



دائرة التعليم والمعرفة
DEPARTMENT OF EDUCATION
AND KNOWLEDGE

التسريبات والعلم وم

TRENDS IN INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

TIMSS 2019 SCHOOL REPORT

#9286 Garden City British School



Dear School Leaders,

In our commitment to ensuring students in Abu Dhabi receive a world-class education, we place great emphasis on international assessments that focus on STEM subjects essential in the pursuit of a knowledge-based economy. Standardized tests such as the Trends in International Mathematics and Science Study (TIMSS), conducted every four years, allow the academic achievements of Abu Dhabi Private Schools to be internationally compared and serve as a great tool to identify areas of improvement.

We would like to thank the 162 private schools who participated in TIMSS 2019. Your unwavering support has resulted in promising results for students in Grades 4 and 8 (Years 5 and 9) in both Mathematics and Science.

Since the last TIMSS cycle in 2015, there has been an improvement in private school scores especially in Grade 4 Mathematics. In addition, our Grade 8 girls are performing above the international average in Science, which bodes well for later tertiary studies in STEM subjects.

The data in your TIMSS 2019 School Report will allow your school to benchmark your results against other curricula, regions and international standards, and provide information for targeted improvement. We therefore encourage you to carefully review the data in your TIMSS 2019 School Report and take note of the recommendations for 'Next Steps' to identify areas for greater focus in your school. It is also worth noting that your TIMSS 2019 School Report will be shared with the Irtiqqa'a inspection team as a source of evidence to assist with the inspection process and future school visits.

Thank you for your continued support as we work together to improve educational outcomes for every student, and for your commitment to continually enhancing the performance of our private schools.

ADEK



TABLE OF CONTENTS

LIST OF FIGURES	•4
LIST OF TABLES	•4
SECTION 1: INTRODUCTION	
WHAT IS TIMSS?	•5
TIMSS 2019 ASSESSMENT FRAMEWORKS	•6
SAMPLING AND PARTICIPATION	•8
MEAN SCORES AND BENCHMARKS	•9
SECTION 2: RESULTS FOR YOUR SCHOOL	
YOUR SCHOOL PROFILE	•10
YOUR OVERALL PERFORMANCE	•11
Percentage of students reaching each TIMSS International Benchmark	•11
School and curricula means by grade and subject	•12
Student means for each grade and subject by gender	•13
UAE National and Expatriate means by grade and subject	•14
YOUR PERFORMANCE IN CONTENT AND COGNITIVE DOMAINS	•15
Grade 4 school means and percentages in Mathematics content and cognitive domains against TIMSS benchmarks	•15
Grade 4 school means and percentages in Science content and cognitive domains against TIMSS benchmarks	•16
Grade 8 school means and percentages in Mathematics content and cognitive domains against TIMSS benchmarks	•17
Grade 8 school means and percentages in Science content and cognitive domains against TIMSS benchmarks	•18
SECTION 3: TARGETS AND NEXT STEPS	
TIMSS 2023 TARGETS	•19
NEXT STEPS	•20
APPENDICES	
APPENDIX A	
Mathematics – Cognitive Domains	•i
Science – Cognitive Domains	•iv
APPENDIX B	
Grade 4: Summary of TIMSS 2019 International Benchmarks of Mathematics Achievement	•vii
Grade 4: Summary of TIMSS 2019 International Benchmarks of Science Achievement	•viii
Grade 8: Summary of TIMSS 2019 International Benchmarks of Mathematics Achievement	•ix
Grade 8: Summary of TIMSS 2019 International Benchmarks of Science Achievement	•x



TABLE OF CONTENTS

LIST OF FIGURES

Fig. 1: Number of schools and students participating in TIMSS 2019	•8
Fig. 2: Percentage of your students reaching each TIMSS International Benchmark by grade and subject	•11
Fig. 3: Grade 4 and 8 Mathematics and Science – mean scores by gender	•13
Fig. 4: TIMSS 2019 mean scores and TIMSS 2023 mean score targets for your school	•19

LIST OF TABLES

Table 1: Grade 4 Mathematics content domains	•6
Table 2: Grade 4 Mathematics cognitive domains	•6
Table 3: Grade 4 Science content domains	•6
Table 4: Grade 4 Science cognitive domains	•6
Table 5: Grade 8 Mathematics content domains	•7
Table 6: Grade 8 Mathematics cognitive domains	•7
Table 7: Grade 8 Science content domains	•7
Table 8: Grade 8 Science cognitive domains	•7
Table 9: TIMSS International Benchmarks and Thresholds	•9
Table 10: Grade 4 and 8 Mathematics and Science – means scores by curriculum	•12
Table 11: Grade 4 and 8 Mathematics and Science – mean scores for UAE Nationals and Expatriates	•14
Table 12: Grade 4 Mathematics content domains – mean scores and benchmark percentages	•15
Table 13: Grade 4 Mathematics cognitive domains – mean scores and benchmark percentages	•15
Table 14: Grade 4 Science content domains – mean scores and benchmark percentages	•16
Table 15: Grade 4 Science cognitive domains – mean scores and benchmark percentages	•16
Table 16: Grade 8 Mathematics content domains – mean scores and benchmark percentages	•17
Table 17: Grade 8 Mathematics cognitive domains – mean scores and benchmark percentages	•17
Table 18: Grade 8 Science content domains – mean scores and benchmark percentages	•18
Table 19: Grade 8 Science cognitive domains – mean scores and benchmark percentages	•18



SECTION 1: INTRODUCTION

WHAT IS TIMSS?

