

# Serbia

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## Introduction

### *Overview of Education System*

The democratization of education in the Republic of Serbia at all levels of education began after 2000.<sup>1</sup> Democratization aimed to contribute to Serbia's economic recovery, the development of its democracy, and its reintegration into the European and international communities.<sup>2</sup> Numerous changes have been made to democratize, decentralize, and depoliticize Serbian education policy and practices, and to promote quality, efficiency, and equity in education.<sup>3,4</sup> The Strategy for the Development of Education in Serbia until 2020 emphasizes that the mission of the Serbian education system in the 21st century is to establish a foundation for students to build their lives and to ensure the development of individuals, society, and the state based on knowledge in accordance with European and international values.

In the Republic of Serbia, the education system is managed and regulated by the Ministry of Education, Science, and Technological Development. The Ministry has the following responsibilities: research, planning, development, and supervision of preschool, elementary, secondary, and higher education and the organization, evaluation, and supervision of employees in the education sector.<sup>5</sup> Within the Ministry, the Institute for Education Quality and Evaluation and the Institute for Education Improvement are responsible for conducting evaluation, research, and development in education at the national and international levels. The National Education Council monitors and analyzes the status of education at all levels within its authority (i.e., preschool, elementary, general, and artistic secondary education) as well as compliance of the education system with European principles and values. It establishes general and specific standards for student achievement, standards for the teaching profession, standards for the role of principals, and quality standards for education institutions; it also approves curricula and proposes final examinations, textbooks, and teaching aids for the Ministry. At the same time, the Vocational

Education and Adult Education Council independently develops a list of education profiles, standards of achievement, curricula, and a qualifications framework, and facilitates connections between education and the labor market for the sectors of education under its authority.<sup>6,7</sup>

The national curricula (the plan and program for teaching and learning) includes a list of compulsory subjects, elective subjects, and activities by grade and the total annual and weekly number of classes by subjects, programs, and activities. The national curricula prescribes the goals of primary education; the learning objectives of subjects, elective subjects, and activities by grade; general and subject competencies; learning outcomes; education standards; the key content concepts of each subject; instruction for didactic-methodical realization of the program; instructions for formative and summative assessment of students; instructions for teaching students with developmental disabilities and gifted students; and education on the language of national minorities. Recommended types of teaching and learning activities are provided along with the required and recommended contents for each compulsory and elective subject. The curricula are used as a basis for evaluating education in schools. Teachers are granted a degree of flexibility in implementing the curriculum as long as they follow the prescribed education standards, goals, and learning outcomes (i.e., in certain subjects, the number of classes for certain topics is prescribed, while in other subjects, teachers are allowed to determine how many classes to devote to certain topics).

The strategy for the development of education in Serbia envisages greater pedagogical autonomy of schools by 2020, encouraging school initiative, as well as greater autonomy of teachers as pedagogical and subject experts.<sup>8</sup>

The Serbian education system is organized in the following levels: preschool education (International Standard Classification of Education [ISCED] Level 0); first cycle of primary education (ISCED Level 1); second cycle of primary education (ISCED Level 2); secondary education (ISCED Level 3 or 4); basic academic and vocational studies (ISCED Levels 5 or 6), which last three or four years; master academic and vocational studies, as well as specialist studies (ISCED Level 7); and doctoral studies (ISCED Level 8).<sup>9,10</sup>

The new Preschool Curriculum Framework – Years of Ascent was adopted in 2018 introducing key systemic changes to preschool education.<sup>11</sup> It provides a common foundation for curriculum development in nursery, preschool and preparatory preschool programs and promotes a coherent approach to learning and development of young children from their enrollment in ECEC until they enter elementary school. Preschool education is provided in nurseries (for children ages 6 months to 3 years) and kindergartens (for children ages 3 to 7). Preschool providers develop their own program guided by unified basic principles for the preschool curriculum.

