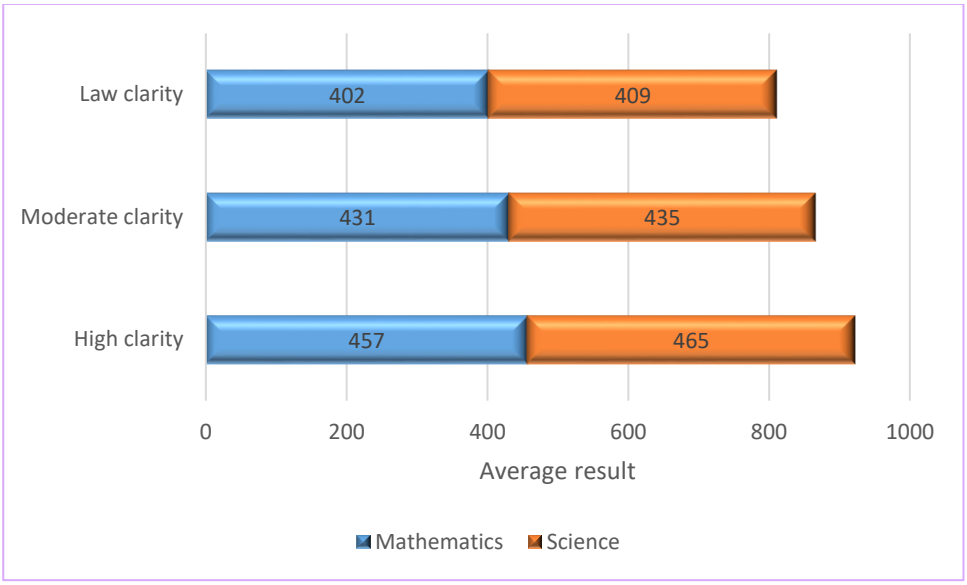
Teaching practices should be delivered in a manner that interest and activate students, that the choice of tasks and activities is appropriate to the age and abilities of students, that there is a connection between learning materials and examples from everyday life, that what is taught is evaluated, that there is individualized and differentiated access to students, and constant feedback provided. The teaching variable that affects student achievement is the level at which students see the teaching of mathematics and science as engaging.

The students answered the questions:

a) I know what my teacher expects me to do,
b) My teacher is easy to understand,
c) My teacher has clear answers to my questions,
d) My teacher is good at explaining mathematics/science,
e) My teacher does a variety of things to help us learn,
f) My teacher explains the topic to us again when we dont understand it.

They could agree with the statements on a scale: *agree a lot, agree a little, disagree a little, disagree a lot.* A composite variable was created for mathematics and science, students were divided into three categories, and students who report on high clarity mathematics teaching scored at or above 8.7 (8.8 for science), answering for 3 statements, *agree a lot* and for other 3, *agree a little, disagree a little, disagree a lot.* Students who reported low clarity in math and science classes scored at or below 6.7 (6.9 for science) on the scale that corresponded to *disagree a little* for 3 of the 6 statements and *agree a little* for other 3 statements, on average. Other students are in the moderate clarity category in mathematics lessons.

Exhibit 3.23 Student achievement vs the level of engaging mathematics teaching



According to the average score of 10.8 on the Scale of Instructional Clarity in Mathematics Lessons, BiH is at the top of the scale, and at the top are some surrounding countries - Albania, Kosovo, North Macedonia and Montenegro. In BiH, 86% of students perceive the engaging teaching of mathematics and science as *high clarity*. The average achievement of these students is statistically significantly better than of the other two categories of students and it should be taken into account that only 2% of students perceive the engaging teaching of mathematics and science as *law clarity*.

Factors Limiting the Teaching of Students

Teachers assessed factors that limited classroom teaching by Students Not Ready for Instruction. The questionnaire for teachers included questions for teachers to express the opinion on the extent of factors such as: a) Students lacking prerequisite knowledge or skills, b) Students suffering from lack of basic nutrition, c) Students suffering from not enough sleep, d) Students absent from classes, e) Disruptive students, f) Uninterested students, g) Students with mental, emotional, or psychological

impairment, h) Students with difficulties understanding the language of instruction, limit the teaching in their TIMSS class. The answers could be given in categories: *not at all, some or a lot.*

Students in the category whose teachers reported that teaching was very little limited scored on the scale 10.8 or higher which corresponds to reporting *not at all* on 4 of 8 statements and *some* on other 4 statements, on average. Students whose teachers expressed limited teaching in the category *a lot* scored 6.8 or lower, which corresponds to reporting a *lot* to 4 out of 8 statements and s*ome* to other 4 statements, on average. The remaining students have teachers who felt their teaching was limited s*ome*. (IEA's Trends in International Mathematics and Science Study - TIMSS 2019).

In BiH, the average score on the scale of teaching restrictions due to students 'not ready for instruction' is 10.4, which means that on average teaching is somewhat limited due to students' lack of prior knowledge. Namely, 45% of students have teachers who think that the teaching process is very difficult due to students' not ready for instruction, 49% of students whose teachers think that these restrictions are *to some extent,* and only 6% of students whose teachers report that the teaching process is very limited. When we take into account student achievement in these three categories, best results have students in the category *very little* and worst results have students in the category *a lot*. Yet, neither category records statistically significant differences in mathematics or science, i.e. teaching limitations due to students' not ready for instruction for learning are not significant factor of achievement in mathematics and science.

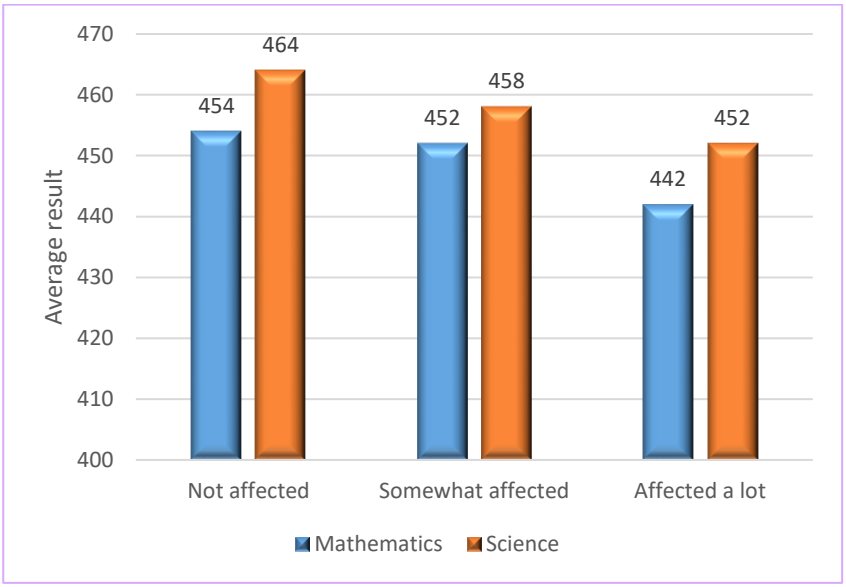
Limiting Factors in Mathematics and Science Teaching

School principals assessed the extent to which a shortage or inadequacy of some general resources or conditions in teaching mathematics and science affect the quality of teaching. General resources relate to teaching aids, heating/cooling systems, school buildings, computer technology, etc., while the conditions in teaching mathematics and science refer to teachers who specialize in these areas, computer programs for teaching these subjects, suitable literature, equipment for teaching science, etc.

Students were scored by school principals ’responses regarding 13 general and teaching resources on the Scale of School’s Capacity to provide instrucion. In mathematics, students are divided into three categories. Students in schools where teaching is not affected by shortage or inadequacy scored at or above 11.3 on the scale, which corresponds to school principals’ reporting that shortage or inadequacy *does not affect* 7 of 13 resources and *somewhat affected* the remaining 6, on average. Students in schools where teaching is *affected a lot* by shortage or inadequacy scored at or below 6.7 on the scale which corresponds to school principals reporting that shortage or inadequacy *affected a lot* 7 of 13 resources and *somewhat affected* the remaining 6, on average. All other students are categorized as *somewhat affected* by shortage or inadequacy.

In science, students are divided into three categories. Students in schools where teaching is *not affected* by shortage or inadequacy scored at or above 11.4 on the scale, which corresponds to school principals reporting that shortage or inadequacy *does not affect* 7 of 13 resources and *somewhat affect* the remaining 6, on average. Students in schools where teaching is severely affected by shortage or inadequacy scored at or below 7 scale score on the scale, which corresponds to school principals reporting that shortage or inadequacy *affect a lot* 7 of the 13 resources and *somewhat affect* the remaining 6, on average. All other students are categorized as *somewhat affected* by shortage or inadequacy.

Exhibit 3.24 Student achievement in mathematics and science vs the impact of a shortage or inadequacy



The average score for BiH in mathematics on the scale of the impact of shortage or inadequacy for teaching is 9.5 and in science 9.6. In both tested areas, it is the category of partial impact of a shortage or inadequacy of resources for teaching in school. Considering the achievement in mathematics and science according to the levels of influence of resource shortages, we can conclude that this variable has no effect on student achievement. The surrounding countries, with the exception of Serbia and Croatia, have lower average score on the scale than BiH, in the same category. Leading countries are Korea and Singapore, where in mathematics and science over 60% of students attend schools that do not have difficulties with a shortage or inadequacy in school. In BiH, 83% of students attend schools where there are some restrictions on teaching due to shortage or inadequacy. There are 80% of such students in science.

Teachers assessed factors that limit or hinder teaching, in relation to students. They answered questions about factors on the scale of 1 to 4, where 1 is for *agree a lot,* 2 for *agree a little*, 3 for *disagree a little* and 4 for *disagree a lot* Teachers in BiH estimate they need more time to help individual students, being the biggest burden. Other factors, such as too many students in the class, too much material, too many teaching hours, more time to prepare for class pressure from parents, and administrative tasks or curriculum changes are not limiting factors for the quality of teaching mathematics and science.

