Republic of Korea

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Introduction

Overview of Education System

The Ministry of Education (MOE) is responsible for the formulation and implementation of policies related to academic activities and public education. The specific responsibilities of the MOE include the following:

- planning and coordinating education policies
- formulating policies that govern primary, secondary, and higher education institutions
- publishing and approving textbooks
- providing administrative and financial support for all levels of the school system
- supporting local education offices and national universities
- operating the teacher training system
- overseeing lifelong education
- developing human resource policies

With the enactment of the Local Education Autonomy Act in 1991, education administration became decentralized, establishing a local education autonomy system. This system delegates authority to local governments, with metropolitan and provincial offices of education and the education committee of the metropolitan or provincial councils serving as core components. The governors of education of the metropolitan and provincial offices are elected by residents and serve for 4 years, overseeing local education administration. Local offices of education, under the metropolitan and provincial offices of education, support students, parents, and schools. As of 2023, there are 17 metropolitan and provincial offices and 176 local offices.[1]

Korea has a single-track 6-3-3-4 system of education: 6 years of elementary school (primary grades), 3 years of middle school (lower secondary grades), 3 years of high school (secondary grades), and 4 years of university. The first academic semester begins in March, and the second semester starts at the end of August. Elementary and middle school education is compulsory. In line with the principle of equal opportunity in education, all children are guaranteed to receive elementary, secondary, and higher education according to their abilities, regardless of their social status or position.[2]

Use and Impact of TIMSS

Korea has participated in every cycle of TIMSS since 1995. In Korea, both education researchers and policymakers have continually tried to benchmark and refer to TIMSS results when developing national curricula and education policies. For example, since TIMSS 1995, it has been an important goal to foster positive attitudes among students toward mathematics and science due to the low interest and confidence they had previously shown in those two subjects despite their generally high levels of attainment. To accomplish this goal, the Comprehensive Plan for Mathematics Education (2020) was implemented that aims to cultivate positive attitudes toward mathematics by supporting the development of basic mathematics competences and providing customized learning and inquiry-based learning experiences.[3] The Comprehensive Plan for Science Education (2020) was also implemented to cultivate positive attitudes toward science through promoting enhanced scientific inquiry and creating improved science education environments with enriched experience spaces and laboratories.[4]

The Mathematics Curriculum in Primary and Lower Secondary Grades

Korean fourth-grade students who participated in TIMSS 2023 had studied under the 2015 mathematics curriculum from Grades 1 to 4; the eighth-grade students who participated in TIMSS 2023 had studied under the 2009 mathematics curriculum in Grade 1 and the 2015 curriculum from Grades 2 to 8. Therefore, the 2015 mathematics curriculum is summarized below.

The 2015 mathematics curriculum aims to help students understand phenomena in everyday life, society, and nature mathematically; solve problems rationally and creatively based on a sound understanding of concepts, principles, and laws of mathematics; acquire skills and reason mathematically and cultivate communication skills; and foster desirable attitudes and practical skills as learners of mathematics. Specifically, the goals of mathematics education for elementary school and middle school in the 2015 mathematics curriculum are as follows:

- elementary school
  - develop an understanding of basic mathematical concepts, principles, and laws, as well as acquire mathematical skills, through observing, analyzing, and expressing everyday life phenomena in mathematical terms
  - develop the capability to reason and communicate mathematically, and understand everyday life phenomena and solve problems in rational and creative ways, based on creative and integrative thinking and the ability to process information
  - experience the joy of learning mathematics, be aware of the usefulness of mathematics, and develop a positive attitude and practical competencies toward acquiring mathematical knowledge

- middle school
  - develop understanding of mathematical concepts, principles, and laws, as well as their interrelationships, and acquire mathematical skills through observing, analyzing, organizing, and expressing social and natural phenomena mathematically
  - develop the ability to reason and communicate mathematically, understand social and natural phenomena, and solve problems in rational and creative ways, based on creative and integrative thinking and the ability to process information
  - develop awareness of the value of mathematics and cultivate interest and confidence, and foster desirable attitudes and practical competencies as mathematics learners

