Slovenia

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Introduction

Overview of Education System

Slovenia is a country with 2,120,000 inhabitants.[1] The education system consists of preprimary education (for children ages 1 to 6), compulsory elementary education (Grades 1 to 9), secondary education (Grades 10 to 13), and tertiary academic and nonacademic education. The share of public expenditure for formal education is 5.3% of the country's gross domestic product (GDP).[2] In academic year 2022–2023, there were 86,000 children enrolled in preprimary education, 197,000 elementary school students in 456 public and 6 private compulsory schools, and 79,000 secondary school students in 146 secondary schools.[3]

The Ministry of Education[a] is mainly responsible for developing and implementing education policies for all pretertiary education. The Ministry determines the basic principles of compulsory schooling, as well as the policies for entrance, grading, and promotion of students, including education policies for children with special needs. The Ministry determines the curricula and knowledge assessments and approves students' textbooks for all subjects. It also sets financial policies for schools, requirements for employment of teachers and staff, and student enrollment policies. In cooperation with local authorities and schools, the Ministry chooses the school principals. At the regional level, the National Education Institute[b] links the Ministry and schools by providing counseling through nine regional offices in the areas of curriculum, teaching methods, and implementing education changes required by the Ministry. Local authorities are responsible for maintaining school buildings and facilities, and individual schools are responsible for hiring, attracting, and maintaining teachers.

Preschool education[4] includes day care, meals, and education in institutions called kindergartens, which follow the national Kindergarten Curriculum.[5] Language, science, social science, mathematics, art, and sport are separate content areas with defined opportunities to learn for children in two age groups: ages 1 to 3 and ages 4 to 6. The national enrollment of children in preprimary education is almost 70% in the younger age group and 90% in the older age group.[6]

Elementary education[7,8] lasts 9 years. A student stays in the same school for all nine grades, although some schools have satellite locations in rural neighborhoods for early grades. In

a See https://www.gov.si/en/state-authorities/ministries/ministry-of-education/ for more information.

b See https://www.zrss.si/en/ for more information.

Grades 1 to 5, all subjects are taught by general class teachers. Specialist teachers teach specific subjects from Grade 6 on. Schools provide education assistance for children with special needs, who are generally included in regular class programs, as well as remedial and advanced classes as needed.

Secondary education[9] is offered in 2- to 4-year vocational and technical schools and in 4-year general secondary schools, called gymnasia, for students aiming for academic university studies. Mathematics is compulsory in all grades in gymnasia[10] and in most technical schools. Physics, chemistry, biology, and geography are compulsory in at least three grades in gymnasia and, together with other specific science subjects, also are compulsory in most secondary programs. For entrance into any university, students have to pass the national Matura examination,[11] which includes mathematics. At the end of technical secondary school, passing the national vocational examination is required for entrance into nonacademic technical studies at high schools. There, students can choose between an exam in mathematics or an exam in a foreign language.

Use and Impact of TIMSS

In Slovenia, TIMSS results are a reliable source of data to consider in efforts to change and improve mathematics and science education. The results are used by policymakers at the Ministry of Education and by specialists at the National Education Institute and universities to develop the learning process and to make decisions about changes in curriculum, methods, teaching priorities, and professional development programs for future and current teachers. High results in TIMSS 2015, especially in science, encouraged teachers and policymakers. The declining attitudes toward learning among students were also taken seriously, as arguments for improving school climate caused the development of the national initiative to provide a safe and stimulating learning environment for all students.[12,13]

The Mathematics Curriculum in Primary and Lower Secondary Grades

The national mathematics curriculum document for compulsory elementary school impacts the teaching of mathematics from Grades 1 to 9.[14] It was introduced in 2011 and transformed into a digital version with small changes during the COVID-19 pandemic.[c] The mathematics curriculum for Grades 1 to 9 contains the following:

- general goals
- lists of topics to be taught in each grade
- lists of optional topics to be taught in each grade at teachers' discretion
- didactical recommendations for each grade

c See https://dun.zrss.augmentech.si/#/ for more information.

