Kazakhstan

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Introduction

Overview of Education System

In accordance with the Constitution of the Republic of Kazakhstan, the State guarantees free compulsory secondary education[a] in public schools for all citizens.[1] For students who are unable to attend secondary education organizations due to health issues, free individual education is arranged at home or in organizations that provide inpatient care, restorative treatment, and medical rehabilitation. In locations with a small population, the functioning of small schools[b] (40.1% of the total number of public schools) is guaranteed to ensure equal access to secondary education for students.

The Kazakhstani education system is centralized. State policy on the development of education and key initiatives are formed and implemented by the Government of the Republic of Kazakhstan. The Ministry of Education (MoE)[c] is responsible for implementation of the unified State education policy and overall coordination of activities of local executive bodies of education. The MoE also facilitates cross-sector coordination; adopts standard curricula, admission, and assessment criteria for students and requirements for the structure and content of textbooks of primary, basic secondary, and general secondary education; ensures quality maintenance of services provided by educational organizations; and oversees the execution of State legislation and compulsory education standards.[2] The organization of the textbook examination for secondary education organizations, as well as methodological and scientific support of the education process (compulsory education standards, standard curriculum), belongs to the State monopoly.

Local representative bodies in regions are responsible for implementation of the State education policy. They also provide the material and technical support for State educational organizations; carry out education monitoring; develop and adopt internal regulation standards for the educational organizations; and provide in-service teacher education and methodological,

a Secondary education includes general education programs of primary, basic secondary, and general secondary education.

b A small school (also known as an ungraded school) is a general education school with a specific form of organization of instruction. Small schools are recognized as a special group of schools in Kazakhstan's legislation and are allowed to provide multigrade teaching and are characterized by having a very small number of students and low student-teacher ratios.

c According to the June 11, 2022, decree of the President of the Republic of Kazakhstan on modernization and improving the efficiency of the public administration system, the Ministry of Education and Science of the Republic of Kazakhstan was reorganized and divided into the Ministry of Education and the Ministry of Science and Higher Education.

pedagogical, psychological, and medical consulting services to schools. In 2021, a new model of education system management in regions was introduced, according to which the education departments located in oblast districts, cities, and city boroughs of oblast and State significance are directly accountable to education departments of oblasts and cities of State significance. Consequently, all financial issues were transferred from local *akimats* to the regional education authorities, allowing the formation of a unified education policy, regardless of the location, material, and financial resources of localities.[3]

Although schools in Kazakhstan have low levels of autonomy, they still have some independence to implement the education process and scientific, financial, and economic activities within established limits; recruit and arrange teaching staff; and allocate resources for students in classes. Public education organizations are financed from the State budget in accordance with State legislation.

The education system in the Republic of Kazakhstan is based on the principles of consistency and continuity and includes the following levels:[4]

- early childhood education and care
- primary education (Grades 1 to 4)
- basic secondary education (Grades 5 to 9)
- secondary education (general secondary education [Grades 10 and 11], technical education, and professional education)
- postsecondary education
- higher education
- postgraduate education

According to the United Nations Partnership Framework for Development (UNPFD), "Kazakhstan has achieved near universal enrolment in primary and secondary levels of education, and the Government is committed to continuing investing in pre-school and school programs."[5]

Use and Impact of TIMSS

International comparative studies have played a key role in modernizing Kazakhstan's education system. Kazakhstan's participation in international studies is stipulated in the State Program for the Development of Education and is funded by the national budget. The country's participation in such studies is invaluable. It not only enables the country to obtain objective data, but it also gives the country a realistic assessment of achievement and problems in its education system.

TIMSS results are used to update the mathematics curriculum, review teaching methods in mathematics and science at schools and universities, and review teacher professional development programs. For example, the Y. Altynsarin National Academy of Education used the TIMSS conceptual model to develop educational programs and school textbooks, and the National Center for Professional Development (NCPD) "Orleu" developed special programs to support teaching staff in implementing international assessments of student achievement.