The Trends in International Mathematics and Science Study (TIMSS) is developed by the International Association for the Evaluation of Educational Achievement (IEA). Conducted every four years since 1995, TIMSS measures student achievement in Mathematics and Science at Grades 4 and 8 (Years 5 and 9). TIMSS 2019, the seventh assessment cycle, was conducted in 64 countries and 8 benchmarking entities, with approximately 600,000 students assessed globally.

Over 10,000 Abu Dhabi private school students across the Emirate were selected to participate in the online assessments, representing a broad range of international curricula and demonstrating variable levels of success.

The assessments provide robust comparative data to assist with informed decision-making and the continuous improvement of teaching and learning.

Your TIMSS 2019 School Report summarises the performance of sampled students from your school in Grade 4 and Grade 8. Results by grade and subject and content/cognitive domains are presented and can be used by school leaders and teachers for targeted intervention, support and improvement. Information in this report may assist in determining strengths and weaknesses in your school's performance compared with regional and international cohorts, curricula and against international benchmarks.

Your TIMSS 2019 School Report will also be shared with the Irtiqa'a inspection team as a source of evidence to assist with the inspection process and future school visits.





TIMSS 2019 ASSESSMENT FRAMEWORKS

The Mathematics and Science assessments were developed according to two dimensions – content and cognitive. Domains within the *content* dimension refer to the subject matter assessed. Each content domain is comprised of topic areas for each subject. Domains within the *cognitive* dimension describe the thinking processes and behavior used by students as they interact with the content. They are categorized as Knowing, Applying and Reasoning for both Mathematics and Science, see Appendix A. The proportion of items in each content and cognitive domain varies across the grades and subjects, shown as a percentage.

Table 1: Grade 4 Mathematics content domains

Grade 4 Mathematics Content Domains		
Domain	Topic Areas	Percentage
Number	<ul style="list-style-type: none"> Whole Numbers Expressions, Simple Equations and Relationships Fractions and Decimals 	50%
Measurement and Geometry	<ul style="list-style-type: none"> Measurement Geometry 	30%
Data	<ul style="list-style-type: none"> Reading, Interpreting, and Representing Data Using Data to Solve Problems 	20%

Table 2: Grade 4 Mathematics cognitive domains

Grade 4 Mathematics Cognitive Domains	
Domain	Percentage
Knowing	40%
Applying	40%
Reasoning	20%

Table 3: Grade 4 Science content domains

Grade 4 Science Content Domains		
Domain	Topic Areas	Percentage
Life Science	<ul style="list-style-type: none"> Characteristics and Life Processes of Organisms Life Cycles, Reproduction and Hereditary Organisms, Environment, and Their Interactions Ecosystems and Human Health 	45%
Physical Science	<ul style="list-style-type: none"> Classification and Properties of Matter and Changes in Matter Forms of Energy and Energy Transfer Forces and Motion 	35%
Earth Science	<ul style="list-style-type: none"> Earth's Physical Characteristics, Resources, and History Earth's Weather and Climates Earth in the Solar System 	20%

Table 4: Grade 4 Science cognitive domains

Grade 4 Science Cognitive Domains	
Domain	Percentage
Knowing	40%
Applying	40%
Reasoning	20%



Table 5: Grade 8 Mathematics content domains

Grade 8 Mathematics Content Domains		
Domain	Topic Areas	Percentage
Number	<ul style="list-style-type: none"> Integers Fractions and Decimals Ratio, Proportion and Percent 	30%
Algebra	<ul style="list-style-type: none"> Expressions, Operations and Equations Relationships and Functions 	30%
Geometry	<ul style="list-style-type: none"> Geometric Shapes and Measurements 	20%
Data and Probability	<ul style="list-style-type: none"> Data Probability 	20%

Table 6: Grade 8 Mathematics cognitive domains

Grade 8 Mathematics Cognitive Domains	
Domain	Percentage
Knowing	35%
Applying	40%
Reasoning	25%

Table 7: Grade 8 Science content domains

Grade 8 Science Content Domains		
Domain	Topic Areas	Percentage
Biology	<ul style="list-style-type: none"> Characteristics and Life Processes of Organisms Cells and Their Functions Life Cycles, Reproduction and Hereditary Diversity, Adaption and Natural Selection Ecosystems Human Health 	35%
Chemistry	<ul style="list-style-type: none"> Composition of Matter Properties of Matter Chemical Change 	20%
Physics	<ul style="list-style-type: none"> Physical States and Changes in Matter Energy Transformation and Transfer Light and Sound Electricity and Magnetism, Motion and Forces 	25%
Earth Science	<ul style="list-style-type: none"> Earth's Structure and Physical Feature Earth's Processes, Cycles, and History Earth's Resources, Their Use and Conservation Earth in The Solar System and the Universe 	20%

Table 8: Grade 8 Science cognitive domains

Grade 8 Science Cognitive Domains	
Domain	Percentage
Knowing	35%
Applying	35%
Reasoning	30%



SAMPLING AND PARTICIPATION

TIMSS is conducted as a sample survey in the majority of participating countries. A sample of students is selected to represent the population of students from each grade from that country or benchmarking participant.

