Spain

Carmen Tovar Sánchez
Verónica Díez Girado
Francisco Javier García Crespo
Rocío Carrascosa Sestines
National Institute for Educational Assessment, Ministry of Education, Vocational Training, and Sports

Introduction

Overview of Education System

In addition to Spain's territorial organization, the country's political, social, and economic characteristics determine the organization of and have a direct influence on the education system. The legislative framework governing and guiding the Spanish education system comprises the Spanish Constitution of 1978 and a series of acts that expand on the principles established therein.[1]

In the field of education, the decentralization of the state involves an administration model in which competencies are shared between the Spanish government and 17 autonomous communities. In the autonomous cities of Ceuta and Melilla, the Ministry of Education, Vocational Training, and Sports assumes the competencies related to education.

The Spanish government oversees the education system regarding legislation, basic structure, and cooperative initiatives among all autonomous communities and with other countries. Other aspects of education, such as curriculum development, schools, financial management, and personnel management in their respective territories, are within the responsibility of the self-governed regions. Education regulations currently in force, including the 2020 Organic Law for the modification of the 2006 Organic Law of Education (LOMLOE), guarantee the uniformity and unity of the education system and allow individual communities to make decisions that meet their needs.[2,3] This law includes an additional provision for state and regional cooperation to promote an adequate description of the relationships among competencies, content, and assessment criteria of the different stages of education. Thus, the curriculum has a centralized common framework that is developed and implemented by the autonomous communities and schools.[4,5]

Schools in Spain are classified as state owned or private. State schools are owned and run by a public authority, while private schools are not. However, the majority of private schools are also financed by public sources; the state funds these schools' operational costs under the general system for grant-maintained schools in return for the public education service they provide to society. Private schools without public funding are mainly financed through tuition

fees paid by the students' families, although those schools may also receive support from subsidies or private institutions such as cooperatives, foundations, or religious orders. Parents or legal guardians can choose between the different schools mentioned above.

The basic structure of the Spanish education system was reinforced in 2020 by LOMLOE, which maintained the existing organization that was established in the 2006 Organic Law of Education (LOE). The system is organized into grades, cycles, and levels of education. The levels of education comprise early childhood education (ages 0 to 6), primary education (ages 6 to 12), compulsory secondary education (ages 12 to 16), and postcompulsory secondary education (over 16 years of age).

Early childhood education is not compulsory and is organized in two cycles—one for ages 0 to 3 (ECED program) and the other for ages 3 to 6 (preprimary education program)—with the second cycle free of charge. During the 2021–2022 academic year, the enrollment rates in the first and second cycles of early childhood education were 41.6% and 97.7%, respectively.[6]

Primary education (Grades 1 to 6) and compulsory secondary education (Grades 7 to 10) comprise Spain's basic education system: 10 years of schooling (generally for students ages 6 to 16) that are compulsory and free of charge. LOMLOE established the objectives that describe what competencies students should develop at the primary level. The aim of this level is to facilitate the learning of oral expression, comprehension techniques, reading, writing, numeracy, and cultural skills. Primary education is also a means to ensure that students develop social skills, work and study habits, artistic sense, creativity, and affectivity. Hence, this level is intended to guarantee comprehensive training that develops students' personalities and prepares them for secondary education.

Secondary education is divided into compulsory secondary and postcompulsory secondary education. Compulsory secondary education comprises 4 years (Grades 7 to 10) and aims to provide students with the basic elements of culture (humanistic, artistic, scientific, and technological) that will make them conscious and committed citizens and allow them to pursue subsequent studies or directly enter the job market. This stage of secondary education is organized with the goal of providing a common core education to all students while also paying attention to student diversity. Schools can organize the curriculum in a flexible way and adopt necessary measures to address student diversity. In doing so, however, each school must ensure that all its students can reach the targets set for compulsory secondary education without any discrimination that might prevent them from achieving the final qualification. Postcompulsory secondary education (Grades 11 and 12) includes the baccalaureate and intermediate vocational education and training (VET) levels. Higher education includes university (United Nations Educational, Scientific and Cultural Organization [UNESCO]'s International Standard Classification of Education [ISCED] Level 6 and above), a higher level of VET, higher studies in art and design, and a higher level of sports education (ISCED Level 5).[7]