The 2015 mathematics curriculum emphasizes that students should not only understand and acquire mathematical knowledge and skills, but also cultivate six mathematical competencies: problem-solving; reasoning; creativity and integration; communication; information processing; and attitude and practice. Through cultivating mathematical subject competencies, it is expected that students will be able to successfully carry out the role of community members in the society of the future, which is becoming increasingly complex and specialized; develop individual potential and talent; understand the need and usefulness of mathematics and experience the joy of learning mathematics; and develop interest and confidence in mathematics.[5]

In the 2015 mathematics curriculum, the content for elementary school consists of five areas: Numbers and Operations, Shapes, Measurement, Patterns, and Data and Chance. The content for middle school also consists of five areas: Numbers and Operations, Variables and Expressions, Functions, Geometry, and Probability and Statistics. Exhibits 1 and 2 provide the core concepts and content elements in an individual grade band for each area in the 2015 mathematics curriculum.

Exhibit 1: Topics Covered in Grades 1 to 6 in the 2015 Mathematics Curriculum

Area	Core Concept	Content Elements		
		Grades 1 and 2	Grades 3 and 4	Grades 5 and 6
Numbers and Operations	the number system	• numbers up to four digits	• five-digit and higher numbers • fractions • decimals	• factors and multiples • reduction of fractions, reduction of fractions with a common denominator • relationship between fractions and decimals

Exhibit 1: Topics Covered in Grades 1 to 6 in the 2015 Mathematics Curriculum (Continued)

Area	Core Concept	Content Elements		
		Grades 1 and 2	Grades 3 and 4	Grades 5 and 6
Numbers and Operations	numerical operations	• addition and subtraction of two-digit numbers • multiplication	• addition and subtraction of two-digit numbers • multiplication and division of natural numbers • addition and subtraction of fractions with same denominator • addition and subtraction of decimals	• mixed arithmetic operations with natural numbers • addition and subtraction of fractions with unlike denominator • multiplication and division of fractions • multiplication and division of decimals
Shapes	plane figures	• shape of plane figures • plane figures and their components	• foundations of shapes • components of a circle • triangles • quadrilateral figures • polygons • moving plane figures	• congruence • symmetry
	solids	• shapes of solids		• rectangular prism, cubes • prisms, pyramids • cylinders, cones, spheres • spatial sense of solids
Measurement	measurement of quantity	• comparing quantities • time and time intervals • length (cm, m)	• time, length (mm, km), capacity, weight, angles	• the ratio of circumference to diameter • the perimeter and area of a plane figure • the surface area and volume of a solid

Exhibit 1: Topics Covered in Grades 1 to 6 in the 2015 Mathematics Curriculum (Continued)

Area	Core Concept	Content Elements		
		Grades 1 and 2	Grades 3 and 4	Grades 5 and 6
Measurement	estimate			• range of numbers • estimation (rounding up, rounding down, rounding off)
Patterns	patterns and correspondence	• identifying patterns	• demonstrating patterns in numbers and equations	• patterns and correspondence • ratio and rate • proportional expressions and proportional distribution
Data and Chance	data processing	• classifications • tables • graphs using symbols O, ×, /	• simple picture graphs • bar graphs • line graphs	• average • pictograph • band graphs and pie charts
	chance			• chance

Exhibit 2: Topics Covered in Grades 7 to 9 in the 2015 Mathematics Curriculum

Area	Core Concept	Content Elements Grades 7 to 9		
Numbers and Operations	the number system	• prime factorization • integers and rational numbers	• rational numbers and recurring decimals	• square roots and real numbers
	numerical operations			
Variables and Expressions	polynomials	• using variables and calculating expressions	• calculating expressions	• multiplication of polynomials and factorization
	equations and inequalities	• linear equations	• linear inequalities and systems of linear equations	• quadratic equations
Functions	measurement of quantity	• coordinate plane and graphs	• linear functions and graphs • relationship between linear functions and linear equations	• quadratic functions and graphs

Exhibit 2: Topics Covered in Grades 7 to 9 in the 2015 Mathematics Curriculum (Continued)

Area	Core Concept	Content Elements Grades 7 to 9		
Geometry	plane figures	• basic figures • construction and congruence • properties of plane figures	• properties of triangles and quadrilaterals • similarity of figures • the Pythagorean theorem	• trigonometric ratios • properties of circles
	solids	• properties of solids		
Probability and Statistics	probability		• probability and basic properties of probability	
	statistics	• organizing and interpreting data		• representative value and degree of scattering • correlation

The Science Curriculum in Primary and Lower Secondary Grades

Korean fourth- and eighth-grade students who participated in TIMSS 2023 had studied under the 2015 science curriculum. Therefore, the 2015 science curriculum is summarized below.