The process of selecting the sample has two stages. In the first stage schools are identified, and in the second, a single class is selected at random from each grade from the selected school. These students represent the student population for that country or benchmarking participant.





	Grade 4		Grade 8	
				
UAE	668	25,834	623	22,334
Abu Dhabi (Public and Private Schools)	247	9037	230	8204
Abu Dhabi Private Schools	158	5887	135	4701

Fig. 1: Number of schools and students participating in TIMSS 2019



MEAN SCORES AND BENCHMARKS

The TIMSS 2019 results are represented as mean (average) scores on the TIMSS Mathematics and Science scales. The Grade 4 and 8 scales each have a mean (or centerpoint) of 500 and were developed to remain constant from assessment cycle to cycle. It is important to note that each grade and subject has an independent TIMSS scale. Comparisons cannot be made across grades and subjects.

In order to provide an interpretation of the TIMSS results in Grade 4 and 8 Mathematics and Science, regarding students' performance, TIMSS describes achievement at four points along the scale. These points are the TIMSS International Benchmarks and represent student achievement.

Table 9: TIMSS International Benchmarks and Thresholds

International Benchmarks	Benchmark Thresholds (points)
Advanced	625 and above
High	550
Intermediate	475
Low	400
Below Low	lower than 400

Where achievement on the scale has not reached the Low International Benchmark (400), performance is reported as 'Below Low'.

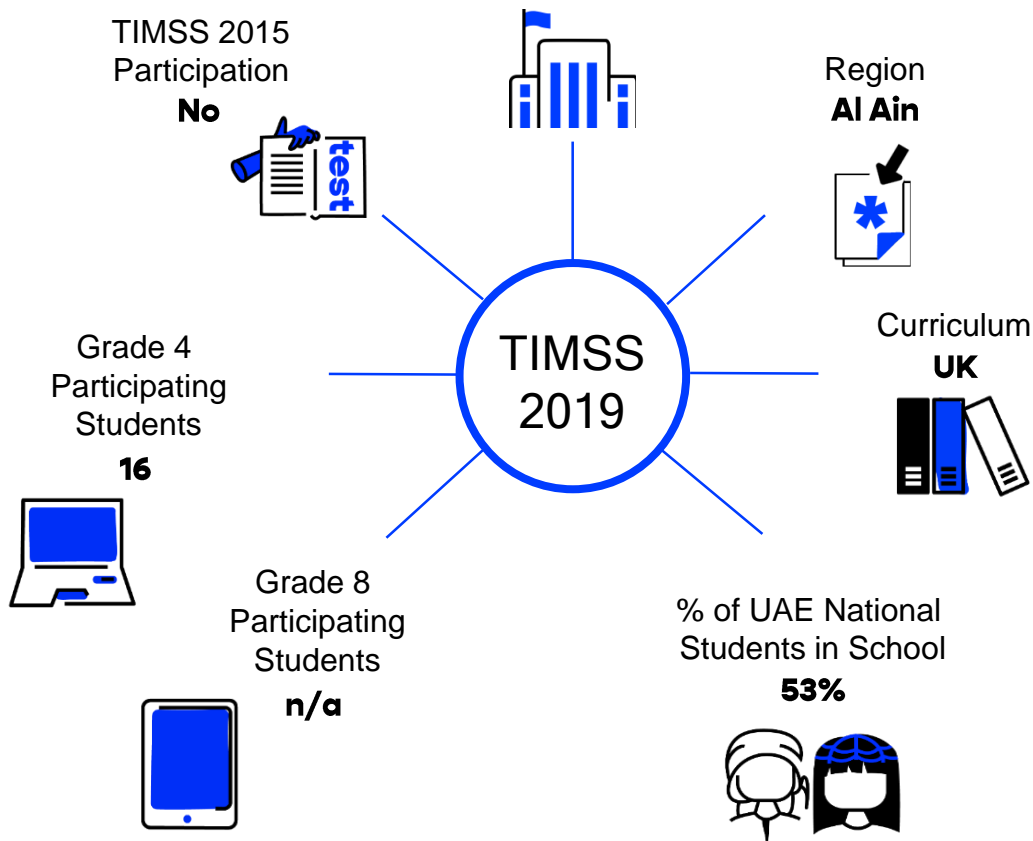
The descriptions of the knowledge and skills for each benchmark can be found in Appendix B. These are cumulative, so that achievement at the Advanced International Benchmark would likely include mastery of the knowledge and skills of the High, Intermediate and Low International Benchmarks.



SECTION 2: RESULTS FOR YOUR SCHOOL

YOUR SCHOOL PROFILE

School #9286
Garden City British School



Grade 4 Mean Scores		
Cohort	Mathematics	Science
Your School	490	476
Abu Dhabi Private Schools	477	466
All UAE Schools	481	473

Grade 8 Mean Scores		
Cohort	Mathematics	Science
Your School	n/a	n/a
Abu Dhabi Private Schools	484	491
All UAE Schools	473	473



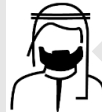
YOUR OVERALL PERFORMANCE

Percentage of students reaching each TIMSS International Benchmark

TIMSS International Benchmarks				
Below Low <400	Low 400	Intermediate 475	High 550	Advanced ≥625



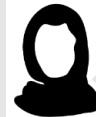
For Grade 4 Mathematics, your overall mean score is **490** which indicates your school has reached the **Intermediate** International Benchmark.