The National Reports, based on the results of previous cycles, present key recommendations for improving the quality of education. Moreover, because of international comparative surveys, the MoE has set itself a number of tasks to improve the academic knowledge of students.

The Mathematics Curriculum in Primary and Lower Secondary Grades

State compulsory education standards define the goals and objectives of mathematics education at the primary, basic secondary, and general secondary levels.[6] The objectives of mathematics education for students in primary education (Grades 1 to 4) are as follows:

- develop number sense through counting and measuring and learn the principles of writing numbers
- learn to perform arithmetic operations with numbers verbally and in writing, solving for unknowns
- learn to write and solve numerical expressions using rules of calculation
- gain experience solving arithmetic problems
- gain familiarity with simple geometric shapes and the meaning of quantities and methods of measurement
- learn arithmetic methods for solving word problems
- learn to solve educational and practical problems using mathematics
- work with algorithms to perform arithmetic operations

The updated mathematics curriculum in primary school is divided into the following five sections that students study further at later levels of education:

- Numbers and Quantities
- Elements of Algebra
- Elements of Geometry
- Elements of Logic
- Math Modeling

To ensure continuity, the curriculum for primary education includes new subsections—Combinatorics, Sequences, Sets and Operations on Sets, and Fractions. It reinforces the previous subsection Geometric Shapes. The study of these subsections promotes the development of skills including logical thinking; analyzing processes and phenomena; and identifying cause-and-effect relationships, patterns, and development trends. TIMSS includes tasks of this type.

The objectives of mathematics education for students in Grades 5 and 6 of basic secondary education are as follows:

- learn about rational numbers and their properties, arithmetic operations with rational numbers, and ordinary and decimal fractions

- develop the ability to solve equations using knowledge of the interconnections of the components of arithmetic operations
- learn to calculate using formulas
- learn to solve problems involving proportions
- learn to solve equations by using the commutative and associative properties of addition
- learn to solve linear inequalities with one variable and their systems
- learn to solve linear equations and inequalities with one variable, containing a variable under the sign of the module
- learn to find the coordinates of points and plot points according to their coordinates on the coordinate line and on the coordinate plane
- learn to solve a system of linear equations with two variables
- develop familiarity with planes, balls, and spheres

Grades 7 to 9 offer two subjects:

- algebra—Students learn how to perform arithmetic operations with polynomials, factor polynomials, use the formulas of abbreviated multiplication, perform actions on rational fractions, perform identical transformations of fractional rational expressions, prove identities, and find absolute and relative errors; learn to perform identical transformations of expressions containing square roots, solve square and fractional rational equations, and solve square inequalities using graphs of quadratic functions; and learn to solve rational inequalities using intervals.
- geometry—Students develop familiarity with geometric shapes, including quantitative and qualitative relationships between components of one or more geometric shapes; develop deductive reasoning skills (direct proof, proof by contradiction), simple drawing and measurement skills, and the ability to represent a real object in the form of one or more geometric shapes; expand and systematize theoretical knowledge of properties of plane figures; develop the ability to solve geometric problems of calculation, proof, and construction; expand the ability to recognize geometric shapes in drawings of various degrees of complexity, using additional constructions and auxiliary drawings to solve problems; develop the ability to construct images of plane figures obtained during plane transformations, solving geometric problems using algebraic methods; develop familiarity with space and spatial figures; and develop familiarity with images of spatial figures and their components.

Basic mathematics content traditionally includes the following topics:

- numbers and calculations—natural numbers, ordinary and decimal fractions, percent and proportion, integers, rational numbers, irrational numbers, order of operations, indicators, finding roots, logarithms, sine, cosine

