Romania

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Introduction

Overview of Education System

Romania has a centralized education system, currently governed by the Education Act 1 of 2011.[1] All key responsibilities for education strategy, policy, and delivery—from preschool to vocational education and training—are concentrated within the Ministry of Education and Research (MER). The education system is organized and led in partnership or in coordination with MER institutions that specialize in curriculum development, assessments and examinations, quality assurance, and other areas.

Over the past decade, various reforms have sought to increase the autonomy of schools and the engagement of local authorities. Schools in Romania have some autonomy over the curriculum, but the degree of flexibility is very limited. School maintenance is the responsibility of local authorities.

The national education system includes the following levels:

- Early childhood education
- Primary education—preparatory class and Grades 1 to 4 (International Standard Classification of Education [ISCED] 1)
- Lower secondary—Grades 5 to 8 (ISCED 2)
- Higher secondary
  - High school education (academic, vocational, or technological)—Grades 9 to 12/13 (ISCED 3)
  - Professional education—three years (ISCED 3)
- Tertiary nonuniversity education—two years (ISCED 4)
- Higher education (ISCED 5 to 8)
  - Bachelor's studies
  - Master's studies
  - PhD studies

Exhibit 1: The Structure of the Romanian Education System

<table>
<tr><th colspan="2">ISCED 0</th><th>ISCED 1</th><th>ISCED 2</th><th colspan="2">ISCED 3</th><th>ISCED 4</th><th>ISCED 5 to 8</th></tr>
<tr><td colspan="2">Not compulsory</td><td colspan="2">Compulsory</td><td colspan="2">Not compulsory</td><td colspan="2"></td></tr>
<tr><td colspan="2">Early childhood education
Ages 0–5</td><td>Primary education
Ages 6–11</td><td>Lower secondary education
Ages 11–14</td><td colspan="2">Upper secondary education
Ages 14–18/19</td><td>Tertiary nonuniversity education</td><td>Tertiary education</td></tr>
<tr><td>Nursery</td><td>Kindergarten</td><td>Preparatory year
Grades 1–4</td><td>Grades 6–8</td><td colspan="2">High school</td><td>Post high school
Two years</td><td>Bachelor's studies
Three years</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td>Grades 9–10</td><td>Grades 11–12/13</td><td></td><td></td></tr>
<tr><td colspan="4"></td><td colspan="2">Professional education
Three years</td><td></td><td>Master's studies
Two years</td></tr>
<tr><td colspan="7"></td><td>PhD studies
Four years</td></tr>
</table>

Preprimary education is provided to students ages 3 to 5 or 6 in both public and private kindergartens. Compulsory education in Romania starts with the preparatory year of primary education, when children reach the age of 6, on average, and ends with completion of 10th grade, when students reach the age of 16. A national examination marks the end of lower secondary school (end of Grade 8). The upper secondary system is divided into two cycles: high school lower cycle (Grades 9 to 10), and high school upper cycle (Grades 11 to 12 or 13).

Education is delivered in both public and private schools, or in alternative education systems (Waldorf, Montessori, Step-by-Step, and others[2]) in the official state language (Romanian), in the native languages of the students belonging to the national minorities,[3] or in modern languages. Mobility of students from one field of study to another or from one pathway to another is allowed.

According to the Education Act of 2011, the main purpose of the national curriculum is to equip all students with a set of competencies defined at different levels of generality. The national curriculum includes two components: (1) the core curriculum, a common and compulsory offering established at the national level for all students, and (2) the school-based curriculum, a set of education processes and learning experiences that every school develops and implements directly for its own students.

Impact of TIMSS

Along with other international assessments, TIMSS data and analyses raised policymakers' awareness concerning the effectiveness of the education policies, the structural problems facing the system, and the necessity for change at the curriculum level and in teaching practice. TIMSS results help education authorities understand the importance of reshaping continuous and national assessments and exams according to the requirements of the competency-based curriculum and good international practices.