For Grade 4 Science, your overall mean score is **476** which indicates your school has reached the **Intermediate** International Benchmark.



For Grade 8 Mathematics, your overall mean score is **n/a** which indicates your school has reached the **n/a** International Benchmark.



For Grade 8 Science, your overall mean score is **n/a** which indicates your school has reached the **n/a** International Benchmark.

Percentage of students at each TIMSS International Benchmark

Grade 4 Mathematics

Below Low	Low	Intermediate	High	Advanced
10%	38%	31%	18%	4%

Grade 4 Science

Below Low	Low	Intermediate	High	Advanced
14%	45%	19%	23%	0%

Grade 8 Mathematics

Below Low	Low	Intermediate	High	Advanced
n/a	n/a	n/a	n/a	n/a

Grade 8 Science

Below Low	Low	Intermediate	High	Advanced
n/a	n/a	n/a	n/a	n/a

Fig. 2: Percentage of your students reaching each TIMSS International Benchmark by grade and subject



YOUR OVERALL PERFORMANCE

School and curricula means by grade and subject



How well has your school performed compared to students in the same and different curricula across Abu Dhabi?

Students from a broad range of international curricula were assessed in TIMSS 2019. The mean scores for the main curricula offered in Abu Dhabi private schools are presented below. Mean scores for some curricula are not shown due to the small number of schools sampled from that curriculum. These are grouped and shown as 'Others'.

Table 10: Grade 4 and 8 Mathematics and Science – mean scores by curriculum

Curricula	Grade 4		Grade 8	
	Mathematics	Science	Mathematics	Science
Your School	490	476	n/a	n/a
Indian	484	485	518	544
MoE	469	473	459	472
UK	486	471	511	522
US	454	431	453	443
Others	522	509	508	510



YOUR OVERALL PERFORMANCE

Student means for each grade and subject by gender



How does student performance at your school vary by gender?

The mean scores for each grade and subject are shown below for girls and boys in your school.

Grade 4 Mathematics



475



524

Grade 4 Science



467



494

Grade 8 Mathematics



n/a



n/a

Grade 8 Science



n/a



n/a

Fig. 3: Grade 4 and 8 Mathematics and Science – mean scores by gender



YOUR OVERALL PERFORMANCE

UAE National and Expatriate means by grade and subject

How well have your UAE National students performed compared to Expatriates and to all UAE National students in Abu Dhabi private schools?



The mean scores for each grade and subject are shown below for UAE National and Expatriate students in your school, and UAE Nationals in all Abu Dhabi private schools.

Table 11: Grade 4 and 8 Mathematics and Science – mean scores for UAE Nationals and Expatriates

Cohort	Grade 4		Grade 8	
	Mathematics	Science	Mathematics	Science
UAE Nationals in your school	447	427	n/a	n/a
Expatriates in your school	510	498	n/a	n/a
UAE Nationals in all Abu Dhabi private schools	442	418	437	426



YOUR PERFORMANCE IN CONTENT AND COGNITIVE DOMAINS

Grade 4 school means and percentages in Mathematics content and cognitive domains against TIMSS benchmarks



How well have your Grade 4 students performed in the Mathematics content and cognitive domains?

Table 12: Grade 4 Mathematics content domains – mean scores and benchmark percentages

Cohort	Grade 4 Mathematics – Content Domain Means		
	Number	Measurement and Geometry	Data
Your School	496	480	502
AD Private Schools	481	467	471

Number	10%	30%	33%	21%	6%
Measurement and Geometry	13%	40%	23%	23%	3%
Data	10%	33%	33%	20%	5%
	Below Low (<400)	Low (400)	Intermediate (475)	High (550)	Advanced (≥625)

Table 13: Grade 4 Mathematics cognitive domains – mean scores and benchmark percentages

Cohort	Grade 4 Mathematics – Cognitive Domain Means		
	Knowing	Applying	Reasoning
Your School	487	486	480
AD Private Schools	477	478	471

Knowing	10%	43%	25%	19%	4%
Applying	14%	36%	25%	20%	5%
Reasoning	13%	39%	28%	16%	5%
	Below Low (<400)	Low (400)	Intermediate (475)	High (550)	Advanced (≥625)



YOUR PERFORMANCE IN CONTENT AND COGNITIVE DOMAINS

Grade 4 school means and percentages in Science content and cognitive domains against TIMSS benchmarks



How well have your Grade 4 students performed in the Science content and cognitive domains?