- mathematical expressions and transformations—variables, alphanumeric expressions, and identities and their use in transforming expressions; algebraic expressions (monomials, polynomials, and fractions) and arithmetic operations with integer and fractional algebraic expressions; trigonometric expressions
- equations and inequalities—proofs of identity and inequality of expressions; equivalence in equations and inequalities; defining equations and inequalities; equations and inequalities with one and two unknowns and their geometric interpretations; rational inequalities; systems of equations and inequalities
- functions—numerical and elementary functions, their properties, and graphs; arithmetic and geometric progressions
- geometric shapes and their properties—points, line segments, rays, lines, planes, subspaces, angles, polygons, circles, and circumference, polyhedral, and bodies of revolution; geometric relationships (parallelism, perpendicularity, equality, and symmetry); geometric values (line length, angle values, area, and volume); vectors and coordinates; using analytical tools in geometry
- elements of probability theory and statistics—presenting statistical data (tables, diagrams, and histograms); calculating descriptive statistics (mode, median, average, range, and standard deviation); graphs; permutation; combinatorics; geometric probability models

The Science Curriculum in Primary and Lower Secondary Grades

In the framework of updating the content of primary education, natural sciences in Grades 1 to 4 are taught through two courses: Knowledge of the World and Natural Science.

Knowledge of the World includes the following components:

- nature—living and nonliving objects and their properties; natural phenomena and their properties, conditions, and relationships; fauna and flora, including similarities, basic needs, breeding, and habitat
- humans—the concept of humans as part of the natural world; significant features that distinguish humans from animals; the role of humans in the development of science, technology, the environment, and society
- society—the homeland, family, school, and understanding of oneself and one's position in society

Natural Science in primary school is designed to lay the foundation for the study of such subjects as biology, geography, chemistry, and physics. It is organized into the following sections:

- I Am a Researcher—the role of science and researchers, methods of understanding nature
- Wildlife—plants, animals, people

- Substances and Their Properties—types of substances, air, water, natural resources
- Earth and Space—Earth, space, and time
- Physics of Nature—forces and motion, light, sound, heat, electricity, magnetism

The content of each component or section is studied continuously from first through fourth grade and becomes increasingly complex from grade to grade.

In basic secondary education (Grades 5 to 9) and general secondary education (Grades 10 to 11 or 12), natural sciences are studied in the following subjects: geography (Grades 6 to 11), biology (Grades 6 to 11), physics (Grades 7 to 11), and chemistry (Grades 8 to 11). As part of the curriculum update, an additional subject—natural science—was introduced in Grades 5 and 6 as a continuation of the primary school program.

- geography—By the end of Grade 9, students should know about Earth as one planet in the solar system; the size and shape of Earth; Earth's continents; natural features of Earth that reflect its structure, space, and differences from other planets; processes and phenomena on Earth; material and spiritual cultural values that reflect human experiences of existence; types, structures, and characteristics of territories; the modern world and concepts related to sustainable development and the diversity of life; and global, regional, and local problems of modern geography and environment and environmental issues.
- biology—Across the grades, students learn the levels of life organization according to molecular, cellular, tissue, organism, population, biogenetic, and biosphere levels; the diversity of living organisms, their interaction, ontogenesis, phylogenesis, and evolution; systemic groups of organisms; the human as a biosocial person; fundamental biological theories (cellular, evolutionary, and chromosomal) and concepts (e.g., ecology and the origin of life). In Grades 6 to 9, students study living organisms, the diversity of organisms, evolution, flora, and fauna in the environment; ecology and the biosphere; humans and their health; cell biology; and the basics of genetics and natural selection, including heredity and human genetics and evolution.
- physics—This topic area focuses on physical methods of studying nature, mechanics, molecular physics and thermodynamics, electrodynamics, atomic and nuclear physics, and astrophysics. By the end of Grade 9, students should be aware of motion, the molecular structure of substances, thermal effects, direct current, the interactions of magnets, electromagnetic waves, the atomic nucleus, nuclear energy, and the structure and composition of the solar system.
- chemistry—This topic area covers various organizational levels of substances, including simple and complex substances, pure substances, and mixtures; wide classes of organic and inorganic substances, natural and chemical polymers, and the theory of the chemical structure of substances; chemical reactions and their classifications; the periodic system of chemical elements; and the theory of electrolytic dissociation. By the end of Grade 9, students are studying atomic-

molecular theory and the law of conservation of mass; physical and chemical changes; chemical elements and formulas, including atomic and molecular masses, oxygen, hydrogen, water, and air; the main classes of inorganic compounds; the periodic table of chemical elements; covalent and ionic bonds; electrolytic dissociation of acids, bases, and salts; physical and chemical properties of metals and nonmetals; and fundamental concepts of organic compounds.