- lists of basic standards of knowledge that are expected from the majority of students at the end of each 3-year period
- minimal standards of knowledge for each grade that are required for student advancement to the next grade

Additionally, the curriculum describes expected approaches to problem-solving, homework policies, individualization and differentiation, and the development of mathematical competencies. It also specifies cross-curricular topics to be taught to link mathematics with other subjects, policies on assessments, and polices on the use of information and communications technology (ICT) and calculators, and lists expected manipulative tools and didactical material to be available in class for learning mathematics.

According to the curriculum, mathematics in Grades 1 to 9 is aimed at developing basic mathematical competence needed for expressing mathematical ideas and accepting mathematics as a cultural value. It should develop students' mathematical thinking and use of procedures and technologies; teach facts, structures, and skills; link students' knowledge of mathematics with other areas; and build students' confidence and a positive attitude toward learning and mathematics.

The mathematics topic areas covered in Grade 4 are as follows:

- In geometry and measurement, students learn to draw and recognize characteristics of line segments, lines, and rays; recognize parallel and orthogonal lines; draw rectangles and squares, discs, and circles with the help of rulers and compasses; recognize the cube and cuboid; and perform operations with units of length, mass, volume, and time.
- In arithmetic and algebra, students learn to add and subtract numbers up to 10,000 (optional: larger numbers); multiply and divide two-digit numbers by one-digit numbers, using appropriate operations to solve problems; solve expressions with brackets; and solve simple equations and inequalities informally with reasoning.
- The topic area of rational numbers includes learning how to divide a whole into equal parts and write simple fractions as parts over the whole (optional: recognizing equivalent fractions) and calculate the size of one part of the whole.
- Students learn to present sets and subsets, develop reading literacy, model situations with mathematical expressions, conduct a study with collection and presentation of the data, and solve combinatorial problems with manipulatives.

Some contents that are part of the TIMSS Mathematics Framework for Grade 4 are taught during Grades 5 to 7. A summary of these contents follows:

- In geometry, students learn to draw parallel and perpendicular lines in Grade 5. By Grade 7, students learn gradually about angles, triangles, circles, and other polygons and how to draw shapes. In Grade 5, students start to recognize the area and perimeter of rectangles and triangles, and the volume of cubes and cuboids. In Grade 6, students start to calculate these with formulas, and in Grade 7, they extend

learning to calculate area and circumference of general polygons. Nets are introduced in Grade 5 and coordinate systems in Grade 7. In Grade 6, students learn about translations, rotations, and reflections to use them in patterns, and in Grade 7, in constructions and mathematical problems.

- In algebra, by the end of Grade 7, students learn to solve equations and inequalities with one unknown by using reasoning. Linear relation and function is introduced informally in Grade 7 through drawing tables and graphs and recognizing increasing or decreasing relationships between two variables.
- In arithmetic, students formally encounter odd and even and negative numbers in Grade 5, decimal numbers and numbers over 1,000,000 in Grade 6, and percentages and general fractions in Grade 7 to perform comparisons and calculations in problem-solving.
- Students gradually learn to collect, order, present, and critically interpret data; use electronic spreadsheets; and calculate with fractions and percentages on calculators by the end of Grade 7, when they also learn to calculate the mean.

The mathematics topic areas covered in Grade 8 are as follows:

- In geometry, students learn about polygons, including their angles, and strategies for calculating the volume and area; understand the meaning of number π; calculate the circumference and area of a circle (optional: the length of a circular arc and the area of a circular segment) using formulas; solve text problems in connection with the circle; learn about right triangle and the use of the Pythagorean theorem in problems; learn to calculate the area and volume of a cube and a cuboid by using formulas; and perform calculation of unknown measurements using formulas.
- In arithmetic, students formally learn about sets or rational, irrational, and real numbers ($N \subset Z \subset Q \subset R$); learn to work with negative numbers and the absolute value of numbers to continue sequences; and use exponents and roots. They learn to use a calculator for work with negative and rational numbers.
- In algebra, students learn powers with an integer exponent; learn square roots of a rational number; perform arithmetic operations with powers; value and calculate with algebraic expressions with more than one variable; transform patterns into expressions with variables, direct proportion, and inverse proportion; and recognize and present linear relations. Linear function is extended by real variables, the coordinate system in a plane, and relationships between variables. They learn to formally solve equations in a set of rational numbers and inequalities in a set of integers.
- Students learn to read graphs and represent sets of points on a number line, as well as present relationships between two discrete variables and two continuous variables with graphs. Besides solving equations, students learn how to recognize identical and equivalent equations and solve general inequalities, and how to model abstract situations or sequences by expressions with variables (e.g., the number of sides in