Table 14: Grade 4 Science content domains – mean scores and benchmark percentages

Cohort	Grade 4 Science – Content Domain Means		
	Life Science	Physical Science	Earth Science
Your School	472	473	463
AD Private Schools	460	469	467

Life Science	18%	39%	24%	19%	1%
Physical Science	19%	40%	21%	18%	3%
Earth Science	15%	50%	20%	14%	1%
	Below Low (<400)	Low (400)	Intermediate (475)	High (550)	Advanced (≥625)

Table 15: Grade 4 Science cognitive domains – mean scores and benchmark percentages

Cohort	Grade 4 Science – Cognitive Domain Means		
	Knowing	Applying	Reasoning
Your School	485	468	464
AD Private Schools	476	462	454

Knowing	19%	33%	24%	16%	9%
Applying	18%	39%	20%	24%	0%
Reasoning	16%	54%	11%	19%	0%
	Below Low (<400)	Low (400)	Intermediate (475)	High (550)	Advanced (≥625)



YOUR PERFORMANCE IN CONTENT AND COGNITIVE DOMAINS

Grade 8 school means and percentages in Mathematics content and cognitive domains against TIMSS benchmarks



How well have your Grade 8 students performed in the Mathematics content and cognitive domains?

Table 16: Grade 8 Mathematics content domains – mean scores and benchmark percentages

Cohort	Grade 8 Mathematics – Content Domain Means			
	Number	Algebra	Geometry	Data & Probability
Your School	n/a	n/a	n/a	n/a
AD Private Schools	486	495	471	465

Number	n/a	n/a	n/a	n/a	n/a
Algebra	n/a	n/a	n/a	n/a	n/a
Geometry	n/a	n/a	n/a	n/a	n/a
Data & Probability	n/a	n/a	n/a	n/a	n/a
	Below Low (<400)	Low (400)	Intermediate (475)	High (550)	Advanced (≥625)

Table 17: Grade 8 Mathematics cognitive domains – mean scores and benchmark percentages

Cohort	Grade 8 Mathematics – Cognitive Domain Means		
	Knowing	Applying	Reasoning
Your School	n/a	n/a	n/a
AD Private Schools	489	478	486

Knowing	n/a	n/a	n/a	n/a	n/a
Applying	n/a	n/a	n/a	n/a	n/a
Reasoning	n/a	n/a	n/a	n/a	n/a
	Below Low (<400)	Low (400)	Intermediate (475)	High (550)	Advanced (≥625)



YOUR PERFORMANCE IN CONTENT AND COGNITIVE DOMAINS

Grade 8 school means and percentages in Science content and cognitive domains against TIMSS benchmarks



How well have your Grade 8 students performed in the Science content and cognitive domains?

Table 18: Grade 8 Science content domains – mean scores and benchmark percentages

Cohort	Grade 8 Science – Content Domain Means			
	Biology	Chemistry	Physics	Earth Science
Your School	n/a	n/a	n/a	n/a
AD Private Schools	493	490	485	486

Biology	n/a	n/a	n/a	n/a	n/a
Chemistry	n/a	n/a	n/a	n/a	n/a
Physics	n/a	n/a	n/a	n/a	n/a
Earth Science	n/a	n/a	n/a	n/a	n/a
	Below Low (<400)	Low (400)	Intermediate (475)	High (550)	Advanced (≥625)

Table 19: Grade 8 Science cognitive domains – mean scores and benchmark percentages

Cohort	Grade 8 Science – Cognitive Domain Means		
	Knowing	Applying	Reasoning
Your School	n/a	n/a	n/a
AD Private Schools	499	491	478

Knowing	n/a	n/a	n/a	n/a	n/a
Applying	n/a	n/a	n/a	n/a	n/a
Reasoning	n/a	n/a	n/a	n/a	n/a
	Below Low (<400)	Low (400)	Intermediate (475)	High (550)	Advanced (≥625)



SECTION 3: TARGETS AND NEXT STEPS

TIMSS 2023 TARGETS



What are your school targets for TIMSS 2023?

Using TIMSS 2019 results, each school has been provided with target mean score ranges for TIMSS 2023. Four target ranges, one for each grade and subject are presented below. It is expected that school leaders will use the information in this report to gain a full understanding of their students' performance and plan accordingly to reach mean scores within these ranges in TIMSS 2023.