- natural science—This topic area focuses on the foundations of research, thinking, communication skills, and abilities: developing and proving hypotheses, and drawing conclusions based on experimental data; formulating research questions and developing a research plan; collecting, describing, and evaluating data obtained during observations and experiments; drawing conclusions; working with natural science information from the media, Internet, and scientific and popular science literature; owning the search methods, highlighting the semantic basis, and evaluating the accuracy of the information; presenting the results of a study in various forms; and explaining the applied value of the most important achievements in natural sciences. Natural science is an integrated course that forms the basis for further study of biology, geography, physics, and chemistry.

Teacher Professional Development Requirements and Programs

Teacher development is a central priority in improving the quality of education in Kazakhstan. According to the Law on Education, teachers should undertake professional development at least once every 5 years to improve their qualifications.[7] Article 15 of the Law on Teacher Status also requires teachers to improve their professional, research, intellectual, and creative skills continually by confirming and enhancing their qualification level at least once every 5 years.[8]

The required professional development programs for teachers of all levels of education are organized and financed by the Government. The courses mainly are provided by 17 regional branches of the joint-stock company (JSC) NCPD "Orleu"; the Center of Excellence of the Autonomous Educational Organization (AEO) Nazarbayev Intellectual Schools; the National Chamber of Entrepreneurs (Atameken); the National Scientific, Practical, Educational and Health Improvement Center "Bobek"; the National Scientific and Practical Center of Correctional Pedagogy; higher education institutions; and regional methodological offices, as well as through teaching internships under the Bolashak international scholarship.

The short-term courses last at least 36 academic hours, while the duration of long-term courses is at least 108 academic hours.[9] Teachers are assigned to courses by educational organizations and departments. The administration of the educational organization monitors the teacher's application of acquired competencies upon completion of the course. In 2021, around 4,000 teachers across the country completed short-term courses on primary school subjects at JSC NCPD "Orleu." The Center of Excellence of the AEO Nazarbayev Intellectual Schools

provided professional development courses on development and examination of assessment tasks and advancement of teachers' subject competencies for 5,101 primary school teachers.[10]

There are several professional development programs that are available to teachers, including the following:

- new approaches to teaching and learning
- teaching critical thinking
- assessment for professional development and assessment of professional development
- use of information and communications technology (ICT) in teaching and learning
- teaching talented and gifted students
- teaching and learning in accordance with the age-level characteristics of students
- management and leadership in professional development

The regional branches of the JSC NCPD "Orleu" conduct short-term 80-hour online courses on Mastering Complex Topics of the Primary School Subjects for primary school teachers in secondary education organizations with Kazakh as the language of instruction.

Kazakhstani teachers benefit from a teacher certification process known as teacher attestation. Attestation is a process that determines the qualification level of teachers, the results of which are used to award a category. Primary school teachers take a national qualification test under the attestation process on subject content (Kazakh or Russian language, literature, reading, mathematics) at least once every 5 years to be qualified in one of five categories: teacher, teacher-moderator, teacher-expert, teacher-researcher, and teacher-master.[11] Qualification in each successive category leads to a salary increase and promotion.

Monitoring Student Progress in Mathematics and Science

To inform the development of educational programs, educational organizations carry out ongoing monitoring of student performance. Educational organizations independently determine the method, order, and frequency of assessments. Currently, teachers in all academic subjects conduct assessments of student performance.