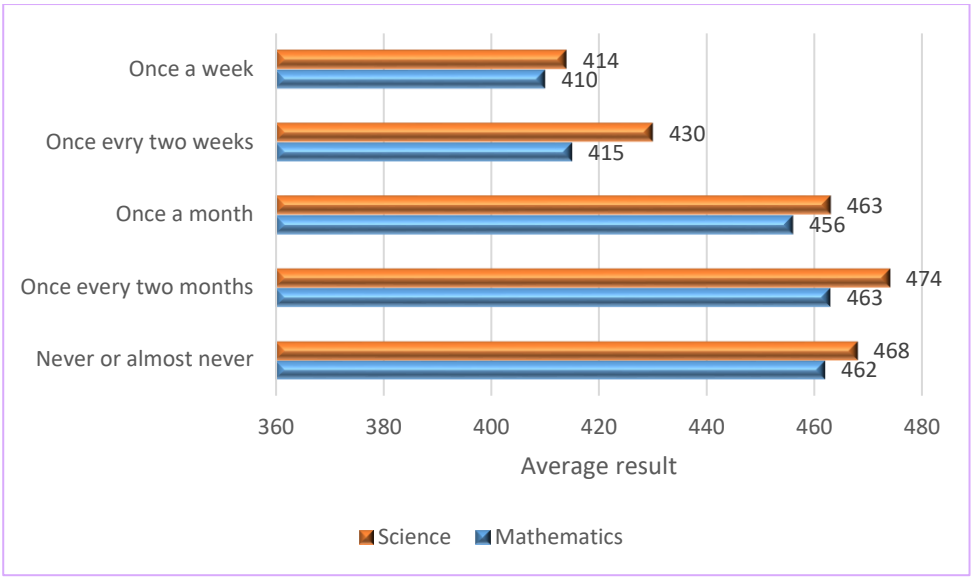
Absenteeism, disciplinary problems and school environment

The schools that can provide students with focused work and teaching and give better opportunities for teachers to meet their educational goals deal less with students' problems and have more chances for better student achievement. Frequent absenteeism deprives students of the opportunity to progress in learning. Students who miss classes need additional classes and help and that can negatively affect the course of classes, because students who are absent often ask other students for help in order to catch up with the material. In addition, students who do not miss out may have anger towards those students who miss out more often, or be compassionate. Thus, the absenteeism, due to these and other reasons, can have negative effect on student academic achievement.

Apart from the numerous school factors related to school resources, school climate and leadership found was that, at the level of BiH, the absenteeism effects student achievement while disciplinary problems have no effect on student achievement, as identified by school principals.

Fourth graders assessed how much they missed classes by following categories of frequency: *once a week, once every two weeks, once a month, once every two months, never or almost never.*

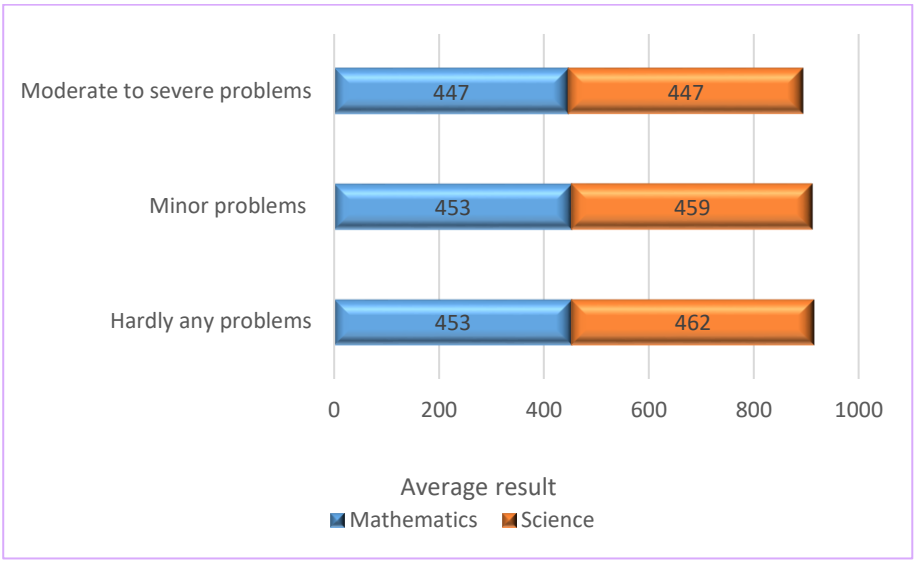
Exhibit 3.25 Student achievement in mathematics and science vs frequency of absenteeism



About 61% of fourth-graders *never or almost never* miss the classes and the achievement of these math students is significantly better than of students who miss more often, *once a week or once every two weeks.* About 13% of students are absent *once every two months* and their performance is also significantly better than of students who are absent *once a week* or *once every two months.* About 9% of students are absent *once a month* and these students achieve average success in mathematics significantly lower than students of categories *once a week* and *once every two weeks*. About 4% of students, or 13% of students, are absent *once every two weeks*, or *once a week*. The situation is similar in science.

School principals assessed the extent to which some of the following forms of behavior among fourth-graders posed a problem at school: a) Arriving late at school, b) Absenteeism, (e.g. unjustified absences), c) Classroom disturbance, d) Cheating, e Profanity, f) Vandalism, d) Theft, h) Intimidation or verbal abuse among student (including texting, emailing, etc.), i) Physical injury to other students, j) Intimidation or verbal abuse of teachers or staff (including texting, emailing, etc.). Students are classified into three categories according to the statements of school principals on 11 potential problems on the scale of school discipline. Students in the category with *hardly any problem* scored at or above 9.7 on the scale which corresponds to the principal's answers to 6 out of 11 questions in the category *no problem* and for the other 5 in the category *minor problem*, on average. Students in a school with moderate to severe problem scored at or below 7.6, which corresponds to the principal's reporting that 6 out of 11 problems are *moderate problem* and the other five are *minor problem*, on average. All other students are in schools with *minor problems*.

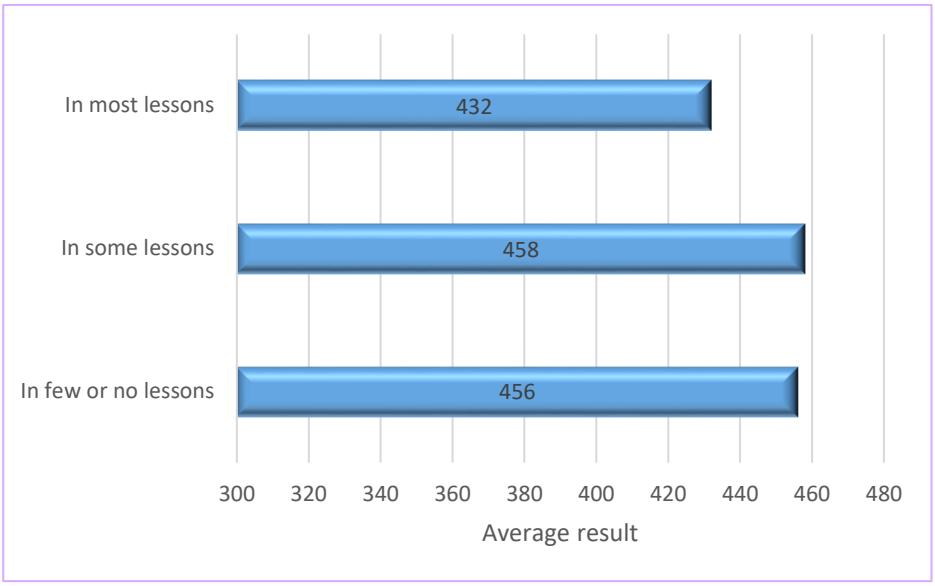
Exhibit 3.26 Student achievement vs disciplinary issues, according to the school principal statements



About 55% of fourth grade students in BiH attend schools with *hardly any* disciplinary *problems*, while 16% of students in schools have major disciplinary problems. In BiH, the average score on the school discipline scale is 9.6, which means that school discipline problems are in the category of *minor problems*. Compared to the surrounding countries, Serbia has similar, 9.7 scale score, while Albania leads internationally, with scale score 10.9. Although there is a scale score difference of student achievement in mathematics and science in schools with *hardly any problems* and schools with *minor problems*, this difference is not statistically significant compared to student achievement of school who *face moderate to severe problems*. Therefore, disciplinary problems are not significant factor in student achievement in mathematics and science among fourth grade primary school students in BiH.

