

# Qatar

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## Introduction

### *Overview of Education System*

In accordance with Qatar National Vision 2030, Qatar aims to develop a world-class education system that meets modern international standards, provides citizens with opportunities to develop their abilities and capacities, and prepares students to succeed in a world with increasing education requirements. Such a system will also promote analytical and critical thinking, develop creativity and innovation, emphasize the promotion of social cohesion and respect for the values and heritage of Qatari society, and call for constructive engagement with the peoples of the world.

The Ministry of Education and Higher Education is responsible for decision making, development, and advancement in the education sector to meet Qatar’s needs for outstanding human resources and competencies in various fields. The Ministry also is responsible for drawing up national education policy and linking it to education goals, plans, and programs in accordance with the general objectives of the state.<sup>1</sup>

Qatar follows a policy of compulsory education until the end of the preparatory stage and provides free education to all citizens. Basic education consists of a primary stage (six years), a preparatory stage (three years), and a secondary stage (three years).<sup>2</sup> The state provides free education for all Qatari students from preschool to university levels and higher. Education in Qatar is compulsory for children between 6-15 years of age. Exhibit 1 presents the levels of education in Qatar.

**Exhibit 1: Levels of Education in Qatar**

Level	Ages	Number of Years
KG 1 & 2	4–6	2
Primary	6–12	6
Preparatory	12–15	3
Secondary	15–18	3
University	18–22	4

Schools in Qatar are classified as follows:

- Government schools belong to the Ministry of Education and Higher Education and follow the national curriculum
- International schools apply international curriculum
- Community schools apply the curriculum of each school's national community
- Private Arabic schools belong partially to the Ministry of Education and Higher Education

Although government schools account for nearly half of the total schools operating in the country, the number of international schools has increased in the past few years. Qatar is home to two state-run post-secondary education institutions—Qatar University and Qatar Community College—as well as eight international institutions that have partnered with the Qatar Foundation, two Qatari universities, and several colleges and schools that make up Education City, a campus comprising multiple education and research institutes.<sup>3</sup>

The mathematics and science curricula differ for the different types of schools. The main difference occurs between international schools and the other types, as international schools apply international curricula with international standards.

### *Use and Impact of TIMSS*

Qatar participated in TIMSS 2007, 2011, 2015, and 2019. This participation has provided insight into students' knowledge and skills in mathematics and science. TIMSS results helped to identify strengths and weaknesses (for example, common mistakes and learning difficulties) in various areas of learning for different groups of students.

Following the publication of TIMSS 2015 results and international reports by IEA, the Ministry of Education and Higher Education in Qatar prepared a document containing TIMSS results and highlighting information and data regarding the participation of Qatar and the Arabic countries in TIMSS 2015.

The Ministry of Education and Higher Education in Qatar has benefited from the recommendations that were presented after analyzing the results of TIMSS 2015 and developed a plan to meet international standards in all schools in Qatar. The aim of this plan is to improve student achievement in international study via the curriculum and standards. The plan contains three key aspects: academic, awareness, and motivation.

The academic aspect seeks to:

- Cover skills through a comprehensive plan to cover the international standards within a specific timeline
- Develop the performance of academic deputies through workshops to train them on international standards and programs for building assessments based on international assessments

- Develop teachers' professional performance (including science and mathematics) by training teachers in formulating test questions similar to international questions and ways to cover international standards
- Enhance student performance by developing school and classroom activities in line with international testing needs
- Train students to use an electronic evaluation system

The awareness aspect seeks to convey the importance of participating in TIMSS among faculty, administrators, students, parents, and society in general by:

- Raising awareness of the importance of participation in assessments
- Raising the level of performance among teachers in familiarizing students with TIMSS
- Clarifying ideas and improving understanding and awareness of international assessments
- Raising awareness among society through visual, print, and audio media

The motivation aspect seeks to motivate students to participate effectively in international assessments by:

- Encouraging them to research and experiment within the curriculum of extracurricular activities in accordance with international standards, such as wall newspapers, magazines, brochures, and leaflets
- Conducting scientific competitions between schools participating in TIMSS
- Adding grades for serious participation in international assessments
- Honoring schools and students on Education Excellence Day

## The Mathematics Curriculum in Primary and Lower Secondary Grades

Qatar's curriculum for mathematics aims to ensure that all students acquire fluency in the fundamentals of mathematics, including concepts, skills, and mathematical processes; apply mathematics to solve a variety of familiar and unfamiliar problems, and develop patience and persistence when solving problems; reason mathematically, think critically and creatively, and communicate mathematical thinking clearly; make connections between different mathematical ideas, mathematics and its applications, and mathematics and other subjects; gain interest and self-confidence in being open to dealing with new challenges; appreciate the variety of ways that mathematical ideas are applied and used in modern society and value mathematicians' contributions to the history and development of mathematics.