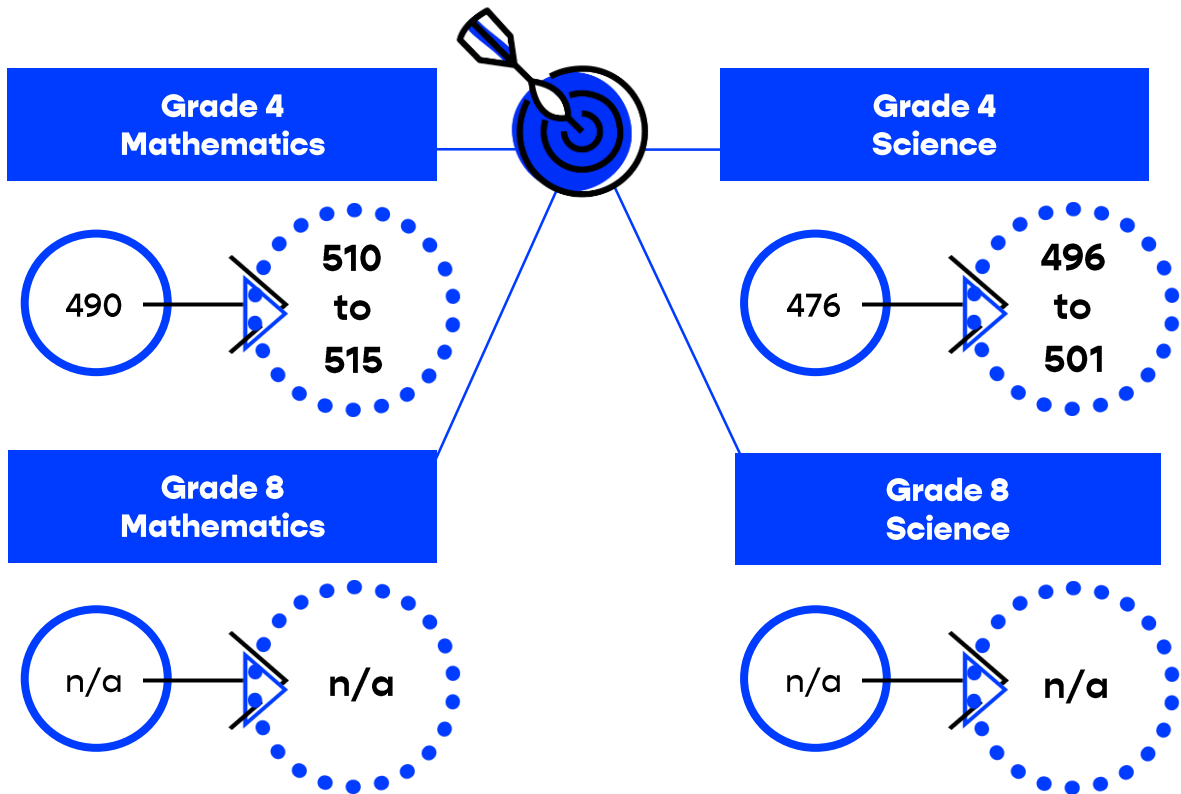


Fig. 4: TIMSS 2019 mean scores and TIMSS 2023 mean score targets for your school

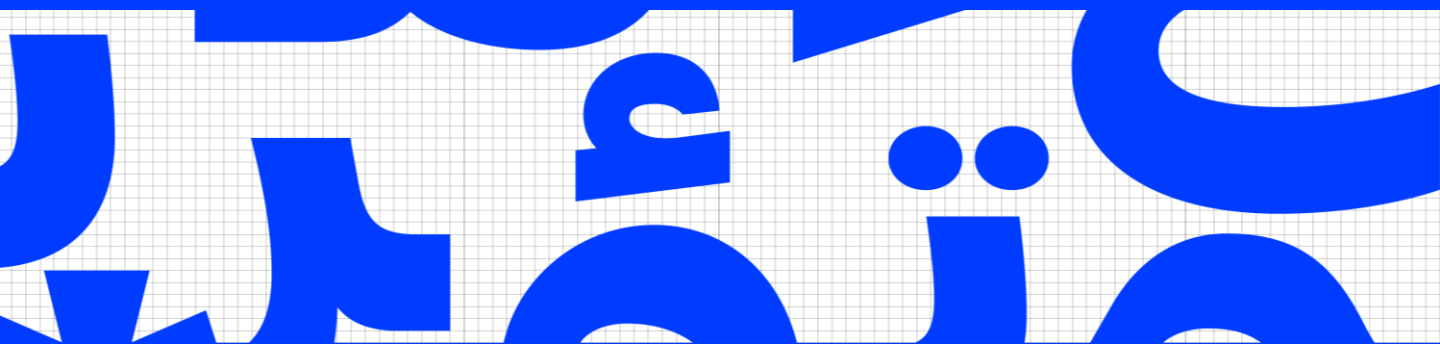


NEXT STEPS

The results from TIMSS 2019 are a measure of your school's performance. School leaders and teachers should work collaboratively to ensure a growth mindset with regards to reaching given targets.

- 1** Familiarize yourself with the TIMSS 2019 Mathematics and Science Frameworks, using the following link: <https://timssandpirls.bc.edu/timss2019/frameworks/>
- 2** Read your TIMSS 2019 School Report and familiarize yourself with the structure, information and tables.
- 3** Engage with the TIMSS benchmarks and descriptions as shown in Appendix B. These provide an overview of the knowledge and skills required to progress through each benchmark threshold.
- 4**
 - * Compare your mean scores with the UAE and Abu Dhabi Private School results.
 - * Compare the percentage of your students at each benchmark for each subject and grade to determine where 'they are' on the TIMSS benchmark continuum.
 - * Study the benchmark descriptions to determine next steps in learning.
 - * Review the content and cognitive domain tables to determine relative strengths and weaknesses.
 - * Look at the topic areas within each content domain, (see *TIMSS 2019 Assessment Frameworks, page 6 of this report*), to ascertain potential areas for improvement.
- 5** Incorporate your findings into your school's development plans.

APPENDICES





APPENDIX A

Mathematics – Cognitive Domains

Knowing

Facility in applying mathematics, or reasoning about mathematical situations, depends on familiarity with mathematical concepts and fluency in mathematical skills. The more relevant knowledge a student is able to recall and the wider the range of concepts he or she understands, the greater the potential for engaging in a wide range of problem solving situations.

Without access to a knowledge base that enables easy recall of the language and basic facts and conventions of number, symbolic representation, and spatial relations, students would find purposeful mathematical thinking impossible. Facts encompass the knowledge that provides the basic language of mathematics, as well as the essential mathematical concepts and properties that form the foundation for mathematical thought.