The 2015 science curriculum emphasizes expanding scientific inquiry into students' daily lives and society in general. The 2015 science curriculum also aims to help students develop lifelong learning skills based on recognition of the joy and value of learning science. Specifically, the goals of the 2015 science curriculum are as follows:

- develop a curiosity and interest in natural phenomena and an attitude toward solving problems scientifically
- develop the ability to scientifically investigate natural phenomena and everyday problems
- understand the core concepts of science by exploring natural phenomena
- recognize the interrelationship between science, technology, and society, and develop skills as a democratic citizen based on this
- recognize the enjoyment of learning science and the usefulness of science to foster lifelong learning

To achieve curricular goals, the 2015 science curriculum emphasizes inquiry-based learning and students' active participation in scientific inquiry, which involves various epistemic practices, such as observation, experimentation, investigation, and discussion. Rather than

focusing on merely acquiring knowledge, the science curriculum emphasizes a comprehensive understanding of basic scientific concepts and the development of the ability to solve everyday problems scientifically. The 2015 science curriculum cultivates five competencies that can explicitly delineate the performances of students who achieve the curricular goals: scientific thinking skills; scientific inquiry abilities; scientific problem-solving ability; scientific communication skills; and engagement in science and lifelong learning ability.[6]

The 2015 science curriculum covers elements of physics, chemistry, biology, and earth science. In the 2015 science curriculum, there was a reorganization of contents in an attempt to emphasize the interdisciplinary aspects of the four branches of science rather than introducing science as the sum of four separate branches. The contents were reorganized into core concepts; they are considered "core" in the sense that they have explanatory ability for other scientific concepts. The core concepts are grouped into broader areas. Moreover, the 2015 science curriculum suggests that core concepts and scientific inquiry should be taught systematically across multiple grade levels and in relation to one another in different areas. Exhibit 3 shows the content covered in Grades 3 to 9 in the 2015 science curriculum.

Exhibit 3: Topics Covered in Grades 3 to 9 in the 2015 Science Curriculum

Area	Core Concept	Content Elements		
		Grades 3 and 4	Grades 5 and 6	Grades 7 to 9
Force and Motion	space-time and motion		• speed • speed and safety	• uniform motion • free fall motion
	force	• weight • horizontal balance • working principle of spring balance		• gravity • frictional force • elastic force • buoyant force
	mechanical energy			• potential energy due to gravity • kinetic energy • conservation of mechanical energy
Electricity and Magnetism	electricity		• electric circuit • saving electricity • electrical safety	• electric force • atomic model • electrification • electrostatic induction • electric circuit • voltage • electric current • resistance

Exhibit 3: Topics Covered in Grades 3 to 9 in the 2015 Science Curriculum (Continued)

Area	Core Concept	Content Elements		
		Grades 3 and 4	Grades 5 and 6	Grades 7 to 9
Electricity and Magnetism	magnetism		• electromagnet	• magnetic field • electric motor • generate electricity
		• magnetic force • properties of magnets		
Heat and Energy	thermal equilibrium		• temperature • conduction, convection • thermal insulation	• temperature • how heat moves • thermal equilibrium • specific heat • thermal expansion
	laws of thermodynamics			• electrical power
	energy conversion			• work • energy conversion
Wave	types of waves	• sound generation • sound intensity • sound pitch • sound transmission • light traveling in a straight line • shadows		• transverse waves, longitudinal waves • amplitude • frequency • waveform
	properties of waves	• plane mirrors • reflection of light	• prism • refraction of light • convex lens	• composition of light • three primary colors of light • image of a plane mirror
Structure of Matter	constituent particles of matter			• element • atom • molecule • element symbol • ion • ion chemical formula