The Qatar National Curriculum Framework reflects a competency-based approach by defining several key competencies in the context of mathematics and other subjects. These competencies are important transversal capabilities that mathematics can develop and foster. In the new Qatar mathematics curriculum, these competencies can be developed in the classroom through the design and execution of mathematics learning experiences as described in the standards as follows:

- Creative and Critical Thinking
- Literacy
- Numeracy
- Communication
- Cooperation and Participation
- Inquiry and Research
- Problem Solving

The content standards are organized into three strands:

- Numbers and Algebra
- Geometry and Measurements
- Data Handling and Probability

Mathematics standards at the fourth grade comprise the following:

- Numbers and Algebra
  - Whole Numbers to 100,000—Count to 100,000 in thousands and ten thousands; read and write whole numbers in numerals and words; represent the place value of five-digit numbers (10,000s, 1,000s, 100s, 10s, and ones) using manipulatives and expanded notation; compare and order five-digit numbers using the symbols  $<$ ,  $=$ , and  $>$ ; round three- or four-digit whole numbers to the nearest 10, 100, or 1,000; and describe and find missing numbers in a number pattern
  - Factors and Multiples—Identify and find multiples of any one-digit number; know that prime numbers have exactly two factors, itself and 1; find common multiples of two 1-digit numbers; identify and find factors of any number within 100; and find common factors of two numbers within 100
  - Four Operations of Whole Numbers—Use and explain the algorithms for multiplication and division, involving numbers up to four digits by one digit for multiplication and division, and up to three digits by two digits for multiplication; estimate answers to whole-number calculations by using approximations, use and explain mental methods for the four operations (one-digit divisor), and solve two-step word problems involving the four operations
  - Money—Read and write money in decimal form, convert riyals in decimal form to dirhams, and dirhams to riyals in decimal form, up to two decimal places, and solve up to two-step word problems involving the four operations (riyals and dirhams)
  - Fractions—Use manipulatives and diagrams to identify and find fractions of a set of objects, express an improper fraction as a mixed number and vice versa, compare and order improper fractions or mixed numbers and add and subtract two related fractions with denominators of given fractions not exceeding 12, and solve two-step addition and subtraction word problems involving fractions

- Decimals—Read and write decimals with one or two places; represent place value in decimals with one or two places in words, manipulatives, or expanded form; use manipulatives and diagrams, including number lines, to compare and order a set of decimals with one or two places; round decimals to the nearest whole number or one decimal place; recognize fractions and decimals for one-half, one-quarter, and three-quarters; use algorithm to add, subtract, multiply, and divide decimals with up to two places by a one-digit whole number; use and explain mental methods to add and subtract decimals up to one decimal place and solve one-step problems involving decimals, including rounding answers to the nearest whole number or one decimal place
- Geometry and Measurements
  - Shapes, Angles and Symmetry—Associate  $360^\circ$  with one whole turn,  $270^\circ$  with a three-quarter turn,  $180^\circ$  with a half turn or a straight line, and  $90^\circ$  with a quarter turn or right angle; estimate and compare the sizes of angles and name them accordingly as obtuse or acute depending on their size; use the labeling conventions for angles; use a protractor to measure angles in degrees and to draw an angle given the size; use knowledge of properties of squares and rectangles to draw squares and rectangles on a square grid and identify symmetric figures and lines of symmetry in two-dimensional (2D) shapes; complete a 2D shape on a square grid to make it symmetrical, given a line of symmetry
  - Time—Convert standard units of time, including years to months or weeks, weeks to days, days to hours, hours to minutes, minutes to seconds, and vice versa; use 24-hour clock times; use timetables and calculate a duration in hours and minutes; and solve up to two-step word problems involving time in hours and minutes
  - Area and Perimeter—Find area and perimeter of figures made up of squares and rectangles; find the length of one side of a square given the area or perimeter, a rectangle given the area and one side, and a rectangle given the perimeter and one side; solve problems involving the area and/or perimeter of squares and rectangles
- Data Handling
  - Tables and Line Graphs—Complete a table from given information and interpret data in tables; represent, read, and interpret data in line graphs with a scale of 2, 4, 5, or 10 and multiples of tens or hundreds; and solve one-step problems using data from tables and line graphs