According to the 2011 Act of Education, national assessments are introduced at the end of Grades 2 and 4 to identify the weaknesses in acquiring the competencies related to reading, writing, and mathematics, and at the end of Grade 6 to evaluate learning in Romanian language, mathematics, and science. National assessment results inform individual improvement plans at the end of Grades 2 and 6 and provide diagnostic information at the end of primary education (end of Grade 4). Generally, the structure of the tests reflects the principles of IEA studies. To improve teaching practices, methodological guidelines were developed highlighting the typical errors in learning reading comprehension, mathematics, and science.

The Mathematics Curriculum in Primary and Lower Secondary Grades

Mathematics education has a prominent place in the Romanian national curriculum. Mathematics is taught throughout all stages of education and, together with Romanian language and mother tongue, is a core subject covered by the national assessments and baccalaureate. According to the national curriculum, at the primary and lower secondary levels, mathematics education aims to build students' understanding of the nature of mathematics as a problem-solving activity, based on a body of knowledge and procedures that can be approached by exploration. Mathematics is not taught in isolation but in correlation with technology, natural sciences, and social sciences, as well as everyday life.

Currently, in Romania, the mathematics curriculum is competency-based, aiming at developing a set of general and specific competencies that, together with all other subjects, contribute to the development of eight key competencies that follow the European Union recommendations.[4]

Despite emphasis on modifying mathematics teaching and learning in recent years, the provisioned reforms have not reached most teachers and students due to various changes in education policies over the last decade and weak professional development programs for teachers. Consequently, the reforms have not effectively influenced student learning.

The Mathematics Curriculum in Primary Education

According to the teaching plan[5] for the students assessed in 2018–2019, mathematics is part of the curriculum area Mathematics and Natural Sciences. In the preparatory class and Grades 1 and 2, mathematics and science are taught together as an integrated subject called Mathematics and Environment Exploration for four periods (i.e., teaching hours) per week in preparatory class and Grade 1 (21 percent of the total number of periods[a]) and five periods per week in Grade 2 (25 percent of the total number of periods). Four periods are allocated to mathematics in Grades 3 and 4 (25 percent of the total number of periods).

The mathematics curriculum for preparatory class and Grades 1 and 2 is approved by Minister Order 3418/2013,[6] while the curriculum for the Grades 3 and 4 is regulated by Minister

[a] This analysis refers to the core/compulsory curriculum, not considering the school-based curriculum.

Order 5003/2014.[7] This new generation of subject curricula is built on the philosophy of Education Law 1/2011, aiming to bring the principles of competency-based curriculum, active learning, and student-centered approach to the classroom. The impact of the new generation of subject curricula was diminished by weaknesses in the teacher training programs.

Exhibit 2 presents the general and specific competencies related to mathematics at the end of primary education (Grade 4).

Exhibit 2: Competencies at the End of Primary Education

General Competencies	Specific Competencies
1. Identifying relations/regularities in familiar settings	1.1. Explaining patterns to create your own thinking 1.2. Generating repetitive patterns
2. Using numbers in computations	2.1. Recognizing natural numbers from 0 to 100,000 and fractions with a denominator smaller or equal to 10, respectively equal to 100 2.2. Comparing natural numbers from 0 to 1,000,000 and fractions having the same numerator or the same denominator smaller or equal to 10 or a denominator equal to 100 2.3. Ordering natural numbers from 0 to 1,000,000 and fractions with the same numerator or the same denominator smaller or equal to 10 or the denominator equal to 100 2.4. Adding and subtracting natural numbers from 0 to 1,000,000 or fractions 2.5. Multiplying natural numbers from 0 to 1,000,000 or fractions when factors have at least three digits and dividing with one- or two-digit numbers
3. Exploring the geometric features of objects familiar settings	3.1. Locating objects in space and symbols in a variety of representations 3.2. Exploring the features, relationships, and properties of one-, two-, and three-dimensional shapes identified in various contexts
4. Using of conventional standards in measurements and estimates	4.1. Using standardized measurement tools and units, in real life contexts 4.2. Operating with standardized measurement units, using transformations
5. Solving problems in familiar settings	5.1. Using mathematical symbols and specific terminology to solve and propose a variety of problems 5.2. Organizing data in tables and representing them graphically