Fourth graders gave estimates on how often student behavior interferes with the teaching process in math classes. The questions referred to the fact that students do not listen to the teacher, that there is disruptive noise, the teacher has to wait until students get quiet, students interrupt the teacher and the teacher has to repeat the rules in the classroom. Students were classified into three categories of their disorderly behavior in mathematics lessons based on student perception. Students who reported little or no disorderly behavior scored at or above cut score 11.6 on the scale, which corresponds to reporting that 3 out of 6 situations never happen, and that 3 situations happened *in some lessons,* on average. Students who estimated disorderly student behavior is present *in most lessons* scored at or below cut score 8.0 and this corresponds to reporting that 3 out of 6 situations occured in every or almost every lesson and the other 3 situations are present in approximately half lessons, on average. All other students are in the category *in some lessons.*

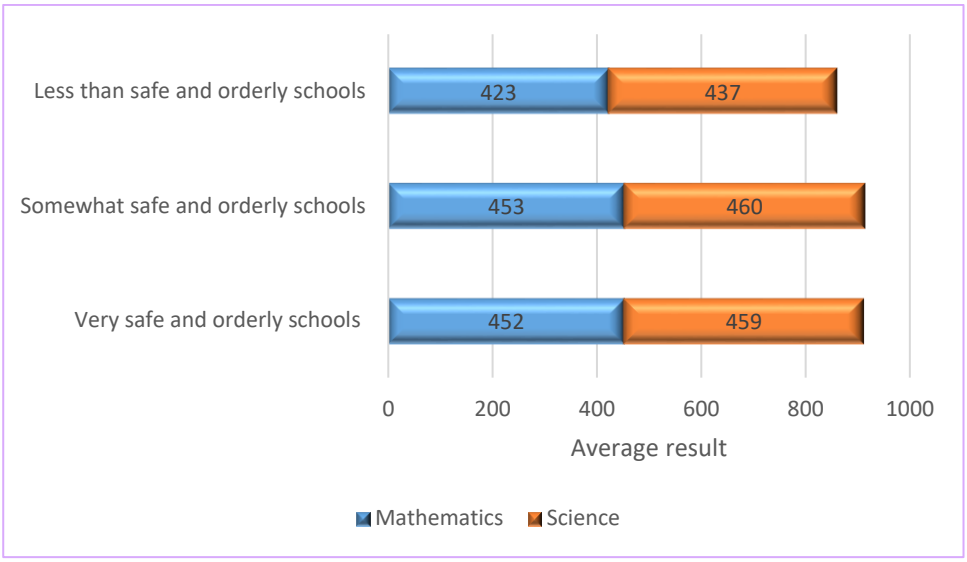
Exhibit 3.27 Achievement in mathematics vs disruptive behavior in mathematics classes



The majority of students, 62%, state that in mathematics lessons there is disruptive behavior in some classes. The average score on the scale for BiH is 9.9. With the exception of Croatia, which has the same score on the scale as BiH, students from other surrounding countries assessed their behavior in math scoring better on the scale, but they are in the same category as BiH. Students exposed to the teaching of mathematics without or with very few forms of disruptive teaching or disruptive behaviors in some classes, achieve significantly better results than students exposed to the teaching of mathematics burdened with behaviors not conducive to learning.

Teachers of fourth grade students assessed school environment in terms of safety, students' behavior towards teachers, and established rules of conduct at school. Teachers assessed following inquiries: a) This school is located in a safe neighborhood, b) I feel safe at this school, c) This school's security policies and practices are sufficient, d) The students behave in an orderly manner, e) The students are respectful of the teachers, f) The students respect school property, g) This school's rules are enforced in a fair and consistent manner, h) The rules of this school are applied in a correct and consistent manner. Students were classified into three categories on the scale of safety and good behavior in school, based on teacher perception. Students in *very safe and orderly schools* scoreed at and above cut score 9.9 which corresponds to the teachers 'answers *agree a lot* with 4 out of 8 statements, and *agree a little* with other 4 statements, on average. Students in *less than safe and orderly schools* scoreed at or below 6.8, which means that teachers rated 4 out of 8 statements at the level of *disagree a little*, and the other 4 at the level of *agree a little*. All other students are in the category of *somewhat safe and orderly schools.*

Exhibit 3.28 Student achievement vs school environment, by teacher statements



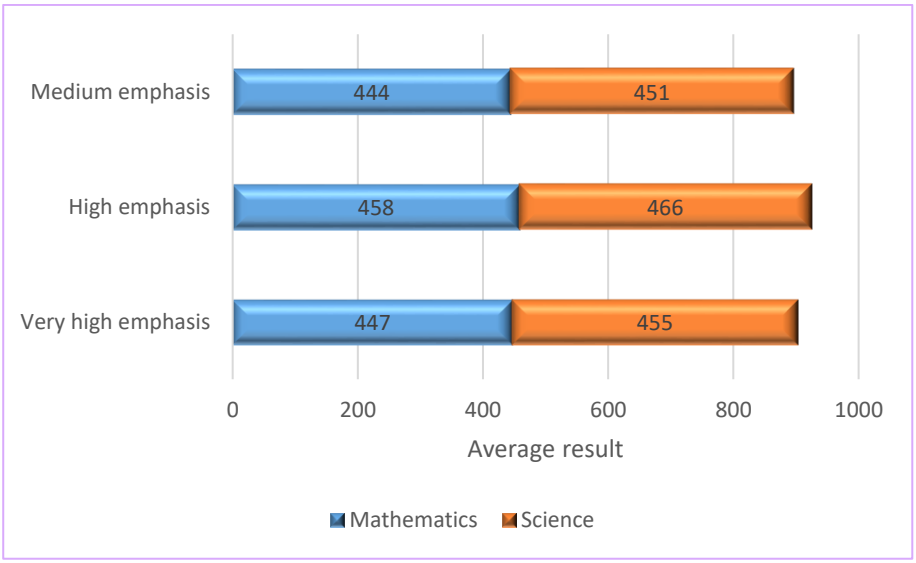
The finding that the vast majority, 80% of fourth grade students in BiH, attend schools that are *very safe and orderly* with the climate of respect and adherence to the rules is encouraging. According to the average score on the scale of safety and good behavior in school, which is 11, 2 scale score, BiH is at the top of the international level, which means that on average most students attend schools that have safe school environment. This variable has no effect on student achievement, and it should be taken into account that only 1% of students attend *less than safe and orderla schools* and this is not a percentage that is taken as sufficient to compare with other categories.

School Emphasis on Academic Success

School principals reported on how focused their school was in regard to academic achievement by estimating *very high, high, medium, low*, *very law* these 11 statements: a) Teacher's understanding of school curriculum goals, b) Teachers' degree of success in implementing the school's curriculum, c) Teachers 'expectations for student achievement, d) Teachers' ability to inspire students, e) Parents' involvement in school activities, f) Parents' commitment to ensure that students are ready to learn, d) Parents' expectations for student achievement, h) Parental support for student achievement, i) Students' desire to to do well in school, j) Students' ability to reach academic schools' academic goals, k Students' respect for classmates who excel academically.

Students are divided into three categories, so that students in schools with *very high emphasis* on academic achievement have at least 13 scale score on the scale, which corresponds to the answers of the principal *very high* for 6 statements and *high* for other 5 statements, on average. Students in schools with *medium emphasis* on academic achievement scored 9.2 or less on the scale corresponding to the principal's answers *medium* for 6 out of 11 statements and *high for* other 5 statements, on average. All other students are in the category of *high emphasis* regarding the academic success in school.

Exhibit 3.29 Average result in mathematics and science vs school emphasis on academic success



The average score on the scale for BiH is 9.8 scale score, which means that students in BiH, on average, are in schools with *high emphasis* on academic success. Considering the countries in the region, Croatia has higher average score on the scale, 10 scale score, Kosovo, 10.1 scale score, Albania, 10.2 scale score, Montenegro, 10.3 scale score. Best results in mathematics and science are achieved by students with *high emphasis* on academic success. The majority of students, 51%, attend schools with this academic success orientation. There are differences in scale score between the three categories, but significance was determined in both examined areas for categories of *high emphasis* and *medium emphasis* regarding student academic achievement.

Student Bullying

Student bullying is a term we often encounter in everyday life. It takes many forms, and each of us defines the boundaries of acceptable behavior differently. Student bullying is a specific type of aggressive behavior in which one can intentionally and repeatedly inflict harm and discomfort on another person (Olweus, 1993). Verbal, interactive and physical violence are classified as traditional forms of student bullying. Cyberbullying is another type of violence and it is mostly a continuation of traditional forms of violence and occurs after school. TIMSS asked students to state the type and frequency of bullying during the school year: a) Made fun of me or gave me derogatory names, b) Left me out of their games or activities, c) Spread lies about me, d) Stole something from me, e) Damaged something of mine on purpose, f) Hit or hurt me (e.g., shoving, hitting, kicking), d) Made me do things I didn't want to do, h) Sent me nasty or hurtful messages online, i) Shared nasty or hurtful messages about me online, j) Shared embarrassing photos of me online, k) Threatened me.

Table 3.5 Exposure to peer bullying at school by student statements

Country	Never or almost never		About monthly		About weekly		Average score on scale
	Student percentage	Achievement mathematics/ science	Student percentage	Achievement mathematics/ science	Student percentage	Achievement mathemtaics/ science	
International average	63	512/503	29	495/486	8	451/437	
Albania	85	500/495	12	480/481	3	404/398	11,3
Croatia	73	513/527	22	506/521	5	476/500	10,4
North Macedonia	68	574/445	28	556/412	4	501/355	10,1
Montene-gro	81	461/460	15	438/444	4	391/390	11,1
BiH	78	458/465	17	446/455	5	402/410	10,8
Kosovo	82	453/424	13	435/396	5	368/326	11,1
Serbia	83	513/522	15	497/505	3	443/451	11,1

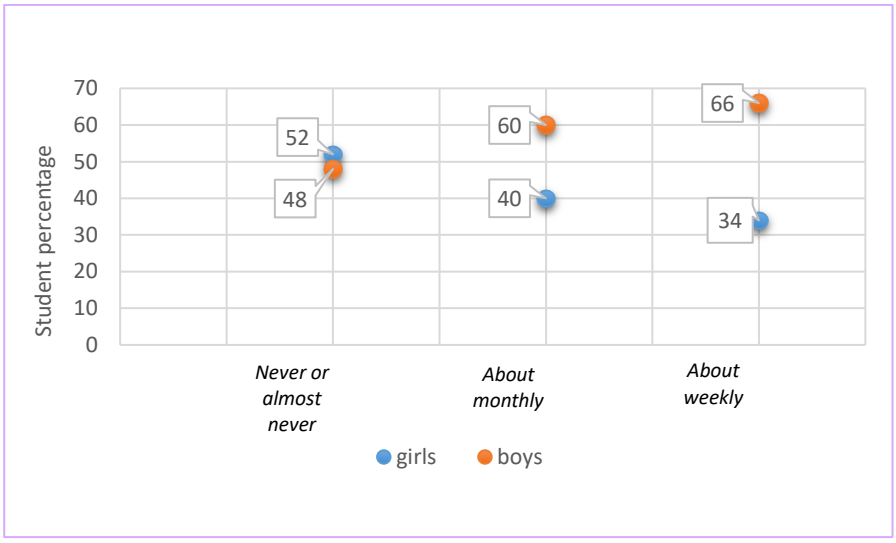
Based on their statements, students are categorized as *never* or *almost never* if they scored at or above 9.2 on the Student Bullying scale, which corresponds to never experiencing 6 out of 11 behaviors of student bulling and 5 others A few times a year, on average. Students are exposed to student bullying *about weekly* if they scored at or below 7.4 on the scale, meaning they have experienced 6 behaviors of violence once or twice a month, and the other 5 a few times a year. All other students are in the category *about monthly*.