The mathematics standards at the eighth grade comprise the following:

- Numbers and Algebra
  - Rational Numbers—Identify and order rational numbers; convert rational numbers to terminating or recurring decimals and vice versa; perform combined operations of rational numbers and apply these skills in problem solving; use a scientific calculator for calculations involving combined operations of rational numbers; round whole numbers and decimals, including measures, to a given number of significant figures; use rounding to estimate calculations

- Percentage and Proportion—Find a percentage of a percentage and simple interest; understand direct proportion and apply proportional reasoning to solve problems
- Powers—Apply index notation and the laws of indices to simplify and evaluate expressions with integral powers; read and write numbers in the scientific notation  $A \times 10^n$ , where  $n$  is an integer and  $1 \leq A < 10$ ; and use scientific notation in calculations and to estimate results of calculations and to make comparisons
- Algebraic Expressions and Formulas—Perform four operations of algebraic expressions; add and subtract algebraic fractions with integral denominators; expand expressions of the form  $(ax \pm b)^2$ ,  $(ax + b)(cx + d)$ , where  $a$ ,  $b$ ,  $c$ , and  $d$  are integers; simplify algebraic expressions by taking out common factors; and change the subject of a formula
- Equations and Inequalities—Solve linear equations and linear inequalities with rational number coefficients in one variable and solve problems involving them
- Functions and Graphs—Understand and find the gradients of straight lines; interpret and find the equation of a line in the form  $y = mx + c$ ; find coordinates of points determined by geometric information; given the coordinates of  $A$  and  $B$ , find the midpoint of line segment  $AB$ , the point that divides line segment  $AB$  in a given ratio, and the length of line segment  $AB$ . Translate “ $y$  is proportional to  $x$ ” into symbolism and into a linear equation with the constant of proportionality as gradient; and recognize the proportional relationship between two variables (that is, if two variables are graphically connected by a straight line passing through the origin, then the two variables are proportional to each other), then use that information to find the constant of proportionality
- Geometry and Measures
  - Transformations—Identify and draw rotation of a 2D shape, about the origin, a given point, or a vertex of the shape, through multiples of 90 degrees and conversely, find the center or angle of rotation when a shape and the resulting image are known; identify rotation symmetry, properties of 2D shapes, including triangles, quadrilaterals, and regular polygons, and draw 2D symmetrical figures; identify and draw enlargement of 2D shapes by positive integers and a positive scale factor using a given center of enlargement; deduce that the object and its image of enlargement are similar and find the scale factor or the center of enlargement, given an object and its image of enlargement
  - Similarity—Identify similar shapes and use the properties of similarity to determine unknown sides or angles; construct and interpret scale drawings and understand that if two shapes are similar, the ratio of the area of the shapes is the ratio of the squares of the lengths of the corresponding sides; in three dimensions, calculate the ratio of volume of a scale model to the volume of the actual object
  - Pythagorean Theorem—State and apply the Pythagorean theorem; determine whether a triangle is right-angled given the length of the three sides; and apply the Pythagorean theorem to solve problems

- Rate—Solve problems involving speed, constant speed, average speed, distance, or time; interpret and sketch a distance–time graph and a speed–time graph; and solve problems involving density
- Surface Area and Volume—Find the volume and surface area of right prisms, cylinders, and related solids
- Data Handling—Use an appropriate method of data collection to address a given question, choose representative samples to collect data from a primary source, and scrutinize samples for obvious sources of bias; plan surveys and design questionnaires to collect primary data to test hypotheses and answer questions by collecting, classifying, representing, and interpreting data, using frequency tables with equal class interval, frequency diagrams with equal class intervals, and stem and leaf diagrams
- Probability—Recognize that the total probability of all mutually exclusive outcomes is 1, and that an event and its complement are mutually exclusive; calculate the probability of two mutually exclusive events; list systematically all the possible outcomes of an experiment in different representations for simple combined events and calculate the probability of simple combined events<sup>4</sup>

## The Science Curriculum in Primary and Lower Secondary Grades

The aims for the science curriculum begin with developing Attitudes, then acquiring Skills and Knowledge (ASK). The science content is divided into three strands: Biology, Chemistry, and Physics. The strands are taught in an integrated way in primary and lower secondary grades. Each content strand is designed around themes that students can relate to in their everyday experiences and on commonly observed phenomena in nature.