Primary education is compulsory and free of charge, and consists of two cycles: classroom teaching in Grades 1 to 4 and subject teaching in Grades 5 to 8. Compulsory education totals nine years in Serbia (preschool education included). Children enroll in first grade when they are 6½ to 7½ years old (in exceptional cases, enrollment may be postponed for one year). At the end of primary school, students take a final examination intended to evaluate student attainment of

general standards. Enrollment in secondary school does not depend on passing the examination. Some secondary schools require students to pass an entrance examination that demonstrates extraordinary skills.<sup>12</sup> Secondary education is free, lasts three or four years, and takes place in secondary schools. After completing the fourth year of secondary school, students take the *Matura* examination, which is used to determine their eligibility for enrollment in higher education.<sup>13</sup>

Tertiary education comprises basic academic and vocational studies (three to four years), after which students may pursue master academic or vocational studies or specialist studies (one to two years). Students may continue their formal education with doctoral studies (three years) that prepare students for independent scientific research. At state universities, education is free for a specified number of students apart from doctoral studies, for which students must pay tuition fees.<sup>14</sup>

Standards for evaluating the quality of education institutions are regulated externally and internally. Education institutions are obliged to conduct self-evaluations every year in certain areas, and every four or five years. External evaluations are carried out at least once every six years.<sup>15</sup>

Education in the Republic of Serbia is carried out in the Serbian language. For members of ethnic minorities, it may be carried out in their mother tongue. The minority languages in Serbia are Albanian, Bosnian, Bulgarian, Wallachian, Hungarian, Macedonian, German, Romany, Romanian, Ruthenian, Slovak, Ukrainian, Croatian, Czech, and others. Teaching is provided in a minority language if there are at least 15 students who speak that language as the mother tongue at the time of enrollment in the first grade of primary education. (In some cases, native language teaching may be implemented for a smaller number of students.)<sup>16</sup> Instruction in the languages of national minorities in primary schools has been organized in eight languages: Albanian, Bosnian, Bulgarian, Hungarian, Romanian, Ruthenian, Slovak, and Croatian.

### *Use and Impact of TIMSS*

Serbia participated in TIMSS 2003 and 2007 at the eighth grade, while fourth grade students participated in TIMSS 2011, 2015, and 2019. The TIMSS results were used in several scientific publications during these five cycles,<sup>17,18,19,20,21,22</sup> as well as for the preparation of two publications presenting TIMSS 2011 sample tasks and student achievement in accordance with the Serbian curriculum.<sup>23,24</sup> TIMSS has had impact on education in Serbia in the following ways:

- Education authorities recognize the results of the study as an indicator of the effectiveness of the education system in Serbia and as a basis for decision making to improve the quality of education. The current Ministry of Education, Science, and Technological Development in Serbia tends to base decisions on research results, and refers to TIMSS results when defining strategies for education development and determining expected levels of student achievement.
- The most important influence of TIMSS in Serbia can be perceived in the development of education standards for mathematics and science for the end of primary education in

fourth grade. An analysis of education standards for mathematics in fourth grade in Serbia indicate that the three achievement levels (basic, intermediate, and advanced) mirror the three TIMSS cognitive levels (knowing, applying, reasoning) to a satisfactory extent.<sup>25</sup>

- TIMSS data on school equipment are used for decision making regarding future investment.
- The TIMSS experience was used for the preparation of the final examinations for primary school (e.g., in biology, geography, chemistry, physics, and history).
- TIMSS methods were used as a model for national testing (some TIMSS released items were also used).
- Researchers use TIMSS data for studying education, including its opportunities and barriers.
- TIMSS data and tasks are used in teacher education programs.

## The Mathematics Curriculum in Primary and Lower Secondary Grades

The goal of learning mathematics formulated in the state mathematics curriculum is for students to master basic mathematical concepts, knowledge, and skills; develop the basics of abstract and critical thinking, positive attitudes toward mathematics, and the ability to communicate in mathematical language and notation; and apply the acquired knowledge and skills to future education and problem solving in everyday life, as well as to form the basis for further development of mathematical concepts.

The curriculum enlists the learning outcomes, content, and didactical instructions for mathematics instruction for each grade level. “The outcomes enable the achievement of education standards and cross-curricular competences, such as communication, digital competence, working with data and information, problem solving, collaboration, and competency for lifelong learning.”<sup>26,27,28,29,30,31,32,33</sup>

Serbia’s new mathematics curriculum is not yet fully implemented in schools. It is the result of a reform initiative that shifted the current curriculum toward teaching and learning oriented on outcomes. The reformed curriculum emphasizes the visualization of concepts, making connections between concepts and applications. Some topics are new; others are dislocated. For example, decimal numbers and the concept of symmetry are now introduced in primary grades, and vectors are to be learned from Grade 5. Some topics receive less attention, for example the concept of set. The domain of picturing data receives substantial attention.