Over the past decade, the Ministry of Education, Vocational Training, and Sports and the autonomous education authorities have placed great emphasis on competencies, particularly in the areas of mathematics and science. Since LOE introduced key competencies to the

curriculum in 2006 in accordance with recommendations from the European Union (EU), the cross-curricular nature of these competencies and the need for all subjects to contribute to their acquisition have been emphasized. Moreover, LOMLOE in 2020 has reinforced the model based on competencies and made it mandatory to acquire and develop the key competence called Competence in Science, Technology, Engineering, and Mathematics (STEM competence) in primary and secondary education.

Use and Impact of TIMSS

Spain has participated in TIMSS 1995, TIMSS 2011, TIMSS 2015, and TIMSS 2019. Based on TIMSS results and those from the Programme for International Student Assessment (PISA), along with national assessments, the government has launched national goals to promote STEM activities as transversal curriculum actions and improve the quality of teaching and learning.

Furthermore, Spain's National Institute for Educational Assessment (INEE) published a report of Spain's TIMSS 2019 results.[8] Other actions taken at the national and regional levels using results from different assessments include the following:

- publishing official education newsletters on the INEE website[a,9,10,11,12,13]
- disseminating released items from PISA, PIRLS, and TIMSS[14,15]
- holding seminars to disseminate results to teachers, principals, and the education community, including the following:
  - the seminars "Keys to Improving Education: An Overview of the International Assessments" and "The Science Challenge, International Assessments at a Glance" in 2017[16,17]
  - the symposia PISA-TIMSS "Science and English in International Assessment" in 2017 and 2018[18,19]
- developing outreach materials such as posters, videos, and brochures available on the INEE website in order to disseminate TIMSS information in schools[b]
- publishing regular information related to TIMSS and other educational assessments on INEE social media networks[c]
- translating policy and compass briefs on education into Spanish and publishing them on the INEE website[d]

a See https://www.educacionfpydeportes.gob.es/inee/publicaciones/publicaciones-periodicas/educainee.html for more information.

b See https://www.educacionyfp.gob.es/inee/evaluaciones-internacionales/timss.html for more information.

c See the X account @educaINEE (https://twitter.com/educaINEE) and blog website (https://blog.intef.es/inee/) for more information.

d See https://www.educacionyfp.gob.es/inee/publicaciones/publicaciones-periodicas/policy-brief-series.html for examples.

The Mathematics Curriculum in Primary and Lower Secondary Grades

Fourth-Grade Mathematics Curriculum

The national curriculum that was in effect for fourth-grade students assessed in TIMSS 2023 was based on the previous education law, Organic Law for the Improvement of Educational Quality (LOMCE).[20,21] This National Core Curriculum was published in March 2014 and implemented in fourth grade for the first time during the 2015–2016 academic year. This national curriculum establishes the basic aspects that comprise the minimum requirements for primary education. The curriculum details content blocks for mathematics instruction across all six grades of primary education as a whole. Additionally, each autonomous community has the authority to develop and, if necessary, supplement the curriculum according to the community's competencies.

Mathematics instruction at this level aims to achieve efficient numeracy acquisition, and learning must be experiential; that is, teaching must contextualize the content in situations familiar to students, with a problem-solving perspective that provides practical application. Problem-solving represents one of the major areas of mathematical activity because it contributes to the acquisition of basic skills such as reading for comprehension, reflecting, establishing a working plan and modifying it if necessary, verifying the found solution, and communicating the results.

The mathematics curriculum incorporates spiral learning. It is organized into five content blocks with topics developed for Grades 1 to 6: Processes, Methods, and Attitudes in Mathematics; Numbers; Measurement; Geometry; and Data and Probability. Exhibit 1 summarizes the topics in each content block that students are expected to have achieved by the end of sixth grade.