the *n*th figure). They model abstract (geometrical) situations, critically value models, and interpret their results.

Standards of Mathematical Knowledge

At the end of Grade 4, students are expected to have the following minimal standards of mathematical knowledge and be able to do the following:

- name and draw straight lines
- describe a square, rectangle, cube, and cuboid
- draw with a ruler
- draw a symmetrical shape
- estimate, measure, and express the measurement with a meaningful unit of measurement
- compare quantities with the same unit and calculate with them
- count, read, write, and compare numbers in the set of natural numbers up to 10,000
- add and subtract in the set of natural numbers up to 1,000
- multiply and divide with a remainder (in the context of the question) with a single-digit number in the set of natural numbers up to 1,000
- solve the equation in the set of natural numbers up to 20 with reasoning
- write the parts of a whole with a fraction
- arrange elements and read graphical representations
- collect data and present the data in a table and with diagrams
- solve a (structured) mathematical problem and a problem from everyday life

At the end of Grade 8, students are expected to have the following minimal standards of mathematical knowledge and be able to do the following:

- use whole and rational numbers in life situations
- find the opposite and inverse value of a number
- compare and edit integers
- calculate the value of a numerical expression with integers and rational numbers (with a maximum of three arithmetic operations)
- take into account the priority of arithmetic operations in the expression
- use a pocket calculator to calculate the value of a numerical expression
- exponentiate whole and rational numbers
- know the square root of a perfect square (up to the number 20)
- add, subtract, and multiply monomials
- calculate the value of an expression with a variable if the value of the variable is known
- multiply the monomial by the binomial

- render a point in a coordinate grid
- read the coordinates of the drawn point
- recognize the dependence of quantities
- know and use the properties of linear relation
- read data from various displays and edit them in a spreadsheet
- know the properties of a polygon and describe it
- calculate the circumference and area of a circle
- use the Pythagorean theorem
- make a model of a cube and a cuboid
- calculate the area and volume of a cube and a cuboid
- use a sketch when solving geometric problems
- solve a math problem and a problem from everyday life

Some contents from the TIMSS framework needed for gaining advanced mathematics knowledge are presented to Slovene students in Grade 9, such as linear function, system of linear equations, statistics, and topics from geometry.

The Science Curriculum in Primary and Lower Secondary Grades

Science is taught in Slovene schools within different compulsory subjects in different grades. In Grades 1 to 3, the subject is called Environment;[15] in Grades 4 and 5, it is called Science and Technics;[16] in Grades 6 and 7, it is called Natural Science;[17] and in Grades 8 to 13, there are the separate science subjects Biology,[18] Physics,[19] Chemistry,[20] and Geography.[21] Just like for mathematics, the curricula for science subjects were introduced in 2011 and transformed into a digital version with small changes during the COVID-19 pandemic.[d] The curricular documents contain the following:

- general goals
- lists of topics to be taught in each grade
- lists of optional topics to be taught at teachers' discretion
- minimal standards of knowledge that are expected from the majority of students at the end of the period of teaching the specific subject
- didactical recommendations

The curriculum describes expected approaches to scientific inquiry and research and other activities to learn science. It specifies cross-curricular topics to be taught to link science with other subjects, as well as policies on assessments of students' knowledge.

Some contents that are part of the TIMSS Science Framework for Grade 4 are taught by the end of Grade 3, as the following summary of contents indicates:

d See https://dun.zrss.augmentech.si/#/ for more information.