The new curriculum has already been introduced in schools in Grades 1, 2, 5, and 6. The generation of students that participated in TIMSS 2019 followed the previous mathematics curriculum.

**Exhibit 1: Mathematics Outcomes in Grades 1 to 4**

Grade Level	Key Outcomes
Grade 1	<ul style="list-style-type: none"> <li>▪ Determine the relative position of objects and beings</li> <li>▪ Compare objects and beings by size</li> <li>▪ Identify and name the geometric shapes of objects (solids and figures)</li> <li>▪ Group objects and beings with a common characteristic</li> <li>▪ Arrange/disassemble a figure consisting of known shapes</li> <li>▪ Distinguish curves; straight lines; broken, closed, and open lines</li> <li>▪ Draw a straight line and a segment</li> <li>▪ Count forward and backward and by rule</li> <li>▪ Read, write, and compare numbers up to 100 and present them on a number line</li> <li>▪ Use ordinal numbers</li> <li>▪ Distinguish between even and odd numbers, largest and smallest numbers, predecessors, and followers</li> <li>▪ Use the terms sum, addend, diminutive, and difference</li> <li>▪ Add and subtract up to 20, and up to 100 without surpassing tens</li> <li>▪ Apply commutative law and associative law in calculations</li> <li>▪ Solve a simple textual task</li> <li>▪ Differentiate and compare currency up to 100 dinars</li> <li>▪ Determine a rule and the next member of a started sequence</li> <li>▪ Read and use data from a simple bar and figure diagram or table</li> <li>▪ Measure the length of a given, nonstandard unit of measurement</li> <li>▪ Copy a point and a figure in a square grid based on a given instruction</li> </ul>
Grade 2	<ul style="list-style-type: none"> <li>▪ Determine the tens closest to the given number</li> <li>▪ Add, subtract, multiply, and divide numbers up to 100</li> <li>▪ Use the terms factor, product, dividend, divisor, quotient, and multiple</li> <li>▪ Implement commutative and associative law in calculation</li> <li>▪ Calculate the value of a numerical expression with a maximum of two operations</li> <li>▪ Solve a textual task by forming an expression with up to two operations</li> <li>▪ Solve an equation with an operation</li> <li>▪ Express an amount of money through different currency values</li> <li>▪ Read and write numbers in Roman numerals (up to 100)</li> <li>▪ Present data in a table and bar chart</li> <li>▪ Distinguish segments, rays, and straight lines</li> <li>▪ Determine the perimeter of a geometric figure</li> <li>▪ Draw a rectangle, square, and triangle on a grid</li> <li>▪ Identify matching figures and symmetrical figures</li> <li>▪ Finish a drawing so that the resulting figure is symmetrical with respect to the given line</li> <li>▪ Express length in different units</li> <li>▪ Measure length and draws a line of the given length</li> <li>▪ Read and write time from a clock</li> <li>▪ Use time units in simple situations</li> </ul>

Grade Level	Key Outcomes
Grade 3	<ul style="list-style-type: none"> <li>▪ Read, write, and compare numbers up to 1,000 and display them on a number line</li> <li>▪ Read and write numbers in Roman numerals (up to 1000)</li> <li>▪ Perform four basic operations, both in writing and mentally</li> <li>▪ Divide a number by another number up to 10, with and without a remainder</li> <li>▪ Calculate the value of a numeric expression with up to three operations</li> <li>▪ Determine the tens and hundreds nearest to the given number</li> <li>▪ Solve an equation with one operation and solve a problem using them</li> <li>▪ Recognize visual representations of fractions <math>m/n</math> (<math>m \leq n \leq 10</math>)</li> <li>▪ Compare fractions with equal denominators</li> <li>▪ Record a length measurement result with a decimal number with one digit</li> <li>▪ Identify and describe the rule for the formation of a number sequence</li> <li>▪ Read and use data presented in tables or graphs (bar chart and pictogram)</li> <li>▪ Draw parallel and perpendicular lines, rectangles, and squares</li> <li>▪ Construct a triangle and a circle</li> <li>▪ Name the elements of an angle, rectangle, square, triangle, and circle</li> <li>▪ Classify angles and triangles</li> <li>▪ Determine the perimeter of rectangles, squares, and triangles by applying appropriate formula</li> <li>▪ Describe the properties of rectangles and squares</li> <li>▪ Draw a geometric figure in a grid layout</li> <li>▪ Use geometric tools</li> <li>▪ Read, collate, and convert units for measuring length, mass, volume of fluid, and time</li> <li>▪ Compare sizes (length, mass, fluid volume, and time)</li> <li>▪ Measure the area of a geometric figure by a given measure (rectangle, square, and triangle)</li> </ul>
Grade 4 (previous curriculum)	<ul style="list-style-type: none"> <li>▪ Write, read, and represent numbers from <math>N_0</math> on the number line</li> <li>▪ Determine place value</li> <li>▪ Perform operations with natural numbers and understand numerical expressions including equations and inequalities</li> </ul>