Procedures form a bridge between more basic knowledge and the use of mathematics for solving problems, especially those encountered by many people in their daily lives. In essence, a fluent use of procedures entails recall of sets of actions and how to carry them out. Students need to be efficient and accurate in using a variety of computational procedures and tools. They need to see that particular procedures can be used to solve entire classes of problems, not just individual problems.

Knowing	
Recall	Recall definitions, terminology, number properties, units of measurement, geometric properties, and notation (e.g., $a \times b = ab$, $a + a + a = 3a$).
Recognize	Recognize numbers, expressions, quantities, and shapes. Recognize entities that are mathematically equivalent (e.g., equivalent familiar fractions, decimals, and percents; different orientations of simple geometric figures).
Classify/Order	Classify numbers, expressions, quantities, and shapes by common properties.
Compute	Carry out algorithmic procedures for +, −, ×, ÷, or a combination of these with whole numbers, fractions, decimals, and integers. Carry out straightforward algebraic procedures.
Retrieve	Retrieve information from graphs, tables, texts, or other sources.
Measure	Use measuring instruments; and choose appropriate units of measurement.

Applying

The applying domain involves the application of mathematics in a range of contexts. In this domain, the facts, concepts, and procedures as well as the problems should be familiar to the student. In some items aligned with this domain, students need to apply mathematical knowledge of facts, skills, and procedures or understanding of mathematical concepts to create representations. Representation of ideas forms the core of mathematical thinking and communication, and the ability to create equivalent representations is fundamental to success in the subject.

Problem solving is central to the applying domain, with an emphasis on more familiar and routine tasks. Problems may be set in real life situations, or may be concerned with purely mathematical questions involving, for example, numeric or algebraic expressions, functions, equations, geometric figures, or statistical data sets.

Applying	
Determine	Determine efficient/appropriate operations, strategies, and tools for solving problems for which there are commonly used methods of solution.
Represent/Model	Display data in tables or graphs; create equations, inequalities, geometric figures, or diagrams that model problem situations; and generate equivalent representations for a given mathematical entity or relationship.
Implement	Implement strategies and operations to solve problems involving familiar mathematical concepts and procedures.



Reasoning

Reasoning mathematically involves logical, systematic thinking. It includes intuitive and inductive reasoning based on patterns and regularities that can be used to arrive at solutions to problems set in novel or unfamiliar situations. Such problems may be purely mathematical or may have real life settings. Both types of items involve transferring knowledge and skills to new situations; and interactions among reasoning skills usually are a feature of such items.

Even though many of the cognitive skills listed in the reasoning domain may be drawn on when thinking about and solving novel or complex problems, each by itself represents a valuable outcome of mathematics education, with the potential to influence learners' thinking more generally.

For example, reasoning involves the ability to observe and make conjectures. It also involves making logical deductions based on specific assumptions and rules, and justifying results.

Reasoning	
Analyze	Determine, describe, or use relationships among numbers, expressions, quantities, and shapes.
Integrate/Synthesize	Link different elements of knowledge, related representations, and procedures to solve problems.
Evaluate	Evaluate alternative problem solving strategies and solutions.
Draw Conclusions	Make valid inferences on the basis of information and evidence.
Generalize	Make statements that represent relationships in more general and more widely applicable terms.
Justify	Provide mathematical arguments to support a strategy or solution.

Science – Cognitive Domains

Knowing

Items in this domain assess students' knowledge of facts, relationships, processes, concepts, and equipment. Accurate and broad-based factual knowledge enables students to successfully engage in the more complex cognitive activities essential to the scientific enterprise.

Knowing	
Recall/Recognize	Identify or state facts, relationships, and concepts; identify the characteristics or properties of specific organisms, materials, and processes; identify the appropriate uses for scientific equipment and procedures; and recognize.
Describe	Describe or identify descriptions of properties, structures, and functions of organisms and materials, and relationships among organisms, materials, and processes and phenomena.
Provide Examples	Provide or identify examples of organisms, materials, and processes that possess certain specified characteristics; and clarify statements of facts or concepts with appropriate examples.



Applying

Items in this domain require students to engage in applying knowledge of facts, relationships, processes, concepts, equipment, and methods in contexts likely to be familiar in the teaching and learning of science.

Applying	
Compare/Contrast/Classify	Identify or describe similarities and differences between groups of organisms, materials, or processes; and distinguish, classify, or sort individual objects, materials, organisms, and processes based on characteristics and properties.
Relate	Relate knowledge of an underlying science concept to an observed or inferred property, behavior, or use of objects, organisms, or materials.
Use Models	Use a diagram or other model to demonstrate knowledge of science concepts, to illustrate a process, cycle, relationship, or system, or to find solutions to science problems.
Interpret Information	Use knowledge of science concepts to interpret relevant textual, tabular, pictorial, and graphical information.
Explain	Provide or identify an explanation for an observation or a natural phenomenon using a science concept or principle.



Reasoning

Items in this domain require students to engage in reasoning to analyze data and other information, draw conclusions, and extend their understandings to new situations. In contrast to the more direct applications of science facts and concepts exemplified in the applying domain, items in the reasoning domain involve unfamiliar or more complicated contexts. Answering such items can involve more than one approach or strategy. Scientific reasoning also encompasses developing hypotheses and designing scientific investigations.