According to the mathematics curriculum, to develop these competencies, teachers should favor classroom activities emphasizing:

- Problem solving activities requiring active involvement in practical contexts and searching for solutions beyond the given frame of school knowledge;
- Formulating questions, analyzing steps, and motivating decision making in problem solving;
- Using various motivational strategies to help learning;
- Working in teams;
- Assessments as a part of learning

Graduates of primary education should be able to show curiosity to find scientific truth, explore patterns and mathematical relations in familiar contexts, formulate simple explanations

using specific mathematical terminology, and solve problems in familiar situations using mathematical tools and/or procedures.

The Mathematics Curriculum in Lower Secondary Education

Mathematics education for Grades 5 to 8 students assessed in 2018–2019 was regulated by Minister Orders No. 3638/11.04.2001[8] and No. 5097/09.09.2009.[9]

According to the approved teaching plan, four periods (i.e., teaching hours) per week were allocated for mathematics, representing 17 percent of the total number of compulsory periods per week, the highest allocation compared with any other subject, except Romanian language, Grade 5.

Exhibit 3 presents the general and specific competencies related to mathematics at the end of lower secondary education (Grade 8).

Exhibit 3: Competencies at the End of Lower Secondary Education (Grade 8)

General Competencies	Specific Competencies
1. Identifying dates and mathematical relations and their correlations depending on the context in which they were defined	1.1. Identifying real numbers and abbreviated calculation formulas in examples, exercises, or problems 1.2. Recognizing correspondences that are functions 1.3. Recognizing and describing the properties of the two-dimensional geometrical shapes in given configurations, in space or on their deployments
2. Processing quantitative, qualitative, structural, or contextual data in mathematical statements	2.1. Using the definition of real number ranges and their representation on a number axis in exercises 2.2. Using the values of functions to solve equations and inequalities 2.3. Using adequate geometrical tools to represent geometrical shapes, in two-dimensional shapes 2.4. Computing the areas and volumes of the studied geometric shapes
3. Using mathematical algorithms and concepts for local or global characterization of a concrete situation	3.1. Choosing the form of representation of a real number and using algorithms to optimize the computation with real numbers 3.2. Representing correspondences and/or functions to characterize them 3.3. Using the properties of straight lines and angles in space to analyze their relative positions 3.4. Classifying geometrical shapes according to given or chosen criteria
4. Expressing the quantitative and qualitative characteristics of real life situations and of the processing algorithms	4.1. Using terminology related to the concept of real numbers (sign, module, opposite, reverse, whole part, fractional part) in a variety of contexts; standardized measurement tools and units in real life contexts 4.2. Representing notions of plane geometry through graphical representations 4.3. Representing concepts related to straight lines and angles in a plane and in space through geometric representations 4.4. Expressing the properties of the figures and geometrical shapes in mathematical language (axioms, direct theorem, reciprocal theorem, hypothesis, conclusion, demonstration)

General Competencies	Specific Competencies
5. Analyzing and interpreting the mathematical characteristics of a problematic situations	5.1. Deducing and applying shortened calculation formulas for optimizing computations 5.2. Determining the solutions of equations, inequalities, or systems of equations 5.3. Choosing the appropriate geometric representations to optimize the description of spatial configurations and to optimize the calculations of segment lengths and angle measurements 5.4. Analyzing and interpreting the conditions necessary for a geometric configuration to verify certain requirements
6. Creating mathematical patterns in problematic contexts, by integrating knowledge from various domains	6.1. Solving problems using real number reports represented by letters and interpreting the result 6.2. Identifying problems that are solved by means of equations, inequalities, or systems of equations, solving them, and interpreting the result 6.3. Interpreting geometric representations and information contained therein in correlation with the determination of segment lengths and angle measurements 6.4. Transposition of a problem into geometric language, solving the problem, and interpreting the result