### Exhibit 2: Mathematics Outcomes in Grades 5 to 8

Grade Level	Key Outcomes
Grades 5	<ul style="list-style-type: none"> <li>▪ Calculate the value of a simpler numerical expression and solve a simple linear equation or inequality in <math>N_0</math> and uses them to solve simple problems in everyday life</li> <li>▪ Apply divisibility rules</li> <li>▪ Divide the number into prime factors</li> <li>▪ Determine greatest common divisor and the least common multiple</li> <li>▪ Perform operations on sets</li> <li>▪ Analyze and describe the relations of geometric objects with mathematical notation</li> <li>▪ Describe the elements of a circle</li> <li>▪ Construct a parallel and perpendicular line</li> <li>▪ Map a given geometric object by central symmetry and translation</li> <li>▪ Identify the types and describes the properties of angles</li> <li>▪ Measure the given angle and draw an angle</li> <li>▪ Compare, add, and subtract angles computationally and graphically</li> </ul>

Grade Level	Key Outcomes
	<ul style="list-style-type: none"> <li>▪ Draw a line of symmetry of a segment and an angle</li> <li>▪ Determine place value</li> <li>▪ Round a number and estimate the rounding error</li> <li>▪ Calculate the value of a simpler numerical expression, solve a simple linear equation and inequality, and solve simple problems</li> <li>▪ Determine the percentage of the given size</li> <li>▪ Apply ratio in simple real-world situations</li> <li>▪ Calculate arithmetic mean</li> <li>▪ Collect data and display it with a chart and pie chart and use a calculator or software as needed</li> <li>▪ Identify an axisymmetric figure and determine its axis of symmetry</li> <li>▪ Construct a line of symmetry for a segment and for an angle</li> <li>▪ Construct a line that is perpendicular to or parallel to the given line</li> </ul>
Grade 6	<ul style="list-style-type: none"> <li>▪ Read, write, compare, and represent integers and rational numbers</li> <li>▪ Determine the opposite number, absolute value, and reciprocal of a rational number</li> <li>▪ Calculate the value of a simpler numerical expression, solve a simple linear equation and an inequality with a set of rational numbers, and solve a simple problem in a real context</li> <li>▪ Apply proportions and percentages in real situations</li> <li>▪ Display the data and the dependence between two sizes in a coordinate system (bar, dot, and line diagram)</li> <li>▪ Interpret the data presented in tables and graphically</li> <li>▪ Classify triangles or quadrilaterals</li> <li>▪ Construct 90 and 60 degree angles and use them to construct other angles</li> <li>▪ Construct a triangle, parallelogram, and trapezoid</li> <li>▪ Apply the properties of triangles and quadrilaterals in simpler problems</li> <li>▪ Add and subtract vectors and use them in real-world situations</li> <li>▪ Determine the center of a circle described and inscribed in a triangle</li> <li>▪ Apply central and axial symmetry and translation properties in simple tasks</li> <li>▪ Calculate the area of a triangle and a quadrilateral using formulas</li> </ul>
Grade 7	<ul style="list-style-type: none"> <li>▪ Calculate the power of a real number and the square root of a complete square</li> <li>▪ Determine the numerical value of a simple expression with real numbers and solve real-life problems</li> <li>▪ Determine the approximate value of a real number and estimate the absolute error</li> <li>▪ Draw a graph of the function <math>y = kx</math>, <math>k \in \mathbb{R} \setminus \{0\}</math></li> <li>▪ Apply proportion in real situations</li> <li>▪ Apply the Pythagorean theorem in computational and constructive problems</li> <li>▪ Transform the sum, difference, and product of a polynomial</li> <li>▪ Apply polynomial transformations to solving equations</li> <li>▪ Use properties of polygons</li> <li>▪ Calculate a polygon surface area</li> <li>▪ Construct the orthocenter and the center of gravity of a triangle</li> <li>▪ Calculate the circumference and area of a circle and its parts</li> <li>▪ Copy a given geometric object by rotation</li> <li>▪ Determine the mean, median, and mode</li> </ul>