Reasoning	
Analyze	Identify the elements of a scientific problem and use relevant information, concepts, relationships, and data patterns to answer questions and solve problems.
Synthesize	Answer questions that require consideration of a number of different factors or related concepts.
Formulate Questions/ Hypothesize/Predict	Formulate questions that can be answered by investigation and predict results of an investigation given information about the design; formulate testable assumptions based on conceptual understanding and knowledge from experience, observation, and/or analysis of scientific information; and use evidence and conceptual understanding to make predictions about the effects of changes in biological or physical conditions.
Design Investigations	Plan investigations or procedures appropriate for answering scientific questions or testing hypotheses; and describe or recognize the characteristics of well-designed investigations in terms of variables to be measured and controlled and cause-and-effect relationships.
Evaluate	Evaluate alternative explanations; weigh advantages and disadvantages to make decisions about alternative processes and materials; and evaluate results of investigations with respect to sufficiency of data to support conclusions.
Draw Conclusions	Make valid inferences on the basis of observations, evidence, and/or understanding of science concepts; and draw appropriate conclusions that address questions or hypotheses, and demonstrate understanding of cause and effect.
Generalize	Make general conclusions that go beyond the experimental or given conditions; apply conclusions to new situations.
Justify	Use evidence and science understanding to support the reasonableness of explanations, solutions to problems, and conclusions from investigations.



APPENDIX B

GRADE 4: Summary of TIMSS 2019 International Benchmarks of Mathematics Achievement

625 **Advanced** International Benchmark

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.

550 **High** International Benchmark

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.

475 **Intermediate** International Benchmark

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.

400 **Low** International Benchmark

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.



GRADE 4: Summary of TIMSS 2019 International Benchmarks of Science Achievement

625 **Advanced** International Benchmark

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.

550 **High** International Benchmark

Students communicate and apply knowledge of life, physical, and Earth sciences. 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.

475 **Intermediate** International Benchmark

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.

400 **Low** International Benchmark

Students show limited understanding of scientific concepts and limited knowledge of foundational science facts.



GRADE 8: Summary of TIMSS 2019 International Benchmarks of Mathematics Achievement

625 Advanced International Benchmark

Students can apply and reason in a variety of problem situations, solve linear equations, and make generalizations. They can solve a variety of fraction, proportion, and percent problems and justify their conclusions. They can understand linear functions and algebraic expressions. Students can use their knowledge of geometric figures to solve a wide range of problems involving angles, area, and surface area. They can calculate means and medians, and understand how changing data points can impact the mean. Students can interpret a wide variety of data displays to draw and justify conclusions, and solve multistep problems. They can solve problems involving expected values.

550 High International Benchmark

Students can apply their understanding and knowledge in a variety of relatively complex situations. They can solve problems with fractions, decimals, ratios, and proportions. Students at this level show basic procedural knowledge related to algebraic expressions and equations. They can solve a variety of problems with angles, including problems involving triangles, parallel lines, rectangles, and congruent and similar figures. Students can interpret data in a variety of graphs and solve simple problems involving outcomes and probabilities.

475 Intermediate International Benchmark

Students can apply basic mathematical knowledge in a variety of situations. They can solve problems involving whole numbers, negative numbers, fractions, decimals, and ratios. Students have some basic knowledge about properties of two-dimensional shapes. They can read and interpret data in graphs and have some rudimentary knowledge of probability.

400 Low International Benchmark

Students have some knowledge of whole numbers and basic graphs.



GRADE 8: Summary of TIMSS 2019 International Benchmarks of Science Achievement

625 Advanced International Benchmark

Students communicate understanding of concepts related to biology, chemistry, physics, and Earth science in a variety of contexts. Students can classify animals into taxonomic groups. They can apply knowledge of cell structures and their functions. Students show some understanding of diversity, adaptation, and natural selection. They also recognize the interdependence of populations of organisms in an ecosystem. Students demonstrate knowledge of the composition of matter and the periodic table of the elements. Students use physical properties of matter to sort, classify, and compare substances and materials. They also recognize evidence that a chemical reaction has occurred. Students communicate understanding of particle spacing and motion in different physical states. Students apply knowledge of energy transfer and electrical circuits, can relate the properties of light and sound to common phenomena, and demonstrate understanding of forces in everyday contexts. Students communicate understanding of Earth's structure, physical features, and processes. They demonstrate knowledge of the Earth's resources and their conservation.

550 High International Benchmark

Students apply understanding of concepts from biology, chemistry, physics, and Earth science. Students can apply knowledge of the characteristics of groups of animals, life processes in humans, cells and their functions, genetic inheritance, ecosystems, and nutrition. Students show some knowledge and understanding of the composition and properties of matter and chemical reactions. They can apply basic knowledge of energy transformation and transfer, electrical circuits, properties of magnets, light, sound, and forces. They can apply knowledge of Earth's physical features, processes, cycles, and history, and show some understanding of Earth's resources and their use.

475 Intermediate International Benchmark

Students show and apply some knowledge of biology and the physical sciences. Students demonstrate some knowledge of characteristics of animals and apply knowledge of ecosystems. They show some knowledge of the properties of matter, chemical changes, and a few physics concepts.

400 Low International Benchmark

Students show limited understanding of scientific principles and concepts and limited knowledge of science facts.