The Science Curriculum in Primary and Lower Secondary Grades

During the primary education cycle, the science curriculum in delivered mainly through two subjects: natural sciences and geography. The main method of teaching is by exploring the immediate environment, then gradually increasing the scale to encompass more distant realities. The world is considered through its observable aspects and phenomena. Exhibits 4 and 5 present the general competencies developed and the achievement standards for fourth grade set out by the two curricula.

Exhibit 4: Competencies and Achievement Standards for the Natural Sciences Curriculum in Primary Education[10, 11]

General Competencies, Grades 3 and 4	Curricular Achievement Standards, Grade 4
▪ To understand and be able to communicate using specific scientific concepts and terminology ▪ To design and develop experiments, making use of specific instruments and procedures ▪ To develop an interest in and feel responsible for environmental sustainability	▪ To identify similarities, differences, and relationships among objects and system components, based on observation ▪ To classify objects, events, and phenomena based on specific criteria ▪ To describe relationships among systems and system components ▪ To communicate about experimental results and about objects, phenomena, events, and systems observed in a variety of ways ▪ To use conventional and unconventional instruments and tools for measurement, and to identify patterns while measuring or observing phenomena ▪ To conduct basic experiments grounded in hypotheses or working plans

Exhibit 5: Competencies and Achievement Standards for the Geography Curriculum in Primary Education[12]

General Competencies, Grade 4	Curricular Achievement Standards, Grade 4
▪ To represent the geographical space (from local to global) ▪ To establish connections between geographical elements, based on different sources. ▪ To make adequate use of language specific to geography ▪ To exhibit behavior conducive to improving the relationships between humans and the environment	▪ To identify observable elements of nearby geographical space ▪ To classify the observable elements of the environment ▪ To identify relationships between observable elements and to represent them on simple cartographic media ▪ To describe a reality based on images ▪ To identify basic relationships based on observation or a variety of sources ▪ To employ basic terms in given contexts

Students starting school during the 2012–2013 school year have benefited from updated school curricula. The achievement standards are no longer part of each curriculum. They are set out by the Graduate's Profile[13] with specific descriptors for 4th, 8th, and 10th grade. They were developed starting from the first iteration of the eight key competencies.[14] Exhibit 6 presents the general science competencies developed during primary education cycle.

Exhibit 6: General Competencies for Natural Sciences and Geography in Primary Education

Subject	General Competencies
Natural sciences, Grades 3 and 4	▪ To explore the characteristics of bodies, phenomena, and processes ▪ To investigate the environment using specific instruments and techniques ▪ To solve daily life problems by employing the acquisitions regarding one's own body and the environment
Geography, Grade 4	▪ To present the observable environment, by employing general and specific terminology ▪ To use important elements from mathematics, natural sciences and social sciences in understanding the environment ▪ To connect the environment with a cartographic representation ▪ To develop an interest in knowing the local horizon, that of the country and of the contemporary world

At the end of fourth grade, students should have achieved the following basic competencies in science and technology:

- Follow a simple investigative process by going through a series of steps to achieve a goal;
- Create simple products, with adult support, for the regular needs of one's own learning activities;
- Exhibit interest for one's own health and for a clean environment;
- Apply basic rules for personal hygiene and rules for responsible behavior towards the environment.

During the lower secondary cycle, the science curriculum branches out to four subjects: biology, geography, physics, and chemistry. Building on previously acquired exploration competencies, the science curriculum moves toward a more systematic approach, focused on experiments and the analysis of the data collected. The curriculum aims to foster a positive attitude of engagement with one's own needs and with the environment, to develop a healthy lifestyle, and to create environmental awareness. Exhibits 7 to 10 present the general competencies developed by the lower secondary science curricula and their respective achievement standards.