The Biology strand comprises the following themes: Structure and Function of Organisms; Growth, Development, Reproduction, and Inheritance; Organisms and Their Environment; Health and Disease; and Diversity and Variation in Living Things.

The Chemistry strand comprises the following themes: Materials and Their Properties; Structure and Bonding of Matter; Patterns in Chemical Reactivity; Reaction Kinetics and Energetics, and Chemistry in Our World.

The Physics strand comprises the following themes: Waves, Light, and Sound; Forces, Motion, and Scale; Electricity and Magnetism; Matter and Energy; and Earth and Space.

The learning experiences in science content are explicitly linked to one or more competencies. The science curriculum enhances five competencies: Inquiry and Research, Critical and Creative Thinking, Cooperation and Participation, Communication, and Problem Solving. These competencies help students to take charge of their own learning and apply knowledge to develop explanations for new situations.

The science standards at the fourth grade comprise the following:

- Biology—Students describe the features of terrestrial, marine, and freshwater habitats; identify some living things in each habitat; and explain how these living things adapt to

live in different habitats. They discuss the positive and negative impacts of humans on habitats. They discuss examples of humans trying to conserve habitats and wildlife. They compare and contrast the life cycles of insects, fish, amphibians, reptiles, birds, and mammals. They list some of the reasons that humans need clean water and describe the effects of dirty water on human health. They describe how changes in body temperature can affect human health. They examine how exercise affects heart rate. They explain why regular exercise and a proper diet are important for health.

- Chemistry—Students understand the terms mass, volume, and shape. They classify matter as solids, liquids, or gases based on their observable characteristics.
- Physics—Students define sound as a vibration and explain the variation of sound volume. They investigate the effects of distance on how a sound is heard. They explain how sound travels to our ears and explain how echo occurs. They describe how living things are able to hear sounds. They explain how and why loud sounds can damage the ear. They demonstrate and explain that sounds can travel through liquids, solids, and air. They investigate the effectiveness of different materials on muffling sound. They estimate and measure the temperature of different objects using a thermometer and a data logger. They investigate the changes in temperature of a hot and a cold object in a room. They investigate the heat conducting and insulating properties of different materials.

The science standards at the eighth grade comprise the following:

- Biology—Students explain the need for organ systems in terms of surface area to volume ratios. They identify the sources and describe the functions of nutrients in a diet (carbohydrates, protein, lipid, vitamins, minerals, water, and fiber). They describe the structure of the human digestive system and explain how the structures are adapted for their functions. They understand the role of enzymes, gastric acid, and bile in controlling digestion. They understand the structure and function of the human respiratory tract including adaptations for ventilation and gas exchange. They understand the structure and function of the human circulatory system. They discuss factors that improve the health of your circulatory system. They describe the link between an unbalanced diet, obesity, and diabetes. They describe and evaluate the effects of tobacco smoke and its toxic components on health. They analyze data and evaluate the effect of smoking and other risk factors on the incidence of coronary heart disease. They explain how carbon and water cycle through the abiotic and biotic components of an ecosystem and how environmental change, including global warming, can affect biodiversity.
- Chemistry—Students identify chemical changes and different types of chemical reactions. They write word equations for simple reactions. They outline how the atomic model changed over time. They describe an atom as made up of protons, neutrons, and electrons. They recognize that elements can be represented by chemical symbols. They understand that atoms can combine to form molecules of constant composition. They investigate the characteristics of common acids and alkalis. They investigate the use of indicators to classify whether the solution is acidic, alkaline, or neutral. They identify strong and weak acids, strong and weak alkalis, and pure water on the pH scale. They

describe the current composition of the atmosphere. They understand the effects of humans on the atmosphere and suggest ways to reduce the main sources of atmospheric pollution.