Exhibit 3: Topics Covered in Grades 3 to 9 in the 2015 Science Curriculum (Continued)

Area	Core Concept	Content Elements		
		Grades 3 and 4	Grades 5 and 6	Grades 7 to 9
Properties of Matter	physical and chemical properties	• objects and matter • properties of matter • function of objects • change of matter • mixtures • separation of mixtures • filtration • evaporation	• dissolution • solution • type of solute • amount of solute dissolved • thickness of solution • properties of solution • classification of solutions • (chemical) indicator • acid solution • basic solution • air	• density • solubility • melting point • freezing point • boiling point • pure substances and mixtures • separation using distillation and density difference • recrystallization • chromatography
	state of matter	• solids, liquids, and gases • weight of gases	• oxygen • carbon dioxide • gas volume according to temperature • gas volume according to pressure	• motion of particles • pressure of gas • relationship between pressure and volume of gas • relationship between temperature and volume of gas
Change of Matter	change of states	• change of states of water • evaporation • boiling • condensation		• three states and particle arrangements • change of state • change of state and input/output of heat energy

Exhibit 3: Topics Covered in Grades 3 to 9 in the 2015 Science Curriculum (Continued)

Area	Core Concept	Content Elements		
		Grades 3 and 4	Grades 5 and 6	Grades 7 to 9
Change of Matter	chemical reaction		• combustion phenomenon • combustion conditions • combustion products • how to extinguish fire • safety measures in case of fire	• physical changes • chemical changes • chemical equation • law of conservation of mass • law of constant composition • law of gaseous reaction
	energy input and output			• energy input and output in chemical reactions
Life Science and Human Life	biotechnology	• examples of mimicry by animals and plants in daily life	• fungi, protozoa, and bacteria utilization • biological science and human life	
Structure and Energy Metabolism of Living Organism	basic unit of living organism		• how to use a microscope • cell • nucleus • cell membrane • cell wall	• hierarchical organization of living organisms
	animal structure and function		• structure and function of bones and muscles • organ structure and function of digestive, circulatory, respiratory, and excretory systems	• nutrients • digestive enzymes • structure and function of digestive system and excretory system • structure and function of circulatory and respiratory systems • relationship between digestion, circulation, respiration, and excretion

Exhibit 3: Topics Covered in Grades 3 to 9 in the 2015 Science Curriculum (Continued)

Area	Core Concept	Content Elements		
		Grades 3 and 4	Grades 5 and 6	Grades 7 to 9
Structure and Energy Metabolism of Living Organism	plant structure and function		• functions of roots, stems, and leaves • transpiration	• water transport and transpiration • production, storage, and utilization of photosynthetic products
	photosynthesis and respiration		• photosynthesis	• substances required for photosynthesis • photosynthetic products • factors affecting photosynthesis • relationship between plant respiration and photosynthesis
Homeostasis and Regulation	stimulus and response		• types and functions of sensory organs • transmission of stimulus	• structure and function of eyes, ears, nose, and tongue • skin sensations and sensory points • structure and function of neurons and nervous system • central nervous system and peripheral nervous system • pathways from stimulus to response • role of hormones in response to stimulus

Exhibit 3: Topics Covered in Grades 3 to 9 in the 2015 Science Curriculum (Continued)

Area	Core Concept	Content Elements		
		Grades 3 and 4	Grades 5 and 6	Grades 7 to 9
The Continuity of Life	reproduction	• life cycle of animals • complete and incomplete metamorphosis • life cycle of plants • conditions for seed germination • male and female animals • male and female animals' various reproductive behaviors	• seed dispersal mechanisms	• reproduction • chromosome • mitosis • meiosis • developmental process of animals
	heredity			• meaning of Mendelian genetic experiments • the basic principles of heredity • human genetic traits • pedigree analysis
	evolution and diversity	• animals and plants in diverse environments • structural features of animals and plants • classification of animals • classification of plants	• characteristics and habitats of fungi, protist, and bacteria	• importance of biodiversity • variation • the purpose of biological classification • species concept and classification system