Exhibit 7: Competencies and Achievement Standards for the Biology Curriculum in Lower Secondary Education[15]

General Competencies, Grades 5 Through 8	Curricular Achievement Standards, Grade 8
▪ To acquire information about the living world ▪ To explore biological systems ▪ To use and develop models and algorithms to demonstrate principles of the living world ▪ To communicate orally and in writing, using correct terminology ▪ To transfer and to integrate specific knowledge and methods of biology in new contexts	▪ To use terminology and concepts correctly to describe and interpret biological processes ▪ To identify, interpret, and classify structural and functional properties of organisms ▪ To carry out research on the living world by correctly applying investigative methods ▪ To Identify a problem and select correct methods and means to solve it ▪ To interpret and comment on data collected while carrying out an experiment and to draw conclusions from the data ▪ To present one's own research activities, verbally or in writing ▪ To select and use appropriate sources of information

Exhibit 8: Competencies and Achievement Standards for the Chemistry Curriculum in Lower Secondary Education[16]

General Competencies, Grades 7 and 8	Curricular Achievement Standards, Grade 8
▪ To explain chemical phenomena, processes, and procedures from daily life ▪ To investigate how substances and chemical systems behave ▪ To use deductive and inductive approaches to problem solving ▪ To explain and report the results of investigations ▪ To evaluate the consequences of using chemical processes and chemical products	▪ To classify simple and complex substances, mixtures, and chemical reactions according to one or more criteria ▪ To describe and interpret chemical phenomena, properties, and models ▪ To experiment using known substances ▪ To represent and interpret observations and data resulting from research and experiments, in the form of tables, graphs, and diagrams ▪ To draw conclusions based on the physical and chemical behavior of substances ▪ To apply mathematical relations and expressions of the laws of chemistry to solve quantitative problems ▪ To use scientific terminology when presenting a piece of research, orally or in writing

Exhibit 9: Competencies and Achievement Standards for the Physics Curriculum in Lower Secondary Education[17]

General Competencies, Grades 6 Through 8	Curricular Achievement Standards, Grade 8
▪ To know and understand physical phenomena, concepts, laws, and models, and to be able to explain the function and use of technical devices in daily life ▪ To investigate experimentally and theoretically ▪ To solve problems using procedures specific to physics ▪ To communicate using scientific terminology ▪ To protect oneself, others, and the environment	▪ To describe observed physical phenomena, using specific terms ▪ To use measuring equipment and specific methods to determine physical quantities ▪ To carry out experiments, either controlled or not, based on physical phenomena ▪ To organize, use, and interpret data from experiments ▪ To interpret the content of a problem from the perspective of physics, quantitatively ▪ To use mathematical relations and principles and the laws of physics to solve theoretical or practical problems ▪ To use physics terminology to describe observations and conclusions drawn from experiments ▪ To understand the overall meaning of physics-related information from various sources

Exhibit 10: Competencies and Achievement Standards for the Geography Curriculum, in Lower Secondary Education[18]

General Competencies, Grades 5 Through 8	Curricular Achievement Standards, Grade 8
▪ To use correct terminology to present and explain geographic reality ▪ To use names and terms in different languages ▪ To transfer knowledge from mathematics and science to environmental studies ▪ To represent geographic reality on maps ▪ To identify and explain the social, civic, and cultural aspects of the geographic space ▪ To acquire skills and techniques for lifelong learning ▪ To develop patterns and solutions for organizing the geographic space, taking into consideration sustainable development	▪ To define the position of basic elements in space and time ▪ To connect elements of real geographical space with their symbolic representations ▪ To use information from maps and drawings to represent a geographical reality ▪ To write a report on a topic related to geography ▪ To use Information and Communication Technology (ICT) to find geographic information

Professional Development Requirements and Programs

The continuous professional development of mathematics, science, and technology teachers is achieved through continuous development courses that offer transferable professional credits. Teachers must accumulate 90 credits over five years. Courses can be focused on areas such as mathematics, sciences and technology, pedagogy, educational psychology, didactics, ICT, and education management.