- orientation in space, Slovenia, Europe, the world, oceans, continents, the directions of the sky
- properties of objects and matter, mixtures and separation of them, changing the properties of substances during phenomena (drying, fading, weathering, dissolving, rusting, rotting, etc.), reversible (melting, solidification) and irreversible phenomena (burning), temperature measurement
- changing motion (acceleration, deceleration), operation of technical devices and vehicles (scissors, pliers, umbrella, bike, etc.), transmission of motion, direction and speed of movement (rotation of a windmill), cause and effect of movement, push and pull, friction, water and air resistance
- weather conditions and phenomena (clouds, precipitation, cold, fog, wind, etc.), the source of light, the Sun, the light (lamp), the traveling of light, the reflection of light, the eye, sources and traveling of sound, volume, pitch, duration of sound, ear
- differences between living and nonliving nature, conditions for animal life (food, water and mineral substances, air, space) and for plant life (light, water, and mineral matter), plant development, creation of a new being (reproduction, growth, development), interdependence of living things, life cycle (birth, growth, development, death, decay)
- conditions for a healthy life, human body (external parts), skeleton, basic internal organs, senses, brain, hazardous substances that threaten health, diseases, protection against diseases
- environmental pollution, consequences of pollution on living things, waste management, pollutants of water, soil, air, energy saving, environmental management

The following is the summary of contents taught to all students up to Grade 4:

- matter: classification (kneadability, compressibility, hardness, density), dangerous substances (corrosive, flammable, toxic, dangerous for the aquatic environment, etc.), technological properties of materials (e.g., strength, permeability, splitting, kneading), permeability in water and air, magnetism, electrical conductivity, separation of mixtures, heating and cooling cause changes in the properties of matter, *casting*,[e] waste disposal (organic waste, paper, plastic, metals)
- movements: forces for movement (weight, friction, force from distance, magnetic, electric), *animal and human movements*, surfaces in relation to movements (skating, running), the components of a bicycle, riding a bicycle and traffic
- Earth movement: day and night caused by rotation of Earth on its axis, darkness between day and night (dusk or twilight), light from object to the eye, the size and position of shadows, spreading of light rays, *changes of the Moon*, *lunar and solar eclipses on a model*

e Topics written in italics are optional, mostly more advanced. Teachers may teach them at their discretion.

- transfers: path of water from a source to a tap, flow of water through pipes, properties of drinking water, contaminated water, model of a water wheel, transfer of heat in a closed central heating pipe, propulsion by liquid water, simple electric circuit, accidents with electrical devices, users of electricity and saving electricity
- human body: humans are made of cells, role of skeleton (with joints) and muscles, meaning of food for the human body, blood, veins, heart, heart rate, pulse and physical effort, respiratory tract, lungs, harmful consequences of addictions (smoking), importance of eliminating waste from the body and the role of the kidneys, senses as data receivers, basics of brain and nervous system, greater similarity between relatives than between nonrelatives, hereditary differences, changes in personal growth and development (weight, height), puberty, sexual development in girls and boys, how people interpret diversity
- classification of living things, kingdoms, most common types of plants and animals, fungi and wood in the local environment, external structure of plants and of animals, invertebrates (snails, clams, insects, spiders, rotifers) and vertebrates (fish, amphibians, reptiles, birds, mammals), living things change due to growth and development and adapt to the environment, properties of living beings depend on heredity and environment

Some contents from the TIMSS Science Framework for Grade 4 are taught in Grade 5 as follows:

- conservation and changing of volume
- mass
- shape
- density in solids and gases
- density of matter
- conservation of mass when dissolving substances
- changes in states of matter
- water cycles
- water pollution and purification
- surface water and groundwater
- air pollution
- a pendulum
- leverage
- lifting loads to a height
- liquid flow
- heat and temperature
- wind and air movement
- burning

- the effects of the Sun on the weather
- air and water
- origin and production of food
- responsibility for one's own health

From Grade 8 onward, science is taught as separate science subjects. In biology, the topics covered are as follows:

- biology as a natural science
- cells and their structure under a microscope
- human body—life functions: taking in substances, digesting food, breathing, transporting substances, excreting waste substances, moving, sensing the state of the environment, controlling body functions and reproduction; diseases, injuries, infections
- human body—a digestive system to obtain energy and building blocks to create the substances a body needs or store them temporarily, transport systems that supply cells with nutrients and oxygen and remove waste materials from them
- human body—a nervous system (fast regulation) and the hormonal system (slow regulation), the senses informing the central nervous system
- human body—a musculoskeletal system to support the body and move
- reproduction for the continuation of any species

The Chemistry curriculum is provided for Grades 8 and 9 together, and teachers choose which contents will be taught in Grade 8. The following contents are included in the chemistry curriculum for Grades 8 and 9:

- chemistry as a science
- aggregate states, elements/compounds vs. atoms/molecules, notation of symbols for elements and molecules; main elements (e.g., iron, copper, silver, mercury, gold), periodic system, structure of an atom, atom and ion, cation and anion; bonds, ionic and covalent bond, ionic compound/crystal and a molecule, polar and nonpolar covalent bonds; the natural sources of some elements and compounds, atomic and molecular masses, concept and calculation of mass of matter, mole
- chemical reaction, reactants and products, exothermic and endothermic reactions, the law of conservation of mass, simple chemical equations for the formation compounds
- acidic, basic, and neutral solutions using indicators; pH scale; reactions between acids and bases as neutralization reactions in which salts and water are made; formulas of some basic acids; bases and salts; solution, solvent, solute, and solubility; calculate the mass fraction of the solute in solutions
- basic hydrocarbons; sources and structural formulas; their properties (solubility, density, boiling point, reactivity); combustion, substitution, and addition reactions; terms monomer, polymer, and polymerization; harmful effects on the environment

- alcohols, carboxylic acids and esters, basic oxygen compounds, selected organic oxygen compounds, applications in everyday life and industry, fats and soaps, carbohydrates for life and the economy; amino acids as nitrogenous organic compounds, proteins as natural polymers, selected properties of proteins and their importance in organisms

The Physics curriclum also allows teachers to choose the order of topics taught. The following is a proposed list of Physics topics for Grade 8:

- physics as a science
- reflection of light, lenses, focal length of a lens, a light beam passing from one substance to another, through the converging lens, the role of lens in an eye, formation of an image in the eye, camera obscura
- a planet, a star and a natural satellite, a galaxy and a constellation, shape of the track of the planets around the Sun, formation of solar and lunar eclipses, changing positions of the constellations during the year, a telescope, historical views of the universe (geocentric and heliocentric)
- forces that act when bodies touch and forces that act at a distance; unit newton (N); forces distributed point-to-point, planar, and spatially; force of gravity at the point of contact and center of gravity; measure the force with a force meter; a friction; balance of forces
- procedures for determining the area of figures and the volume of bodies, calculating the area of basic geometric figures, converting between surface units and volume units, body density as a quotient of mass and volume, specific weight, pressure in pascal and bar units
- the pressure in liquids; air pressure; equations for calculating density and specific gravity, for calculating pressure, for calculating the pressure in the liquid, and for calculating buoyancy; manometer and barometer comparing densities and average densities to explain whether an object floats or sinks

The Geography curriculum for Grade 7 covers geographic features of Europe and Asia. For Grade 8, the curriculum covers geographic features of Africa, Australia and Oceania, America, and Arctic regions, and includes learning about each area's land, rivers, mountains, natural resources, population, climate, economy, and traffic. While studying different continents, students do the following:

- learn about critical issues of the modern world
- explain advantages and disadvantages of each geographic location as they analyze and compare the past and present
- build attitudes and values, such as respect for other nations and cultures, as well as international collaboration
- realize the need to preserve natural and cultural heritage

- understand the delicate connection between humans and nature
- learn about areas under environmental threat and ways of protecting the environment through case studies of individual continents
- use basic methods for collecting geographical information

Teacher Professional Development Requirements and Programs

The Ministry of Education offers or financially supports many forms of professional development programs for teachers: thematic conferences, regular teacher workshops organized by the National Education Institute, licensing courses, and subject matter training courses at universities and other education institutions. A teacher may apply for promotion every 4 to 5 years on the basis of points earned through a variety of activities, such as participating in professional development or other education program, writing articles or textbooks, overseeing school projects or mentoring students in Young Researcher programs (see the Special Initiatives in Mathematics and Science Education section for more information about these programs), or preparing students for competitions. Teachers have the right to participate in professional development programs for 5 days per year.