- **Physics**—Students explain the concept of energy and state the principle of conservation of energy. They explain energy transfers by conduction, convection, and radiation. They compare and contrast metals and nonmetals based on thermal conductivity. They describe the formation of convection currents in different natural environments. They investigate how the properties of different surfaces affect the amount of infrared radiation absorbed and/or emitted by them. They determine the nature and position of an image in a plane mirror and use the laws of reflection to construct a periscope and explain how it works. They understand how light refracts at the interface between two media. They distinguish alternating current from direct current. They recognize and discuss the hazards of mains electricity. They describe the purpose and operation of safety devices. They explain how electricity is generated in Qatar. They understand the concept of power in the context of electrical appliances. They calculate the cost of running different appliances from their power rating. They recognize the main features of the solar system. They explain the functions of natural and artificial satellites. They explain eclipses in terms of the movement and relative sizes of the Sun, Earth, and Moon. They discuss the reasons for the differences between the Islamic calendar and the Gregorian calendar.<sup>5</sup>

## Professional Development Requirements and Programs

The Training and Educational Development Center in the Ministry of Education and Higher Education provides professional development opportunities for teachers and school leaders, to keep them current on the latest teaching, school leadership, and management techniques. It provides training workshops in mathematics and sciences for teachers in all stages (K–12) held by specialists in this field. The workshops aim to raise teachers’ performance, which will impact the achievement of students on the TIMSS assessment, as well as keep teachers up to date with the latest teaching techniques, strategies, and developments in the education field.<sup>6</sup>

## Monitoring Student Progress in Mathematics and Science

Human development is the cornerstone of Qatar’s National Vision 2030, which stresses that development cannot be achieved without advanced and high quality education and training services, in harmony with the needs of the labor market and the ambitions and abilities of each individual.

The evaluation department is responsible for designing and implementing the Qatar National Tests, a program that measures student learning, the knowledge and skills included in the curriculum standards, and the development in the educational skills and competencies acquired by students in each subject at each appropriate age level. The program administers standardized tests to students in the government schools and private schools that apply the Qatari curriculum in Qatar. Testing is done annually at the end of the second semester. Grade 3 is tested in Arabic,

English, and mathematics subjects, and Grades 6 and 9 are tested in Arabic, English, mathematics, and science.

The national testing system aims to develop and modernize the evaluation system to obtain accurate information on the performance of schools and student learning, and to develop indicators to measure the quality of education, in terms of the effectiveness of the education system, schools and teachers, and the curricula. It seeks to raise the student performance by enabling the development of treatment plans based on feedback.

## Special Initiatives in Mathematics and Science Education

Mathematics and science education in Qatar aims to cultivate student interest and lay a strong foundation in numeracy and scientific literacy from the early years of formal education. There are policies and programs in place designed to engage students with diverse interests and learning needs. For example:

- The 16th International Junior Science Olympiad took place in Doha in 2019. It was organized by the Ministry of Education and Higher Education in collaboration with Qatar University. More than 300 students ages 15 years and younger, from more than 50 countries, met during the Olympiad to test their knowledge and skills in physics, biology, and chemistry. The aim of this annual science competition is to introduce students, at a young age, to an international network of beta enthusiasts. In addition, it promotes the pursuit of excellence in scientific endeavors, rewards achievement, and stimulates gifted students to further develop their talents in natural sciences.<sup>7</sup>
- STEM Adventure Camp is a collaborative project between the College of Education, Qatar University, and Exxon-Mobil. The event engages preparatory students in learning about science, technology, engineering, and mathematics (STEM). The purpose of the camp is to encourage students in Qatar to consider careers in STEM and STEM education by reaching out to the preuniversity student population. Other goals include improving attitudes toward STEM and STEM education careers among precollege students and increasing intent to pursue careers in STEM and STEM education.

The project brings together practicing professionals in the STEM fields, STEM educators, and preparatory students, so students can learn about and personally engage in STEM activities. They thus may learn about careers they were originally interested in, consider others, have questions answered, and see how exciting and engaging such careers may be. Activities are designed by specialists in each area and include such projects as robot building, animation and/or movie creation, environmental data collection and analysis, biology and chemistry experiments, and materials science challenges. STEM education is critical to Qatar's economic future.<sup>8</sup>

## References

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