According to the data in the table, most fourth grade students in BiH *never* or *almost never* were exposed to student bullying. According to the average score on the Student Bullying scale, BiH is one of the countries in which, on average, students are *never* or *almost never* exposed to any form of student bullying. This variable has effects on student achievement and students in the category *never or almost never* have statistically significantly better achievement compared to student achievement in other two categories. Also, students who have approximately *about monthly* experience with some form of student bullying achieve statistically significantly better results than students who have such experience *about weekly.*

When we talk about student bullying among boys and girls, on average, boys are more likely to report exposure to student bullying. This is especially true for students with experience of student bullying on a monthly or weekly basis (Figure 3.30)

This is a clear signal that schools need to have their own policies to stop student bullying, as well as to act in the event of these outbreaks. In BiH, there is an Action Plan for Children of BiH 2015-2018 with measures related to the development of curricula on violence against and among children in undergraduate and postgraduate studies at some faculties, including an initiative to introduce education on all forms of violence in primary and secondary school curricula, child abuse and neglect, how to report these forms and what protections to take. The Guidelines for dealing with violence against children in BiH, issued in 2013 by the Ministry of Human Rights and Refugees, and the Strategy for Combating Violence against Children in BiH 2012-2015 are the documents that schools can use to guide their policies on student bullying issues.

Exhibit 3. 30 Exposure to bullying by gender



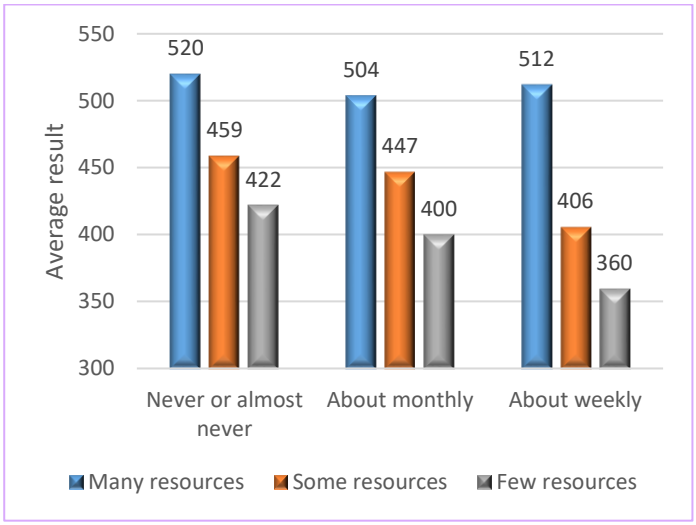
It is interesting to examine the differences in exposure to student bulling among students of urban and rural schools.

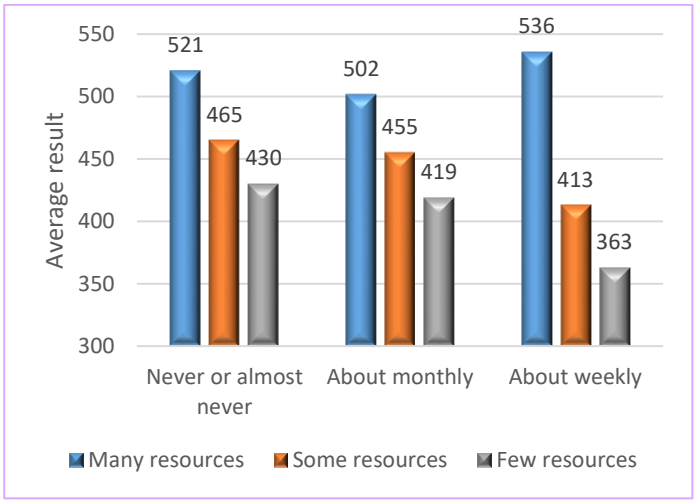
Table 3.6 Student exposure to student bullying by urban and rural schools

Domain		Never or almost never		About monthly		About weekly	
		Student percentage	Average result	Student percentage	Average result	Student percentage	Average result
Mathematics	urban	60	464	56	453	67	398
	ruraln	40	450	44	435	33	411
Science	urban	60	471	56	461	67	406
	ruraln	40	456	44	447	33	416

In BiH, there is a higher exposure to student bullying among students in urban schools, especially in the category of exposure about weekly. Students who are exposed to student bullying *about weekly* or *about monthly* score significantly lower in math than students who are *never* or *almost never* exposed to student bullying. Also, students of urban schools, compared to students of rural areas, achieve significantly better results if they are *never* or *almost never* exposed to student bullying or it occurs *about monthly.* In science, this is only the case in the *never* or *almost never* category. Students who are more often exposed to student bullying, especially if the frequency is *about weekly*, perform worse, statistically significantly lower than students from the category *about monthly, never* or *almost never*, and it is significant for the category *about weekly*. In BiH, fourth-grade students' exposure to student bulling is related to the academic performance. More frequent exposure to student bullying negatively affects academic achievement.

Exhibit 3.31 Mathematics and science achievement by exposure to student bullying and the level of home learning resources





Within *many resources* category, there are no statistically significant differences in achievement between students of any category of student bullying. It is important to emphasize that students from the category of *many resources* achieve the average result in mathematics and science, which is in the category of intermediate benchmark. In the category of *some resources*, there are statistically significant differences in science achievement between students who are *never* or *almost never* exposed to student bullying compared to students who are exposed *about monthly* or *about weekly*.

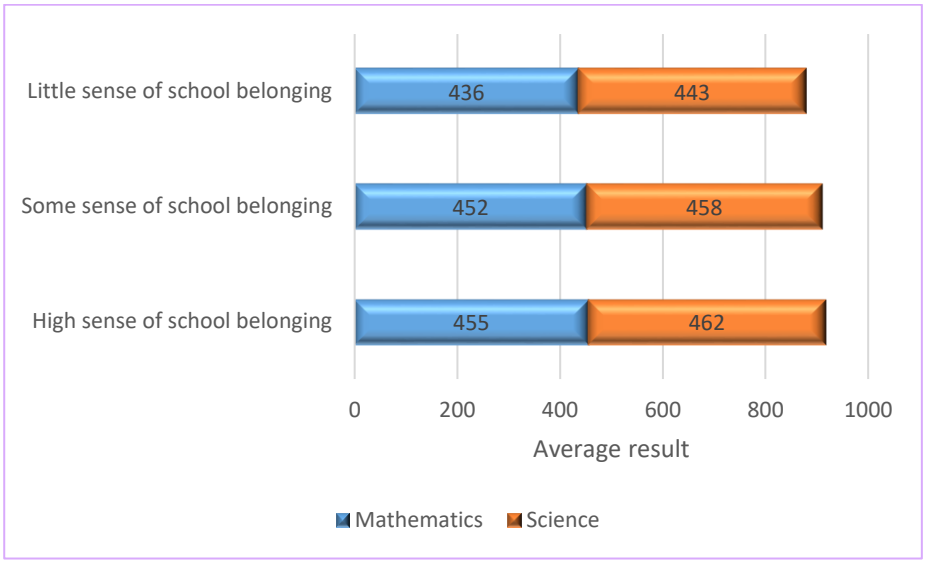
Students' Sense of School Belonging

A sense of school belonging is defined as a sense of acceptance and liking by others, and a sense of belonging to community (Baumeister & Leray, 1995; Maslow, 1943). Young people need to have social connections, appreciated acceptance, care, and support by others. When they are in school, it is important for students to feel they belong to their community, because it supports the feeling of security, identity, togetherness, and positively affects all aspects of development.

Measuring students 'sense of belonging in TIMSS 2019 survey is based on students' answers to questions: a) I like being in school, b) I feel safe when I am at school c) I feel like I belong at this school, d) Teachers at my school are fair to me, e) I am proud to go to this school. Students are divided into three categories: in the category of *high sense of school belonging* are students who scored at or above 9.6 on

the School Belonging Scale, which corresponds to a*gree a lot* for 3 out of 5 statements and for other two statements *agree a little,* on average. Students in *little sense of school belonging* category scored at or below 7.2 on the scale, which corresponds to *disagree a little* for 3 out of 5 statements and for other two statements *agree a little*. All other students are in the category of *some sense of school belonging.*

Exhibit 3.32 BiH student achievement vs the sense of school belonging



The average score on the School Belonging Scale for BiH is 10.5 scale score, which means the average fourth grade student in primary school in BiH has a *high sense of school belonging*. The countries in the region, with the exception of Croatia, on average, have students of this age with a *high sense of school belonging,* with Albania, Kosovo, North Macedonia and Montenegro at the top of the scale. Students in BiH with *little sense of school belonging*, 6% of them, achieve the lowest average results in mathematics and science and there is statistically significant difference in achievement compared to students with *some and high sense of school belonging*. About 68% of students in BiH express *high sense of school belonging.*

Whatever the link to academic success, a sense of belonging and acceptance in school is very important for adolescents 'self-esteem and their overall life satisfaction (Juvonen, 2006). A sense of connection to school contributes to fewer opportunities for risky and antisocial behavior to occur (Catalano et al. 2004; Hawkins & Weis, 1985).