Monitoring Student Progress in Mathematics and Science

Regulations Concerning National Assessments

Mathematics is a national assessment subject for students in primary and lower secondary cycles, in Grades 2, 4, 6, and 8. While the national assessments for Grades 2, 4, and 6 are meant to provide students, parents, and teachers with formative feedback, the eighth grade national assessment is used to direct students for upper secondary education. The fourth grade evaluation is also intended to provide policymakers with a systemic overview of the student achievement after the primary cycle. It is important to mention that the sixth grade assessment also includes natural sciences.

All national assessment tests were designed by the National Centre for Assessment and Examinations (Ministry of Education) in accordance with the national curriculum, but the scoring is done either in-house (evaluations in Grades 2, 4, and 6) or across several schools (for the fourth grade evaluation). All students assessed in 2018–2019 participated in these national assessments. Some students also participated in mock exams in Grades 7 and 8. The mock exams are meant to train students for the eighth grade national assessment. They are organized at county or national level, and participation is voluntary.

Regulations Concerning the Classroom Evaluation

Mathematics and science teachers are assigned to design and conduct the classroom evaluation according to the general regulations of the Ministry of Education. Therefore, the classroom evaluation should target students' competencies as stated by the national curriculum. Classroom evaluations should provide formative feedback to students and parents, but it is worth mentioning that the results obtained in the lower secondary school are used to direct students to upper secondary education.

Student evaluation should be performed regularly by the classroom teachers using the methods that they consider most appropriate (e.g., oral questioning, written papers, practical activities, reports and projects, interviews, portfolios) provided that they use the written tests at least once during a school semester. Moreover, at upper secondary level, by the end of each semester, the teacher should evaluate its students in mathematics by using a summative, written test (the result of this test counts for 25 percent of the semester average).

Evaluations are graded at the primary level with a qualitative mark on a 4-point scale (insufficient, sufficient, good, and very good) and at the lower secondary level with a quantitative mark on 10-level scale that is recorded in the class record. Every school semester, teachers assign

a minimal number of marks to each student; the number must be at least equal to the number of classes per week established by the national curriculum for the given subject and grade. At the end of each semester and school year, teachers calculate and record the average mark/qualitative mark for each student and subject.

Special Initiatives in Mathematics and Science Education

In recent years, the Ministry of Education has implemented various programs for improving and modernizing the curriculum for primary and secondary education, focusing on integrated science subjects with real life examples and contexts. An important change is the modification of the national assessment at the end of the eighth grade by introducing a cross-disciplinary test of mathematics and sciences. The educational measure has not yet been implemented, because teacher training has not taken place and also there are changes to teaching in science classrooms.

At the national level, initiatives and programs focused on science education from NGO include the following:

- The Romanian Space Agency (ROSA) program uses the concept of "cosmic space" as a creative context for integrated teaching and learning in science, technology, engineering, and mathematics (STEM) in preuniversity education institutions in Romania. The European Space Education Resource Office (ESERO) organizes national events regarding STEM education in the context of cosmic space, as well as training for primary and secondary teachers.
- Programs from the Centre for Evaluation and Educational Analysis (CEAE) are updating and modernizing the curriculum for physics and chemistry at the secondary level through Inquiry Based Learning (IBL) methods. CEAE organized accredited training courses for physics and chemistry teachers, created methodological guides for teaching physics, and developed an online platform for physics teachers with best practices and instruments to be used in classrooms.
- Community Education for Science programs, such as National Conference and Magurele Summer School of Science and Technology, support the exchange of ideas and best practices in science education through learning communities and ecosystems that support professional development and guidance for students.

To improve the education process, the Ministry of Education is implementing the School after School program, complementary to the compulsory school program, which offers opportunities for consolidation of competencies, remedial learning, and acceleration of learning through educational, recreational, and leisure activities.

Suggested Readings

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