Internal Assessments

To assess students, educational organizations monitor progress and conduct intermediate certification of students in accordance with independently chosen forms, procedures, and frequency. The evaluation criteria of student achievement (summative evaluation with scoring and formative assessment with feedback provision) were adopted as a part of the transition to the updated education content considering the special education needs and individual abilities of students. The criteria-based assessment, introduced in 2016, allows educators to assess students' achievement based on clearly measurable criteria, to form students' capacity to monitor and evaluate their own learning activities, adjust the learning process, and identify and

eliminate difficulties in the learning process. The evaluation criteria of students' educational achievement in language subjects are based on assessment of the following domains: listening, speaking, reading, and writing. Each lesson starts with demonstrating learning objectives (to observe, analyze, compare, identify essential features, recognize, define, model, explain, etc.) and criteria for achieving them. The evaluation criteria should correspond to the learning objectives.

Summative and formative assessments of primary school students start in second grade. Summative assessment is carried out at the end of an academic period (term) or after finishing certain module/cross-cutting topics in accordance with the curriculum. For language subjects, two types of speech activity are combined (for example, listening and speaking or reading and writing) for summative assessment. The items are developed by teachers based on the curriculum content of the section/quarter/half-year using creative items, practical tasks, projects, essays, etc.

The assignment structure includes the following:

- multiple-choice items
- open questions with short answers
- open questions with expanded answers
- creative/practical/research items with specific evaluation criteria

Formative assessment is carried out during daily work in the classroom as an actual indicator of students' progress, providing an operative relationship and feedback between student and teacher and allowing for improvement of the education process. During formative assessment, the teacher independently determines the number of students to assess and the frequency of providing feedback with consideration of the number of performed tasks. The expanded feedback can be provided through comments, headings, and recommendations. The scores of formative assessments and summative assessments for the section (SAS) and for the quarter (SAQ) are displayed in electronic journals. Annual assessment at the end of the academic year includes the results of both formative (25%) and summative assessment (SAS: 25%, SAQ: 50%).

According to the State education standards, students are also given homework assignments, which take no more than 50 minutes for Grade 2 and no more than 1 hour 10 minutes for Grades 3 and 4.[12]

External Assessments

Monitoring of students' educational achievements (MSEA) is a systematic independent control of the quality of education at the national level. It measures the quality of students' basic knowledge for compliance with State compulsory standards of primary and basic secondary education. The test is presented in a digital format. According to the Regulations for Monitoring Students' Educational Achievements, the MoE prepares and conducts assessment; processes and analyzes test results; and provides methodological assistance and recommendations by regions and specific schools for ensuring the quality of education.[13] The analytical report on test

results reflects the current situation in the Kazakhstani education system and is used broadly by research organizations to conduct comparative studies. The results identify factors affecting the quality of education (e.g., study difficulties, training gaps, needs for teacher professional development); determine educational organizations that need methodological support; and strengthen the pedagogical potential of the educational organizations.

The target groups of MSEA assessment are students in Grades 4 and 9. For fourth-grade students, MSEA is conducted on an annual basis in the form of a comprehensive test that measures functional literacy (application of knowledge and skills, analytical and logical thinking) within three areas: reading literacy, mathematical literacy, and science literacy. The MoE determines the list of educational organizations for monitoring via random sampling according to their location (urban/rural), language of instruction (Kazakh/Russian), school type (secondary school, lyceum, gymnasium), and student contingent. Twenty-five percent of schools that meet all indicated criteria are randomly sampled. The list does not include schools that participated in assessment in previous academic years. The number, content, and form of test items are determined by the test specification developed by the National Testing Center. The center also provides software and technical support for testing procedures and implements statistical processing of results. For primary education organizations, the assessment results meet the requirements of State education standards when at least 40% of participants answer at no lower than the "satisfactory" level.[14]

Special Initiatives in Mathematics and Science Education

In accordance with the Law of the Republic of Kazakhstan on Education, in-depth science and mathematics education is one of the focus areas of school education. Students can receive in-depth training in science and mathematics in innovative institutions, including lyceums, schools for gifted children, specialized schools, and Nazarbayev intellectual schools in Kazakhstan.

To promote careers in science and mathematics, Kazakhstan actively takes part in international Olympiads, in addition to coordinating them.

Suggested Reading

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