Exhibit 3: Topics Covered in Grades 3 to 9 in the 2015 Science Curriculum (Continued)

Area	Core Concept	Content Elements		
		Grades 3 and 4	Grades 5 and 6	Grades 7 to 9
Environment and Ecosystem	ecosystem and interaction		• biotic and abiotic factors • impact of environmental factors on organisms • structure and function of ecosystem • effects of environmental pollution on living organisms • efforts to conserve the ecosystem • food chains and food webs • ecological stability	
Solid Earth	Earth system and force field	• the environment of Earth		• components of the Earth system • layered structure of the geosphere • crust • mantle • core
	plate tectonics	• volcanic activity • earthquakes • countermeasures against earthquakes		• seismic belt • volcanic belt • intensity scale and magnitude scale • plate • Wegener's theory of continental drift
	composition of earth	• soil formation and soil properties • weathering and erosion • granitic and basaltic rocks • sedimentary rocks		• minerals • rocks • rock cycle • weathering • soil

Exhibit 3: Topics Covered in Grades 3 to 9 in the 2015 Science Curriculum (Continued)

Area	Core Concept	Content Elements		
		Grades 3 and 4	Grades 5 and 6	Grades 7 to 9
Solid Earth	history of Earth	• formation and characteristics of strata • formation of fossils • extinct creatures and the environment		
Atmosphere and Ocean	properties and circulation of seawater	• characteristics of the ocean • hydrologic cycle		• hydrosphere • stratification in the ocean • law of the regular salinity ratio • oceanic current in the sea around the Korean peninsula • tidal phenomenon
	atmospheric movement and circulation		• humidity • dew and clouds • low pressure and high pressure • seasonal weather	• thermal structure of the atmosphere • radiation equilibrium • greenhouse effect • global warming • relative humidity • adiabatic expansion • precipitation process • air pressure and wind • air masses and fronts • low pressure and high pressure • weather map

Exhibit 3: Topics Covered in Grades 3 to 9 in the 2015 Science Curriculum (Continued)

Area	Core Concept	Content Elements		
		Grades 3 and 4	Grades 5 and 6	Grades 7 to 9
Universe	composition and movement of the solar system	• shape of Earth and the Moon • atmosphere of Earth • environment of the Moon	• the Sun • solar system planets • size and distance of planets • day and night • seasonal constellations • Moon phases • daily variation in solar altitude	• size of Earth and the Moon • terrestrial and Jovian planets • solar activity • Earth's rotation and revolution • Moon phase changes • solar and lunar eclipses
	characteristics and evolution of stars		• definition of star • Northern Sky constellations	• annual parallax • the stellar magnitude scale • surface temperature of a star • shape and composition of our galaxy
	structure and evolution of the universe			• universe expansion • space exploration achievements and significance

Teacher Professional Development Requirements and Programs

In Korea, both primary and secondary school teachers are generally required to develop their professionalism through two types of teacher training programs: qualification training programs and in-service training programs.[7] One of the qualification training programs is the Grade 1 certificate teacher program. To be a Grade 1 certificate teacher, in-service teachers with at least 3 years of teaching experience should take an intensive professional career development course of more than 90 hours during school vacation. The intensive program mostly covers the following areas: classroom reflection, teacher leadership, subject content knowledge, instructional strategies and assessment, and guidance and counseling for students.[8] The program is not mandatory, but the majority of Korean teachers participate in it and obtain a certificate in order to enhance their expertise.

Korean teachers are encouraged to develop their professionalism by completing in-service training programs that focus on fortifying their subject content knowledge and teaching skills, as well as equipping them with new competencies to meet the demands of changing education environments.[9] For example, science teachers at the secondary school level are encouraged to complete at least 30 hours of a science experiment training program to improve their expertise in the field of experimentation. Moreover, every 3 years, primary school teachers are encouraged to complete programs on understanding the characteristics of underachievers in mathematics and how to teach them in order to improve their basic skills in math. Recently, in response to living in a digitalized society, training programs about using technology in the classroom are also offered to help teachers improve their ability to design and practice teaching using various technologies in line with instructional goals. Teachers can also make use of online training programs in addition to traditional face-to-face professional development opportunities.