Homework

Homework is defined as any assignment given to students by teacher that should be done outside of school, that is, during non-school hours (Cooper, 1989). Homework is part of schooling, and its purpose is to help students develop awareness of work, work habits, and independence. Many studies on homework have been conducted, covering a wide range of methodologies and degrees of specificity (Bloom 1984, Cooper 1989, Hattie 1992, Coper; Robinson & Patall 2006). With rare exceptions, the relationship between the amount of homework assignments and the results of student achievement was found to be positive and statistically significant. Many of these studies have shown that homework improves academic achievement. When asked about the frequency of homework in mathematics, teachers could answer that they *do not give homework* or that they do it *less than once a week*, *1 or 2 times a week*, *3 or 4 times a week* and *every day*. The largest percentage of students in BiH attend classes with teachers who assign homework for both tested areas *3 to 4 times a week*. In mathematics there is no significance to achievements according to higher frequency of homework, while in science it exists for

category *3 or 4 times a week* and *every day* in favor of the first category. This indicates that homework should be given with purpose, to refer to new content, to practice skills or processes that students can do independently, to provide students with opportunity to explore topics of their own interest.

When it comes to the time needed to do the homework, the largest percentage of students attend classes with teachers who estimate that it takes 16-30 minutes to do the homework.

There is tendency for the required homework time to give best results in both tested areas. This indicates that teachers should optimally plan the time for completing the assignment according to the student age, characteristics and abilities.

The question of teacher giving feedback to homework is challenging, since the feedback feature as a tool for increasing the impact of homework on students' learning and academic achievement. The practice of fourth grade teachers in BiH can be determined based on teachers' answers to questions on how they handle homework, whether they give feedback, discuss or monitor how homework is done. The answers are *always* or *almost always*, *sometimes, never or almost never.*

Table 3.7 Keepeing track of homework assignements in math and science and giving feedback

	Always or almost always		Sometimes		Never or almost never	
	Percentage	Average result mathematics/ science	Percentage	Average result mathematics/ science	Percentage	Average result mathematics/ science
Correct assignments and give feedback to students	55	449/456	44	456/463	1	427/437
Discuss the homeworkin class	59	455/463	41	448/454	0	
Monitor whether or not the homework was completed	95	453/460	5	434/438	0	

As for giving the feedback to homework in both tested areas, the largest percentage of students have teachers who *always* or *almost always* perform these activities. There is statistically significant difference in student achievement in science in the category *always* or *almost always* compared to the category *sometimes* when it comes to monitoring whether homework has been done. The situation is similar in mathematics.

Experience and Formal Education of School Principals

The school questionnaire included questions related to the experience and education of school principals. In BiH, the largest number of students, 57%, attend schools in which school principals have less than 5 years of experience as a school principal. About 29% of students attend school where principals have at least 5 and at most 10 years of experience in managing the school community, 12% of students are in schools where principals have at least 10 and at most 20 years of principal experience, and only 1% of students attend schools where principals have 20 or more years of principal experience. According to these data, BiH is in the rank of countries with a lower average number of years of experience of principals in the position of school principal. The average for BiH is 5 years. In the surrounding countries, school principals in North Macedonia have fewer years of experience, on average, 4 years. The TIMSS average is 10 years.

Regarding the level of formal education of school principals, 17% of students attend schools where principals have a postgraduate degree (master's degree, specialist, master's degree or doctor of science). The largest number of fourth grade students in BiH attend schools where principals have obtained a diploma of basic higher education, but 6% of students also attend schools where principals do not have a higher education degree. About 7% of students attend schools where school principals hold a postgraduate degree in leadership or management in education. In Croatia, as many as 96% of students are in schools where principals have a postgraduate degree.

3.1.5 Relationship between School Equipment and Student Achievement

This part of the report deals with school resources from the perspective of school principals. So far, TIMSS results have shown a link between student achievement and school equipment, so that students in better equipped schools also show better performance in mathematics and science compared to peers in poorly equipped schools (Hoope, Mullis & Martin 2013).

In School Questionnaire, in TIMSS 2019 survey, principals answered a set of questions related to the demographic characteristics of students, organization and conduct of teaching, resources and technology, discipline and safety in school.

Questions about resources refer to general resources in the school, and to those that are necessary for the realization of teaching mathematics and science. The first group of resources includes teaching aids, school buildings, heating, cooling systems, audiovisual teaching aids, computer technology (computers, tablets for students) and equipment for students with disabilities. The second group of resources consists of computer programs for teaching mathematics and science, equipment for teaching science and materials for performing experiments. In addition, the principal was asked to answer questions about whether the school had a science lab, a school library, and the approximate number of books available, as well as whether students were provided with access to digital learning resources.

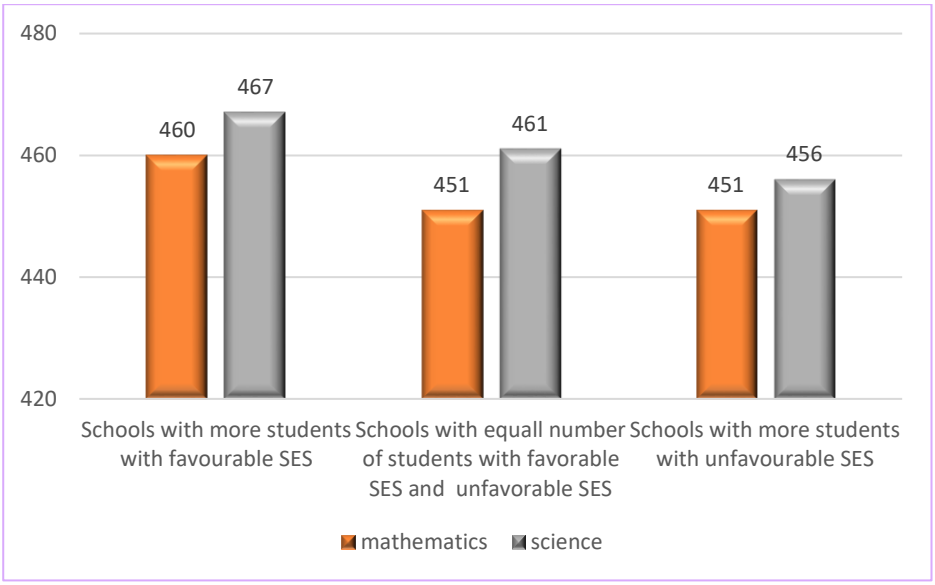
Data from TIMSS 2019 show that schools in BiH are less well equipped than the international average, and the situation is similar in the surrounding countries. For example, in Singapore, whose students do best in math and science, schools have an average of 224 computers for fourth-graders, while the international average is 40 computers. These data are important, because we live in a society that is developing technologically very quickly and is technologically oriented. In addition to owning digital devices, it is especially important that teachers are trained to use educational technologies in teaching in a quality way.

In BiH, according to school principals, 14% of students attend schools with science laboratories used by fourth graders and the average achievement of these students are slightly better than of students in schools where there are no such opportunities, but the difference is not significant. In high-achievement countries, such as Singapore, Japan, Chinese Taipei, Korea Rep., there are laboratories in all schools covered by the survey, while in the surrounding countries in Montenegro, Kosovo and Albania, the situation is better than in BiH. There are about 20% of students who attend schools where there are science laboratories used by fourth graders. An online management system for supporting the learning and teacher-student communication with access to teaching materials and the like, according to school principals, exists in 26% of schools. Some 99% of schools have a school library, with 77% of schools having less than 2,000 different titles, excluding magazines and periodicals. The school practice of having a library in the classroom was recorded in very few schools in BiH, only 4% of schools. About 50% of schools provide students with access to digital learning resources (books, videos).

It is interesting to consider the school structure according to the socio-economic status of students, based on the answers of school principals. School principals answered the question on the percentage of students who come from materially weaker or better standing families. A composite variable was created so that better-off schools are those where more than 25% of students come from economically better-off families and no more than 25% of students come from economically poorer families. The schools in which more than 25% of students are from economically poorer families and no

more than 25% of students come from better-off families go to the category of materially poorer-standing schools. The category of school with students of neither favorable nor unfavorable material condition presupposes all other possible combinations.

Exhibit 3.33 School structure vs student socio-economic status by school principal assessment



In BiH, about 44% of students attend schools that have more students *with favorable* than *unfavorable SES* while 22% of students attend schools where there are more students with *unfavorable* than *favorable SES.* While the students, who attend schools in which there are more students with *favorable* than with *unfavourable SES*, achieve better results in mathematics and science, the score difference compared to other categories is not statistically significant.

3. CONCLUSIONS AND RECOMMENDATIONS

This part of the report adresses the TIMSS 2019 survey key findings in BiH and the possibilities of educational implications based on these findings. For decision-makers in education, as well as for parents, improving educational achievement in schools is a priority of education policy.

– *Low achievement of fourth grade students*. The achievement of the fourth-grade students from BiH in TIMSS 2019, in which BiH participated for the first time, is not satisfactory. The average result, in both domains, is at the low benchmark level. In regional context, BiH, also, had the lowest result, with slightly better average achievement in science than in mathematics. The average result in BiH is significantly lower than in the Asian and European best performing countries.

Regarding the distribution of student achievement by benchmark levels, there are as many as 24% of students in mathematics, and 22% in science, not reaching even the lowest level. In the region, only Kosovo has lower percentage of students at the low benchmark in mathematics. Nevertheless, in North Macedonia, Montenegro and Kosovo, the percentage of students who achieve low benchmark level in science is lower than in BiH. This category of students deserves special attention since the current teaching is insufficiently efficient for them and it is necessary to make changes in order to reduce the number of students who do not acquire basic mathematical and scientific competencies. Also, the percentage of students in BiH who can solve most demanding TIMSS items is very low, only 1% in mathematics and in science as well. This raises the question on whether schools recognize high achieveing students, pay enough attention to them and give them support in order to make the best use of their potential - for their own sake and for the benefit of the society as a whole. The system of monitoring, testing and assessing students should take into account students' prospects and individual differences. Still, organized are individual and additional classes, and extracurricular activities in schools. However, all of these forms need to be envisiged and planned to truly contribute to the improvement of student achievement. Educational goals should meet the specific needs of society and be represented in schools, subjects, and teaching.