Grade Level	Key Outcomes
Grade 8 (previous curriculum)	<ul style="list-style-type: none"> <li>▪ Solve linear equations (including inequalities) and systems of linear equations in one or two unknowns and interprets solutions graphically</li> <li>▪ Present word problems using mathematical language and solve them</li> <li>▪ Identify functional dependencies and display them in different ways</li> <li>▪ Understand the concept of functions and graphical representations of functions</li> <li>▪ Understand linear functions and their properties</li> <li>▪ Draw and interpret linear functions</li> <li>▪ Interpret data presented in graphs and tables</li> <li>▪ Construct a table and draw appropriate graphs and diagrams using the given data</li> <li>▪ Calculate the median of a data set</li> <li>▪ Understand the relationships between points, lines, and planes in space</li> <li>▪ Understand projections in a plane and the elements and properties of solid figures (e.g., prisms, pyramids, cylinders, cones, and spheres)</li> <li>▪ Calculate the surface area and volume of a solid figure</li> <li>▪ Apply the knowledge of solid figures in practice, linking the content of mathematics with other areas</li> <li>▪ Apply the elements of deductive reasoning in proofs</li> </ul>

## The Science Curriculum in Primary and Lower Secondary Grades

Science at the primary level in Serbia is taught in several subjects. In the first cycle of primary education, there are two compulsory subjects: The World Around Us (Grades 1 to 2) and Nature and Society (Grades 3 to 4). Science education may be extended with the following elective subjects: Hands on Test (Grades 1 to 4) and Nature Protectors (Grades 1 to 4).<sup>34</sup>

The new curriculum has already been introduced in schools in Grades 1, 2, 5, and 6. The generation of students that participated in TIMSS 2019 followed the previous science curriculum. The new curriculum for The World Around Us and Nature and Society defines the outcomes to be developed through recommended content, adequate teaching and learning methods, and student activities. The primary purpose of outcome-based teaching is not the transfer of subject content, but rather the development and mastery of knowledge as a basis on which diverse skills are developed. In that sense, the teaching and learning program offers a content framework, and teachers have the freedom to choose other content, if they believe it is more appropriate for the environment in which their students live, their age and developmental characteristics, and their interests. The intent is for the content to serve as a means of achieving outcomes, not as an end in itself. Teachers have significant freedom in choosing and connecting content, teaching and learning methods, and activities to guide students toward achieving a given outcome. In this way, priority is given to the contextualization of the program, the active participation of students in teaching, and the autonomy of teachers in their choice of content. A novelty in the program is the clear introduction of humans as parts of living nature and an introduction to the functions of human body parts. Outcomes and recommended content related to health and safety are also defined. Emphasis is placed on developing a healthy lifestyle (body hygiene, diverse and regular diet,



spending time in nature, and physical activity) and enabling students to identify and respond to situations that may endanger their health and lives.

The previous curriculum for Nature and Society encompasses content from various natural and social sciences and may be connected to other subjects within the grade and between grades. The goal of Nature and Society is to help students develop familiarity with themselves and their natural and social surroundings and abilities for living responsibly. The subject also aims to help students understand phenomena familiar to them from everyday life, and to lay a foundation for understanding abstract concepts and scientific opinions. The curriculum was structured using an upward spiral approach.

General standards of achievement for Nature and Society are provided in the following content areas: Living and Nonliving Nature, Ecology, Materials, Motion and Orientation in Space and Time, as well as Society and the Republic of Serbia and Its Past. When formulating the key competencies for the subject Nature and Society, both subject content and the intellectual abilities of students in the first cycle of primary school were considered.<sup>35</sup>

In the second cycle of primary education (Grades 5 to 8), science is taught in several compulsory subjects: biology (Grades 5 to 8), geography (Grades 5 to 8), physics (Grades 6 to 8), and chemistry (Grades 7 and 8). The elective subject Nature Protectors is offered in Grades 5 and 6, as well. The structure of the curricula for all subjects includes subject area, aims and objectives, and curriculum implementation methods. The main goals for biology, geography, physics, and chemistry are stated below:

- **Biology**—Education in Biology should ensure that students learn the basic concepts of the living world, its historical development, and the natural phenomena related to the laws of the living world. The curriculum prescribes the following objectives for eighth grade biology: understand the role and importance of biology in the progress of mankind and in sustainable development; understand the gradual evolution of wildlife; understand that living things are classified into five kingdoms based on similar characteristics; know about the structure and function of living organisms; develop the ability to relate concepts and processes in living organisms and nature; know about the diversity and distribution of living organisms; understand the relationships between living things and the environment, as well as the dynamics of the circulation of matter and energy flow; develop a sense of responsibility for the state of the environment; understand threats to the biosphere and the role of individuals in its protection and improvement; know about the structure and functions of the human body systems; develop the necessary hygiene habits to preserve personal health and the health of others; realize that sexuality is an integral part of life and respect the norms of behavior between people; use methods of observation, measurement, and experimentation; and develop a clear idea of occupations related to biology to help with the selection of a future profession.
- **Geography**—Education in geography should provide knowledge about natural and sociogeographic objects, phenomena, and processes and their relationships in geospace, contributing to understanding the world as it is and the role of Serbia in the world.

According to the curriculum, students should learn about the following: basic objects, phenomena, and processes in the universe; Earth's surface and environments; and basic geographical features of Europe, the other six continents, and the Republic of Serbia. Students also should understand the Earth's structure and the causes and effects of phenomena and processes on the Earth. The geography curriculum contributes to developing students' views on the protection and improvement of the environment. Cartography has great educational importance within geography, because it forms the basis for understanding all aspects of geography and has general educational importance because of the need to use maps in almost all domains of human activity.

- **Physics**—Education in physics should ensure that students acquire knowledge of natural phenomena and the laws of nature, develop basic linguistic and scientific literacy, learn to recognize physical phenomena in their everyday lives, and acquire further knowledge. The implementation of the physics curriculum takes into account three facts: that the ability to think abstractly is not completely developed in primary school students; that physics is an abstract, precise, and diversified scientific discipline; and that experimentation may be neglected unjustly in teaching physics. Physics teaching goals include introducing basic ways of thinking and reasoning in physics; understanding phenomena, processes, and relationships in nature based on physical laws; developing the ability to acquire knowledge about physical phenomena through active investigation; encouraging curiosity, rational thinking, independence, and critical thinking; developing skills for clear and precise communication; developing logical and abstract thinking; understanding the meaning and methods of implementing experiments and the importance of measuring; solving simple physics problems; developing the ability to apply the knowledge of physics; identifying and understanding the relationship between physical phenomena and ecology; developing awareness of the need for environmental protection, restoration, and improvement; developing work habits and preferences conducive to studying the natural sciences; and developing awareness of one's own knowledge, skills, and professional orientation.
- **Chemistry**—Chemistry education aims to ensure that students develop basic linguistic and scientific literacy, as well as functional chemical literacy, progress toward implementing appropriate standards of education achievement, and the ability to solve problems in unknown situations and express their own opinions. In the seventh grade, the chemistry curriculum covers basic concepts organized around the following five topics: the development of chemistry as a science and its role in contemporary life; basic chemical concepts; solutions, solubility, and quantitative expressions of solution composition; connecting chemistry concepts to everyday life; and chemical changes and quantitative aspects of chemical reactions. In the eighth grade, the curriculum covers inorganic and organic chemistry organized around the following six topics: characteristics of nonmetals and metals; salts and ionic compounds; the properties of acids and bases and electrolytic dissociation; the basic characteristics of organic compounds and how they differ from inorganic compounds; the physical and chemical characteristics of some organic compounds, including biologically important

compounds; and the causes of environmental pollution and procedures for minimizing the consequences of their impact.