Monitoring Student Progress in Mathematics and Science

Korea monitors student progress and the quality of school education through various assessment systems: the National Assessment of Educational Achievement (NAEA) at the national level, Diagnostic Tests of Basic Skills (DTBS) at the metropolitan and provincial levels, and Achievement Standards-Based Assessment (ASA) at the school level.

The NAEA is the largest nationally representative and continual assessment that evaluates students' knowledge and skills in target subjects. Conducted annually, the NAEA's four primary purposes are

- assessing educational progress and achievement nationwide,
- monitoring the quality of school education and the appropriateness of the national curriculum,
- collecting background information that impacts educational achievement, and
- providing information about achievement to students, teachers, parents, and the government.

A sample of Grade 9 and Grade 11 students is selected to represent the national student population at those grades, and the NAEA is used to evaluate their proficiency in Korean, mathematics, and English. For ninth-grade students, additional tests in science and social studies are included. The NAEA also collects detailed information on students' learning experiences, affective factors, and backgrounds through contextual questionnaires administered to school principals, teachers, and students.

The DTBS is designed to monitor and support students who perform below the basic level of achievement in the subject assessed by the NAEA. The DTBS is conducted at the beginning of the school year for students in Grades 1 to 11. Schools can administer the test to all students or focus on those recommended by teachers. After the test, supplementary learning materials are provided alongside the results to help improve students' performance.

The ASA is a student assessment system based on the national curriculum. Teachers administer both performance-based and written tests each semester and record students' achievements in the National Educational Information System (NEIS). Student progress and assessment quality can be monitored through NEIS. These classroom assessments are criterion referenced, with teachers developing test items and reporting results based on the national curriculum's achievement standards.

Additionally, the Customized Assessment of Educational Achievement (CAEA) is available for schools to assess students' achievement levels and track their progress. The CAEA is conducted at the beginning of the school year, upon request by schools, and is available for students in Grades 3 to 11. The CAEA allows schools to select the testing dates and subjects, as its name, "Customized Assessment," suggests.

All of these assessments include mathematics and science.

Special Initiatives in Mathematics and Science Education

The Ministry of Education has released the 2020 Comprehensive Plan for Mathematics Education and the Comprehensive Plan for Science Education. With the goals of maintaining students' interest in learning mathematics, equipping them with real-life problem-solving skills, and fostering core human resources for mathematics, the Comprehensive Plan for Mathematics Education promotes policies to support math education by strengthening students' mathematical competences and confidence, enhancing the professionalism of math teachers, emphasizing the use of information technology in math education, establishing a competency-based customized mathematics education system, supporting the underprivileged, and popularizing mathematics culture. The Comprehensive Plan for Science Education proposes various plans related to science with the aim of fostering human resources with literacy in science and establishing the foundation of future science education, reflecting the needs of future society. Specifically, the plan seeks to improve basic education, foster positive attitudes toward science, strengthen science education in terms of career exploration, enhance the professionalism of science teachers, secure spaces for science experiments and operate next-generation laboratories, utilize advanced technology in science classes, establish a collaborative system in science education, and improve access to science culture and enhance experiences relevant to the science subject.

The declining educational performance of students and the galvanizing education gap are also important issues in South Korea, and their significance has been highlighted in the wake of COVID-19. In South Korea, the Basic Academic Achievement Guarantee Act was enacted in 2021 and implemented in 2022. The Basic Academic Achievement Guarantee Act aims to ensure basic education for all students by providing learning support to students who need it, thereby creating a foundation for students to receive education according to their abilities.[10]

According to the Basic Academic Achievement Guarantee Act, the central government and local governments shall endeavor to maintain the number of students per school at an

appropriate level and secure a budget to ensure basic education. In addition, school principals may conduct tests to diagnose whether each student has reached the basic education level in order to detect and effectively aid students in need of learning support at an early stage based on their individual characteristics. Education and counseling for guardians may be provided if necessary, or learning support may be offered in cooperation with professional organizations outside the school.

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