– *The importance of early learning is indisputable*. Parents should be encouraged to engage in early learning activities and help develop literacy and mathematics competencies with their children. It is necessary to create additional parent education programs in terms of methods and aspects to help in developing literacy and mathematical skills, since the parents, in traditional approaches, held unrealistic expectations for their children. It is important that children communicate and receive speech stimulus in their family in the form of telling stories, retelling events, and conversations, for, all these represent opportunities for children to develop their literacy skills.

– *The contribution of attending preschool education.* Each year of preschool education contributes to the achievement at the end of fourth grade. It is recommended to increase pre-school coverage in early age, with special emphasis on three-year-olds. Having in mind the kindergarten differs from nursery program, we can say the length of stay in kindergarten is a significant factor of achievement in mathematics and science. In other words, the children who did not attend, or stayed only one year in kindergarten, have statistically significantly lower result in mathematics and science than the children who attended kindergarten for two, three, or more years. In addition to increasing the coverage, it is really important that developmental programs in preschool institutions are based on the Common Core of Preshool Comprehensive Developmental programs defined on learning outcomes, developed by the Agency for Pre-Primary, Primary and Secondary Education. Since the report analyzes student achievements in mathematics and science, recommended is to focus the following themes: the world around us, early numeracy, and science and technology in order to have best possible effects on student achievement in these domains in primary school. Also, recommended is to have ensured a systematic and continuous insight into the quality of work of preschool institutions and into the short-term and long-term impacts of early and preschool education on various developmental areas.

– *Addressing the difference between student achievement of advantaged* and *disadvantaged socio-economic status (SES)*. Every society should provide conditions for every child to have the experience of researching, creating and achieving best possible results, regardless of shortcomings that surround him. The fourth-grade students in BiH whose parents have higher levels of education achieve better results in mathematics and science. Students whose parents have more respected occupations (computer scientists, teachers, lawyers, artists, engineers, theologians, etc.) also achieve better results. Differences in home learning resources affect student achievement. Students in urban schools achieve better results than their peers in rural schools. As a responsible society, we need to act towards reducing educational inequalities. A series of affirmative actions such as: availability of preschool education, free test booklets, and extended stay in schools are the measures to support poor families. Additional funding is needed. Also, it is necessary to help families, schools and students who, due to economic and social difficulties, cannot follow the academic progress of their peers. Investing in intellectual capital is directly related to the progress of many human aspirations be it intellectual, economic, social or cultural. Education in BiH requires more attention and much more than just theoretical changes. Ignoring the investment in education, as a form of investing in human resources, leads to stagnation and backwardness of society, because there is no activity that systematically creates new jobs and provides opportunities for young people to work and make progress.

– *The Quality of teaching and teaching staff*. Although the years of work experience of fourth grade primary school teachers are not a significant factor in student achievement, it is evident that students of teachers with the least experience, 5 years or less, have the worst achievement. Obviously, these teachers need much more support than they have. First, it would be important that they come out of their teaching studies much stronger, that the programs of their studies are updated, that they follow changes in pedagogical and methodological aspect of teaching, that they are able to use a wide range of monitoring and evaluating tools, and that they are familiar with the reforms taking place in education. Then, when they start teaching, the schools, colleagues, and pedagogical institutions should act as their advisors, mentors, but also critics, in order to make them become high-quality teachers. The teachers in BiH, in TIMSS study, expressed the need for training on ICT integration in teaching. The system needs to recognize teachers' needs, take them seriously and realize them. The approach to lifelong learning and the concept of learning society is a response to these needs and modern educational policy should encourage the development of various forms of adult education. Generally, teachers should be asked more often about their needs in additional trainings, because the offered ones are neither based on teachers' needs nor well organized, missing the continuity.

– *Modern teaching* should be set up so students learn to research independently, find new knowledge and adopts them with interest and reason in order to apply them in everyday life. The principle of engaging teaching, which is reflected in the fact that students know what is expected of them and that they have clear answers from teachers who help them learn and re-explain what is not clear, includes all the factors that affect student achievement in BiH. The increased engagement of students during classes means the usage of active learning methods while it is necessary for teachers to organize professional development programs on the topics.

– *Absentism from classes negatively affects student achievement.* Students' absentism from classes negatively affects both the individual and society. Absenteeism is a serious and complex problem, because it can cause disorders in the maturation of students and their experience of obligations. It should be further investigated how much adults contribute to this phenomenon and whether they support this behavior. Although 61% of students state they never or almost never missed a class during the school year (by the time they were tested, June 2019), about 17% of students say they were absent at least once every two weeks and the performance of these students was significantly lawer than of students who are not absent or almost never absent. Students should not experience absenteeism as a gain, so that those who are absent have better treatment. In particular, this phenomenon must not be associated in any way with the fear of assessment or the fear of educational measures.

– *Contribution of positive belief.* A positive belief in mathematics and science contributes to the fourth-grade student achievement in BiH. It is necessary to continue to build up these beliefs in the next generations of students, so that they are not lost or diminished in higher levels of education.

– *Disruptive behaviors in the classroom affect student achievement.* Goal-oriented teaching requires controlling the noise and clutter in the classroom, creating a climate that is positive and motivating where all students can hear the teacher and dedicate themselves to the tasks. There is no fear in modern classroom, it is about the behavior where the order and work atmosphere prevail, and where there is a dialogue between teachers and students seeking additional clarifications and freedom of expression. About 62% of students state that in some math classes there is atmosphere not conducive to learning. Since disruptive behavior affects achievement, more conducive learning atmosphere is needed in the classroom.

– *Student bulling affects student achievement*. In BiH, primary school fourth grade boys are more exposed to the various forms of student bulling than girls. Violence is more common in urban schools. In good standing family environments, i.e., environments with amany learning resources, there are no significant differences in student achievement between any category of student bulling. In the category some resources, there are statistically significant differences in achievement in science, between students who are never or almost never exposed to violence compared to students who are exposed to violence on a monthly or weekly basis. Schools, especially professional services, should work to ensure the peer conflicts do not turn into violence. It is necessary to talk on how to treat others with respect in the class. A list of class rules can be developed on how to treat someone with respect. Also, discussed can be how to receive and give apologies or how to learn from mistakes. Every school should have an elaborated protocol on dealing with the cases of violence among children.

– *Homework assignments.* Although homework assignments have not shown significant effects on student achievement in mathematics and science, its impact should not be neglected. Homework should be designed to maximize chances to be completed by students, which means that it should be given at the appropriate level of difficulty. Anyway, students should practice new material and gain a sense of security in mastering them. Students should do homeworks independently while parents can be involved appropriately. They are not to act as teachers, but to help students summarize what they learned by doing homework.

– *Changes in the curriculum towards the learning outcomes-based curriculum*. Necessary are changes in mathematics and science curricula, and this change should be based on the Common Core Curricula defined on learning outcomes, developed by the Agency for Pre-Primary, Primary and Secondary Education, with special focus on mathematics and science. It is necessary to gradually introduce the examples of items used in TIMSS study and to train teachers on how to develop such items. There are databases of TIMSS items publicly available on the IEA Agency websites. The mathematics curriculum from first to fourth grade can be enriched with the new topics that are, otherwise, represented in the curricula of the TIMSS survey participating countries. Also, it is necessary to pay more attention to the acquisition of knowledge and skills in geometry, teaching practice and teacher education. The Data domain should be included in primary school curriculum for all grades, with different requirements, while primary school teachers should be trained to adequately teach and relate this domain to other subjects. Also, mathematical reasoning should be included in math education, being vital to acquiring mathematical literacy. Students from countries achieving best results in mathematics, such as Singapore, Hong Kong, Korea, Rep. and Japan, learn topics on probability and statistics early in education. In Singapore, statistics and probability are studied as concepts from the first grade of primary school. Students are first introduced to the tables and graphical representations of the data and then they use them to solve problems. After the sixth grade, they deal with the interpretation and analysis of various statistical representations and determination of probabilities. Hong Kong has a slightly different approach, so initial mathematics is taught as part of general skills applicable in different life situations. An important content domain is Data handling, which includes statistics and, from sixth grade, probability. Korea, Rep. has a similar approach, math education begins with teaching statistics,

and in sixth grade, probabilities. In Japan, in the first six grades there is no prominent unit of probability and statistics, but some topics in this area are covered within mathematical relationships, and in the eighth-grade probability and statistics are covered within the unit of making use of data. It is very important to know that "the following pre-mathematical skills are important in teaching statistics: classifying subjects according to a certain characteristic, comparing, arranging and maintaining order, and orientation in a plane" (Glasnović Gracin, 2016). As another support for the introduction of statistics in the early grades of primary education, the teaching of statistics in many countries is realized within the teaching of mathematics, through experiments that correlate with science subjects, and other subjects. The development of technology inevitably requires the acquisition of new knowledge that students need to acquire in order to use them effectively in life situations. Statistics and probability are some of the most important mathematical areas that need to be learned. Hence, the education authorities in BiH, on behalf of the society, need to decide if new generations should master formal knowledge in mathematics or the mathematical knowledge that enables application in everyday life.