Monitoring Student Progress in Mathematics and Science

National examinations prepared by the National Examinations Centre monitor student achievement relative to the minimal standards defined by the curriculum and provide general feedback to the school system about student achievement.[22] Test items mostly contain open-ended questions. The National Education Institute is responsible for evaluating the results, proposing changes, and planning further development activities in elementary education.

The national examinations at the end of Grade 9 are compulsory for all students (with some exceptions such as migrant students, foreign students, and students with special needs) in mother tongue, mathematics, and a third subject selected by the Ministry of Education. Individual results are used only as additional admission criteria to secondary school with limited entry places (mostly the most advanced gymnasia).

Teachers assess students' knowledge two to four times during the school year according to the school policy, the curriculum for each subject, and the Elementary School Act,[23] with written tests, oral questioning, and student presentations or seminars. In Grades 1 to 3, student achievement is presented in the form of descriptions. From Grade 4 onward, numerical marks are given on a national scale from 1 (fail or negative) to 5 (excellent). At the end of the school year, each teacher summarizes students' marks from the subject taught, and students receive report cards containing final marks for all subjects.

Recommendations about ways to evaluate knowledge, called marking, for each subject are part of the national curriculum. Regular and final marks should reflect a student's achieved knowledge standard. These marks are separate from teachers' observations and feedback

on temporary student knowledge, skills, and effort put into schoolwork. Teachers always use their own tests, items, or questions. Teachers are encouraged to use many different methods for evaluating, marking, and giving feedback of knowledge to provide various opportunities to students to demonstrate all they know and can do, including oral questioning, witten assessments and projects, and inquiries and presentations. In recent years, formative assessments have been strongly promoted as a form of evaluation of knowledge.

Special Initiatives in Mathematics and Science Education

Mathematics is recognized as an important subject throughout the school system. It is a compulsory subject on all national examinations (Grades 6, 9, and 13). Mathematics and science subjects are taught as compulsory subjects in elementary and all secondary schools in most years. They are also compulsory curricular subject areas in kindergarten for children ages 1 to 6. Learning mathematics in school is promoted in each of the lower grades with popular school competitions (e.g., International Mathematical Kangaroo tests). In upper grades, national competitions are offered for all science subjects and mathematics and are popular among students. The best achievers at the school level get the bronze award and the right to compete at the regional and national level for silver and gold awards. Gold awards from any subject are among criteria for talented students to receive stipends during their secondary schooling.

Lower-achieving students are invited into additional mathematics classes offered by their schools to fill the gap in their knowledge. The curriculum strongly recommends that teachers adapt instructions to struggling students and assure that all students achieve minimal standards of knowledge in every grade.

The Ministry financially supports elementary students' informal learning of mathematics and science. Through the Program for Young Researchers, students in Grades 8 and 9 can work on a 1-year research project in mathematics, science, computer science, economics, or another academic area of interest under the supervision of their specialist subject teacher and compete for awards given by The Association for Technical Culture of Slovenia.[24] Other institutions or organizations, such as the House of Experiments,[25] the Technical Museum of Slovenia,[26] the Festival of Science, and science camps provide mathematics and science learning activities during regular school days or special activity weeks. University faculties of mathematics and science organize summer schools for secondary school students interested in the university subjects they teach (e.g., University of Ljubljana and University of Maribor faculties of mathematics and physics, biotechnology, computer science and informatics, engineering, chemistry, and chemical technology).[27,28,29,30,31]

Suggested Reading

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