## Professional Development Requirements and Programs

The Center for Professional Development of Employees in Education, within the Institute for Education Improvement, is in charge of preparing the competence standards for the profession of preschool and school teachers; improving and developing the system of continuous professional development in education; preparing programs for beginning teachers, preschool teachers, professional associates, and school principals; and providing expert and pedagogical assistance for educators. An integral part of professional development is career development by promotion. A trainee teacher is introduced to a job by mastering the program in the institution where that teacher is employed, or in another institution of the same type, if it ensures successful preparation for education work. A mentor colleague from the institution is appointed to work with the trainee. Knowledge testing is organized at the school itself in front of the school board, while license exams are taken at a school designated by the Minister and before a committee appointed by the Minister. The Ministry of Education, Science, and Technological Development issues the license to the trainee who has passed the license examination.<sup>36</sup>

Teacher professional development is both a right and a legal obligation. Teachers are required to obtain 64 points every year through participation in professional development activities (typically, one hour of professional development is equivalent to one point). Professional development may take place in schools or outside schools (e.g., teachers may present an experimental class to colleagues or participate in scientific research and present experiences from different learning activities in school; they can also participate in approved professional development programs outside school or to take online seminars). Teachers select the programs they wish to attend from a list of programs approved by the Institute for Education Improvement. There are 36 programs for mathematics (out of 47), as well as 16 programs for science (out of 40) on the list of programs for professional development of classroom teachers. Most mathematics programs and all of the science programs are related to the improvement and development of teacher competencies in the planning and realization of teaching oriented on learning outcomes.<sup>37</sup>

## Monitoring Student Progress in Mathematics and Science

Since the 2013–2014 school year, students take the following three final examinations at the end of the eighth grade of primary education: their mother tongue, mathematics, and a combined test that examines competencies in the natural and social sciences, covering content and competencies in biology, geography, history, physics, and chemistry, as well as general competencies that the natural and social sciences have in common. The final examinations consist of questions and tasks that test competencies described in the education standards on basic, intermediate, and advanced levels.<sup>38</sup>

The Institute for Education Quality and Evaluation prepares workbooks and tests and performs quantitative and qualitative analysis of the results. Reports are prepared for stakeholders

at different levels: students, classes, schools, municipalities, districts, school management, and the entire country. The annual tests in mathematics for the fourth and six grade students were set in 2015. In the 2014, 2016, and 2017 school years, initial testing in mathematics was conducted for students in Grades 4, 6, and 8.

Monitoring student development, progress, and achievement during the school year in mathematics and science is carried out through formative and summative assessment.<sup>39</sup> Formative assessment includes verifying achievement and monitoring the conduct of students during their acquisition of the curriculum; it contains feedback and recommendations for further progress, and as a rule, it is included in teachers' pedagogical documentation. Summative evaluation comprises assessing student achievement at the end of program units or evaluation periods in subject mastery and conduct.

In the classroom, teachers assess students based on verbal achievement, written achievement, and practical work, in accordance with the subject syllabus. Depending on the subject and the students' age, teachers also assess expression and communication skills; understanding, implementing, and evaluating learned processes and procedures; working with data and working with different types of texts; artistic expression; skill in handling equipment, tools, and technologies; and task performance. Student evaluations are descriptive in the first grade, and remain descriptive for compulsory and optional subjects. Beginning in the second grade, students are graded numerically based on the following scale: excellent (5), very good (4), good (3), sufficient (2), and insufficient (1).

## Special Initiatives in Mathematics and Science Education

All schools in Serbia organize extra classes for high and lower achieving students in mathematics and science subjects at all grade levels. In addition, the Ministry of Education, Science, and Technological Development organizes national competitions in mathematics and science at the state level. Students can also participate in international mathematics and science competitions. Serbia is famous for its independent science and education center, Petnica Science Center (PSC), intended for high achieving students from elementary and high schools and one of the oldest centers of its kind in Southeast Europe. The Center organizes extracurricular activities supervised by university professors and researchers from various Serbian education and science institutions. Most PSC programs are designed for high school students, although the Center offers several programs for primary school pupils, as well as seminars and activities for pre-service and in-service science teachers.

There are many successful and high quality European Union projects involving science, technology, engineering, and mathematics (STEM) education for schools, teachers, and students in Serbia. The Center for Promotion of Science<sup>40</sup> participated in several initiatives that contribute to the improvement of teachers' competencies, facilitate the implementation of innovative teaching methods in STEM subjects, and strive to attract young people to the STEM area. For example, the STEM School Label project enables school representatives to evaluate their schools

according to universal criteria that define a school as STEM-oriented via an online platform and find out which fields they should work on to improve the level of STEM education in their school. Project Scientix is primarily aimed at teachers in STEM areas, to support and promote their work via an online platform created for the cooperation and sharing of ideas and experience of education professionals. The Hypatia project was created to encourage young girls and boys to study and build a career in one of the STEM fields.

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