– *Supporting the development of higher cognitive domains.* The finding that students achieve best results in the cognitive domain of Reasoning is encouraging. Although student achievement in this cognitive domain is low, it is necessary to further empower teachers in a way that supports active learning and more frequent use of examples from everyday life to make students more successful in solving tasks that require application of science and mathematics knowledge in solving various problems. Also, it is very important that subject teachers create a teaching process that emphasize the application of knowledge and skills, so that the effects of classroom teaching in further schooling would not be lost. PISA 2018 survey in BiH confirmed that 15-year-old students in BiH do not have an average level of language, mathematics or scientific literacy, which implies the acquisition of key knowledge and skills necessary for full participation in social and economic life. Regarding the fourth-grade students who participated in the TIMSS 2019 survey and students to come, our society and education systems must not fail to timely intervene and make changes, in helping them become generations able to contribute to the success of social and economic processes in the best possible way. Based on the PISA, and similar studies, results the educational systems in BiH should establish the sound foundation to cope with the detected shortcomings.

– *At the system level, established should be mechanisms for monitoring the quality of education*. It is necessary to provide mechanisms for continuous systematic monitoring and improvement of education quality, both at the individual level and at the level of educational policies. To this end, it is necessary to conduct systematic and continuous studies on the quality of educational processes and institutions both at the state and at the international level. These studies, along with the indicators of the international surveys, would ensure more efficient recognition and use of the scientific research results, linking the outcomes to the educational practices.

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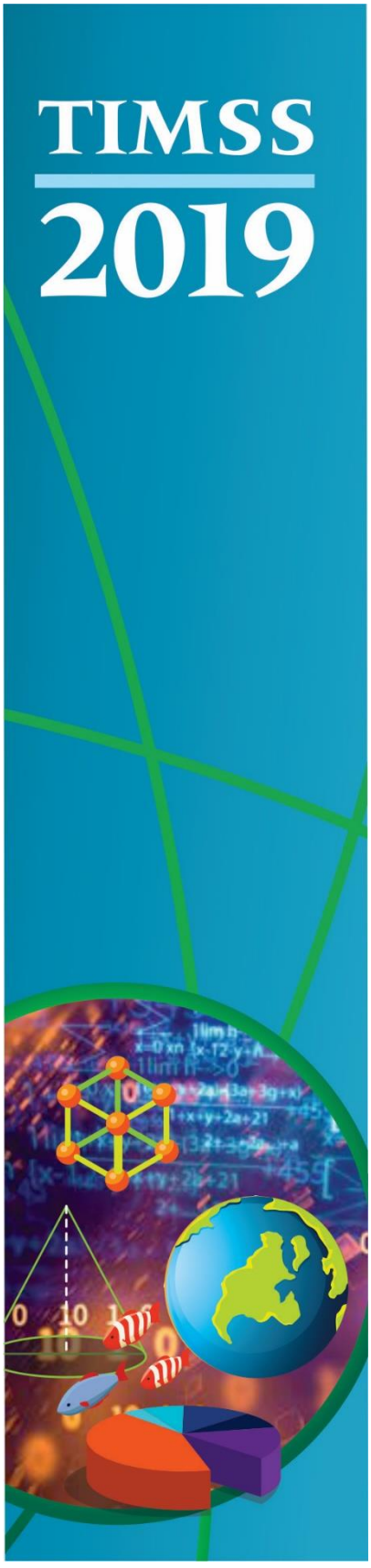
ANNEX



TIMSS 2019 Mathematics Content Domain

Whole numbers are the predominant component of the Number domain and students should be able to compute with whole numbers of reasonable size as well as use computation to solve problems. Pre-algebra concepts also are part of the TIMSS assessment at the fourth grade, including understanding the concept of variable (unknowns) in simple equations, and initial understandings of relationships between quantities. However, because objects and quantities often do not come in whole numbers, it is also important for students to understand fractions and decimals. Students should be able to compare, add, and subtract familiar fractions and decimals to solve problems.

Whole Numbers

1. Demonstrate knowledge of place value (2-digit to 6-digit numbers); represent whole numbers with words, diagrams, number lines, or symbols; order numbers.
2. Add and subtract (up to 4-digit numbers), including computation in simple contextual problems.
3. Multiply (up to 3-digit by 1-digit and 2-digit by 2-digit numbers) and divide (up to 3-digit by 1-digit numbers), including computation in simple contextual problems.
4. Solve problems involving odd and even numbers, multiples and factors of numbers, rounding numbers (up to the nearest ten thousand), and making estimates.
5. Combine two or more properties of numbers or operations to solve problems in context.

Expressions, Simple Equations, and Relationships

1. Find the missing number or operation in a number sentence (e.g., $17 + x = 29$).
2. Identify or write expressions or number sentences to represent problem situations that may involve unknowns.
3. Identify and use relationships in a well-defined pattern (e.g., describe the relationship between adjacent terms and generate pairs of whole numbers given a rule).

Fractions and Decimals

1. Recognize fractions as parts of wholes or collections; represent fractions using words, numbers, or models; compare and order simple fractions; add and subtract simple fractions, including those set in problem situations. (Fractions may have denominators of 2, 3, 4, 5, 6, 8, 10, 12, or 100.)
2. Demonstrate knowledge of decimal place value including representing decimals using words, numbers, or models; compare, order, and round decimals; add and subtract decimals, including those set in problem situations. (Decimals may have one or two decimal places, allowing for computations with money.)

Measurement and Geometry

We are surrounded by objects of different shapes and sizes, and geometry helps us visualize and understand the relationships between shapes and sizes. Measurement is the process of quantifying attributes of objects and phenomena (e.g., length and time). The two topic areas in Measurement and Geometry are as follows:

- Measurement (15%)
- Geometry (15%)

At the fourth grade, students should be able to use a ruler to measure length; solve problems involving length, mass, capacity, and time; calculate areas and perimeters of simple polygons; and use cubes to determine volumes. Students should be able to identify the properties and characteristics of lines, angles, and a variety of two- and three-dimensional shapes. Spatial sense is integral to the study of geometry, and students will be asked to describe and draw a variety of geometric figures. They also should be able to analyze geometric relationships and use these relationships to solve problems.

Measurement

1. Measure and estimate lengths (millimeters, centimeters, meters, kilometers); solve problems involving lengths.
2. Solve problems involving mass (gram and kilogram), volume (milliliter and liter), and time (minutes and hours); identify appropriate types and sizes of units and read scales.
3. Solve problems involving perimeters of polygons, areas of rectangles, areas of shapes covered with squares or partial squares, and volumes filled with cubes.

Geometry

1. Identify and draw parallel and perpendicular lines; identify and draw right angles and angles smaller or larger than a right angle; compare angles by size.
2. Use elementary properties, including line and rotational symmetry, to describe, compare, and create common two-dimensional shapes (circles, triangles, quadrilaterals, and other polygons).
3. Use elementary properties to describe and compare three-dimensional shapes (cubes, rectangular solids, cones, cylinders, and spheres) and relate these with their two-dimensional representations.

Data

The explosion of data in today's information society has resulted in a daily bombardment of visual displays of quantitative information. Often the Internet, newspapers, magazines, test booklets, reference books, and articles have data represented in charts, tables, and graphs. Students need to understand that graphs and charts help organize information or categories and provide a way to compare data.

The Data content domain consists of two topic areas:

- Reading, interpreting, and representing data (15%)
- Using data to solve problems (5%)

At the fourth grade, students should be able to read and recognize various forms of data displays. Given a simple question, students should be able to collect, organize, and represent the data in graphs and charts to address the question. Students should be able to use data from one or more sources to solve problems.

Reading, Interpreting, and Representing Data

1. Read and interpret data from tables, pictographs, bar graphs, line graphs, and pie charts.
2. Organize and represent data to help answer questions.

Using Data to Solve Problems

1. Use data to answer questions that go beyond directly reading data displays (e.g., solve problems and perform computations using data, combine data from two or more sources, draw conclusions based on data).

TIMSS 2019 Science Content Domain

The practice of science is, by its very nature, strongly connected to the area of science under study and, therefore, cannot be assessed in isolation. Some items in the TIMSS 2019 science assessment at both the fourth and eighth grades will assess one or more of these important science practices together with content specified in the content domains and thinking processes specified in the cognitive domains.

Life Science

The study of Life Science at the fourth grade provides students with an opportunity to capitalize on their innate curiosity and begin to understand the living world around them. In TIMSS 2019, Life Science is represented by five topic areas:

- Characteristics and life processes of organisms
- Life cycles, reproduction, and heredity
- Organisms, environment, and their interactions
- Ecosystems
- Human health

By the fourth grade, students are expected to be building a base of knowledge about general characteristics of organisms, how they function, and how they interact with other organisms and with their environment. Students also should be familiar with fundamental science concepts related to life cycles, heredity, and human health that in later grades will lead to a more sophisticated understanding of how the human body functions.

Characteristics and Life Processes of Organisms

1. Differences between living and non-living things and what living things require to live:
    A. Recognize and describe differences between living and non-living things (i.e., all living things can reproduce, grow and develop, respond to stimuli, and die; and non-living things cannot).
    B. Identify what living things require in order to live (i.e., air, food, water, and an environment in which to live).
2. Physical and behavioral characteristics of major groups of living things:
    A. Compare and contrast physical and behavioral characteristics that distinguish major groups of living things (i.e., insects, birds, mammals, fish, reptiles, and flowering plants).
    B. Identify or provide examples of members of major groups of living things (i.e., insects, birds, mammals, fish, reptiles, and flowering plants).
    C. Distinguish groups of animals with backbones from groups of animals without backbones.

3. Functions of major structures in living things:

   A. Relate major structures in animals to their functions (e.g., teeth break down food, bones support the body, lungs take in air, the heart circulates blood, the stomach digests food, muscles move the body).

   B. Relate major structures in plants to their functions (i.e., roots absorb water and nutrients and anchor the plant, leaves make food, the stem transports water and food, petals attract pollinators, flowers produce seeds, and seeds produce new plants).

Life Cycles, Reproduction, and Heredity

1. Stages of life cycles and differences among the life cycles of common plants and animals:

   A. Identify stages of the life cycles of plants (i.e., germination, growth and development, reproduction, and seed dispersal).

   B. Recognize, compare, and contrast the life cycles of familiar plants and animals (e.g., trees, beans, humans, frogs, butterflies).

2. Inheritance and reproduction strategies:

   A. Recognize that plants and animals reproduce with their own kind to produce offspring with features that closely resemble those of the parents.

   B. Distinguish between features of plants and animals that are inherited from their parents (e.g., number of petals, color of petals, eye color, hair color), and those that are not (e.g., some broken branches in a tree, length of human hair).

   C. Identify and describe different strategies that increase the number of offspring that survive (e.g., a plant producing many seeds, mammals caring for their young).

Organisms, Environment, and Their Interactions

1. Physical features or behaviors of living things that help them survive in their environment:

   A. Associate physical features of plants and animals with the environments in which they live and describe how these features help them to survive (e.g., a thick stem, a waxy coating, and a deep root help a plant survive in an environment with little water; the coloring of an animal helps camouflage it from predators).

   B. Associate behaviors of animals with the environments in which they live and describe how these behaviors help them to survive (e.g., migration or hibernation helps an animal to stay alive when food is scarce).

2. Responses of living things to environmental conditions:

   A. Recognize and describe how plants respond to environmental conditions (e.g., amount of available water, amount of sunlight).

   B. Recognize and describe how different animals respond to changes in environmental conditions (e.g., light, temperature, danger); recognize and describe how the human body responds to high and low temperatures, exercise, and danger.

3. The impact of humans on the environment:

A. Recognize that human behavior has negative and positive effects on the environment (e.g., negative effects of air and water pollution, the benefits of reducing air and water pollution); provide general descriptions and examples of the effects of pollution on humans, plants, and animals, and their environments.

Ecosystems

1. Common ecosystems:

A. Relate common plants and animals (e.g., evergreen trees, frogs, lions) to common ecosystems (e.g., forests, ponds, grasslands).

2. Relationships in simple food chains:

A. Recognize that all plants and animals need food to provide energy for activity and need raw materials for growth and repair; explain that plants need sunlight to make their food, while animals eat plants or other animals to get their food.

B. Complete a model of a simple food chain using common plants and animals from familiar ecosystems, such as a forest or a desert.

C. Describe the roles of living things at each link in a simple food chain (e.g., plants produce their own food; some animals eat plants, while other animals eat the animals that eat plants).

D. Identify and describe common predators and their prey.

3. Competition in ecosystems:

A. Recognize and explain that some living things in an ecosystem compete with others for food or space.

Human Health

1. Transmission, prevention, and symptoms of communicable diseases:

A. Relate the transmission of common communicable diseases to human contact (e.g., touching, sneezing, coughing).

B. Identify or describe some methods of preventing disease transmission (e.g., vaccination, washing hands, avoiding people who are sick); recognize common signs of illness (e.g., high body temperature, coughing, stomachache).

2. Ways of maintaining good health:

A. Describe everyday behaviors that promote good health (e.g., a balanced diet, exercising regularly, brushing teeth, getting enough sleep, wearing sunscreen); identify common food sources included in a balanced diet (e.g., fruits, vegetables, grains).

Physical Science

At the fourth grade, students learn how many physical phenomena that they observe in their everyday lives can be explained through an understanding of physical science concepts. The topic areas for the Physical Science content domain at fourth grade are:

- Classification and properties of matter and changes in matter
- Forms of energy and energy transfer
- Forces and motion

Fourth grade students should have an understanding of physical states of matter (solid, liquid, and gas), as well as common changes in the state and form of matter; this forms a foundation for the study of both chemistry and physics in the middle and upper grades. At this level, students also should know common forms and sources of energy and their practical uses, and understand basic concepts about light, sound, electricity, and magnetism. The study of forces and motion emphasizes an understanding of forces as they relate to movements students can observe, such as the effect of gravity or pushing and pulling.

Classification and Properties of Matter and Changes in Matter

1. States of matter and characteristic differences of each state:
    A. Identify and describe three states of matter (i.e., a solid has a definite shape and volume, a liquid has a definite volume but not a definite shape, and a gas has neither a definite shape nor a definite volume).
2. Physical properties as a basis for classifying matter:
    A. Compare and sort objects and materials on the basis of physical properties (e.g., weight/mass, volume, state of matter, ability to conduct heat or electricity, ability to float or sink in water, ability to be attracted by a magnet). [Note: Students in the fourth grade are not expected to differentiate between mass and weight.]
    B. Identify properties of metals (i.e., conducting electricity and conducting heat) and relate these properties to uses of metals (e.g., a copper electrical wire, an iron cooking pot).
    C. Describe examples of mixtures and how they can be physically separated (e.g., sifting, filtration, evaporation, magnetic attraction).
3. Magnetic attraction and repulsion:
    A. Recognize that magnets have two poles and that like poles repel and opposite poles attract.
    B. Recognize that magnets can be used to attract some metal objects.
4. Physical changes observed in everyday life:
    A. Identify observable changes in materials that do not result in new materials with different properties (e.g., dissolving, crushing an aluminum can).
    B. Recognize that matter can be changed from one state to another by heating or cooling; describe changes in the state of water (i.e., melting, freezing, boiling, evaporation, and condensation).
    C. Identify ways of increasing how quickly a solid material dissolves in a given amount of water (i.e., increasing the temperature, stirring, and breaking the solid into smaller pieces); distinguish between strong and weak concentrations of simple solutions.
5. Chemical changes observed in everyday life:
    A. Identify observable changes in materials that make new materials with different properties (e.g., decaying, such as food spoiling; burning; rusting).

Forms of Energy and Energy Transfer

1. Common sources and uses of energy:
    A. Identify sources of energy (e.g., the Sun, flowing water, wind, coal, oil, gas), and recognize that energy is needed to move objects and for heating and lighting.

2. Light and sound in everyday life:

A. Relate familiar physical phenomena (i.e., shadows, reflections, and rainbows) to the behaviour of light.

B. Relate familiar physical phenomena (i.e., vibrating objects and echoes) to the production and behavior of sound.

3. Heat transfer:

A. Recognize that warmer objects have a higher temperature than cooler objects; describe what will happen when a hot object and a cold object are brought into contact (i.e., the temperature of the hot object decreases and the temperature of the cold object increases).

4. Electricity and simple electrical systems:

A. Recognize that electrical energy in a circuit can be transformed into other forms of energy (e.g., heat, light, sound).

B. Explain that simple electrical systems (e.g., a flashlight) require a complete (unbroken) electrical pathway.

Forces and Motion

1. Familiar forces and the motion of objects:

A. Identify gravity as the force that draws objects to Earth.

B. Recognize that forces (i.e., pushing and pulling) may cause an object to change its motion; compare the effects of these forces of different strengths in the same or opposite directions acting on an object; and recognize that friction force works against the direction of motion (e.g., friction working against a push or a pull makes it more difficult to move an object along a surface).

2. Simple machines:

A. Recognize that simple machines, (e.g., levers, pulleys, gears, ramps) help make motion easier (e.g., make lifting things easier, reduce the amount of force required, change the distance, change the direction of the force).

Earth Science

Earth Science is the study of Earth and its place in the Solar System, and at fourth grade focuses on the study of phenomena and processes that students can observe in their everyday lives. While there is no single picture of what constitutes an Earth Science curriculum that applies to all countries, the three topic areas included in this domain are generally considered to be important for students at the fourth grade to understand as they learn about the planet on which they live and its place in the Solar System:

- Earth's physical characteristics, resources, and history
- Earth's weather and climates
- Earth in the Solar System

At this level, students should have some general knowledge about the structure and physical characteristics of Earth's surface, and about the use of Earth's most important resources. Students also should be able to describe some of Earth's processes in terms of observable changes and understand the time frame over which such changes have occurred. Fourth grade students should also demonstrate some understanding about Earth's place in the Solar System based on observations of patterns of change on Earth and in the sky.

Earth's Physical Characteristics, Resources, and History

1. Physical characteristics of the Earth system:
    A. Recognize that Earth's surface is made up of land and water in unequal proportions (more water than land) and is surrounded by air; describe where fresh and salt water are found, and recognize that water in rivers or streams flows from mountains to oceans or lakes.
2. Earth's resources:
    A. Identify some of Earth's resources that are used in everyday life (e.g., water, wind, soil, forests, oil, natural gas, minerals).
    B. Explain the importance of using Earth's renewable and non-renewable resources responsibly (e.g., fossil fuels, forests, water).
3. Earth's history:
    A. Recognize that wind and water change Earth's landscape and that some features of Earth's landscape (e.g., mountains, river valleys) result from changes that happen very slowly over a long time.
    B. Recognize that some remains (fossils) of animals and plants that lived on Earth a long time ago are found in rocks and make simple deductions about changes in Earth's surface from the location of these remains.

Earth's Weather and Climates

1. Weather and climates on Earth:
    A. Apply knowledge of changes of state of water to common weather events (e.g., cloud formation, dew formation, the evaporation of puddles, snow, rain).
    B. Describe how weather (i.e., daily variations in temperature, humidity, precipitation in the form of rain or snow, clouds, and wind) can vary with geographic location.
    C. Describe how average temperature and precipitation can change with the seasons and location.

Earth in the Solar System

1. Objects in the Solar System and their movements:
    A. Identify the Sun as a source of heat and light for the Solar System; describe the Solar System as the Sun and the planets that revolve around it.
    B. Recognize that the Earth has a moon that revolves around it, and from Earth the Moon looks different at different times of the month.
2. Earth's motion and related patterns observed on Earth:
    A. Explain how day and night are related to Earth's daily rotation about its axis, and provide evidence of this rotation from the changing appearance of shadows during the day.
    B. Describe how seasons in Earth's northern and southern hemispheres are related to Earth's annual movement around the Sun.