Exhibit 1: Mathematics in Primary Education

Content Block	Topics
1. Processes, Methods, and Attitudes in Mathematics	• planning the problem-solving process: analyzing and understanding the formulation/sentence/statement; implementing strategies and procedures (draw a picture, a chart, an outline, reasoned trial and error, appropriate mathematical operations, etc.); and obtaining results • conducting brief inquiries in numerical, geometric, and functional contexts • using technological resources in the learning process to obtain information, perform numerical computations, solve problems, and deliver results • integrating information and communications technology (ICT) in the learning process

Exhibit 1: Mathematics in Primary Education (Continued)

Content Block	Topics
2. Numbers	• integers, decimals, and fractions; Roman numerals • numerical order, use of ordinal numbers, comparing numbers • reading and writing numbers up to six figures • decimal number system: positional value of the figures and equivalences between its elements (units, tens, hundreds, etc.) • the decimal number: tenths, hundredths, and thousandths • meaning of a fraction as part of a whole • proper and improper fractions, mixed numerals, graphic representation • equivalent fractions, reduction of two or more fractions to a common denominator • relating fractions to decimals, ordering fractions • divisibility: multiples, factors, primes, and composite numbers; divisibility criteria • estimating results • ordering different sets of numbers • positive and negative numbers; operations with whole numbers: addition, subtraction, multiplication, and division • powers as a product of equal factors, squares and cubes, powers of 10 • operations with fractions and decimals • percentages and proportionality: correspondence between simple fractions, decimals and percentages, percentage increases and decreases, and direct proportionality • real-life problem-solving • computation: use of standard algorithms and mental computation • use of calculators
3. Measurement	• units of measurement in the metric system and their equivalents • length, capacity, mass, area, and volume; equivalences between capacity and volume measurements • developing strategies for measuring figures accurately and approximately • selecting the most appropriate unit and instrument for expressing a measurement • comparing surfaces of plane figures by superposition, deconstruction, and measurement • adding and subtracting length, capacity, mass, area, and volume measurements • estimating measurements of length, capacity, mass, area, and volume in familiar objects and spaces

Exhibit 1: Mathematics in Primary Education (Continued)

Content Block	Topics
3. Measurement	• managing units of time and understanding analog and digital watches or clocks • angle measurement and sexagesimal system • monetary systems: European Union monetary system, euro, value of different coins and banknotes • solving measurement problems
4. Geometry	• relative positions of lines and circumferences • angles in different positions: consecutive, adjacent, etc. • Cartesian plane: description of positions and movements • elementary representation of space, scales, and simple graphs • plane and spatial figures: elements, relations, and classification • classifying triangles, quadrangles, parallelepipeds, and polygons • perimeter and area • the circumference and the circle • polyhedrons and round shapes: cone, cylinder, and sphere • regularities and symmetries
5. Data and Probability	• graphs and statistical parameters • intuitive introduction to central tendency measures: arithmetic mean, mode, and range • creating and understanding simple graphics: bar graphs, pie charts, and polygonal graphs • critical analysis of the information expressed by statistical graphs • intuitive introduction to the computation of the probability of an event

The new curriculum outlined in the current law (LOMLOE) establishes the organization and minimum teaching requirements for primary education. It came into effect in 2022 and is being gradually implemented.[22,e] In the 2022–2023 academic year, it was implemented for odd-numbered grades; in the 2023–2024 academic year, it will be implemented for even-numbered grades, including fourth grade. The curricular development of mathematics is aimed at achieving the general objectives of the stage, as well as the development and acquisition of the key competencies defined in the Exit Profile that students should have achieved upon completing the primary education stage. For this reason, both the objectives of the stage and the descriptors that form part of the Exit Profile have been used as the reference framework for defining the specific competencies of mathematics. The specific competencies are interconnected and organized into five fundamental aspects: problem-solving, reasoning and proof, connections, communication and representation, and socioaffective skills. In addition, they provide guidance on the methodological processes and principles that should direct

e The full implementation schedule can be found at https://educagob.educacionyfp.gob.es/lomloe/calendario-implantacion.html

the teaching and learning of mathematics and favor both an interdisciplinary approach and innovation. The acquisition of specific competencies is the basis for assessing students and is evaluated through the assessment criteria. The specific competencies for mathematics in primary education are as follows:

- interpret everyday situations, providing a mathematical representation of them through concepts, tools, and strategies, in order to analyze the most important information
- resolve problem-based situations, applying different techniques, strategies, and forms of reasoning, to explore different ways of proceeding, obtaining solutions, and ensuring their validity from a formal perspective, as well as in relation to the context posed
- explore, formulate, and check simple conjectures or pose mathematical problems in situations based on everyday life in a guided way, recognizing the value of reasoning and argumentation, in order to contrast their validity, and acquire and integrate new knowledge
- use computational thinking, organizing data, breaking it down into parts, recognizing patterns, generalizing and interpreting, modifying, and creating algorithms in a guided way, in order to model and automate everyday situations
- recognize and use connections between different mathematical ideas, as well as identify mathematics involved in other areas or in everyday life, interrelating concepts and procedures, to interpret diverse situations and contexts
- communicate and represent, individually and collectively, mathematical concepts, procedures, and results, using appropriate oral, written, graphic, multimodal language, and terminology, in order to give meaning and permanence to mathematical ideas
- develop personal skills that help to identify and manage emotions when facing mathematical challenges, fostering confidence in one's own possibilities, accepting mistakes as part of the learning process, and adapting to situations of uncertainty, in order to improve perseverance and enjoyment when learning mathematics
- develop social skills, recognizing and respecting the emotions and experiences of others, as well as the value of diversity and actively participating in heterogeneous working teams with assigned roles, in order to build a positive identity as a mathematics student, foster personal well-being, and create healthy relationships

Eighth-Grade Mathematics Curriculum

The national curriculum that covered mathematics instruction at eighth grade in the 2022–2023 academic year also corresponded to the previous education law (LOMCE).[23] Throughout the various stages of education, students should progress in the achievement of mathematical thinking skills, specifically in the ability to mathematically analyze and research, interpret, and communicate various phenomena and problems in different contexts, as well as providing practical solutions for them. Hence, the core mathematics curriculum for compulsory secondary education should not be seen as a set of independent blocks. It must be considered in a holistic

manner, thinking about the internal connections of the subject both within the school year and between the different stages. This curriculum aims to integrate knowledge, competencies, and values; thus, learning standards have been specified that take into account the essential relationship between these elements. In Grades 7 and 8, students follow a common mathematics curriculum organized into five blocks: Processes, Methods, and Attitudes in Mathematics; Numbers and Algebra; Geometry; Functions; and Statistics and Probability. The following points detail the skills the students are expected to have reached by the end of eighth grade, resulting from the evaluation criteria:

- Processes, Methods, and Attitudes in Mathematics—Students will have learned to express the process followed to solve a problem in a reasoned manner; use problem-solving strategies; describe and analyze situations of change in order to find patterns, regularities, and mathematical laws in numerical, geometric, functional, statistical, and probabilistic contexts; and use the appropriate technological tools in an independent way.
- Numbers and Algebra—Students will have studied whole numbers, integers, fractions, decimals, and simple percentages, and their operations and properties, to collect, transform, and exchange information and solve problems related to everyday life. They also will have developed competencies in the use of combined operations and in the use of different strategies in order to obtain unknown elements in a problem based on real-life situations in which there are percentage variations and directly or inversely proportional magnitudes. In addition, students will have learned how to use algebraic language to represent and solve problems through first- and second-degree equations and systems of equations, applying algebraic or graphic methods and contrasting the results obtained.
- Geometry—Students will have studied plane figures, their elements, and their characteristic properties, and address problems related to perimeters, areas, and angles, using appropriate mathematical language to express the procedure followed to find the solution. They also should know the meaning of the Pythagorean theorem and solve problems involving the calculation of lengths, surfaces, and volumes in the physical world, using properties, regularities, and relationships of polyhedrons.
- Functions—Students will have learned how to use and interpret the Cartesian system, the different ways of presenting a function (e.g., everyday language, numerical table, graph, equation), and how to analyze linear functions to solve problems.
- Statistics and Probability—Students will have learned how to organize and present relevant data, using appropriate statistical methods and tools. They also should distinguish between deterministic and random phenomena, and appreciate the possibility offered by mathematics to analyze and make reasonable predictions about the behavior of the random phenomena from the regularities obtained by repeating a significant number of times a random experience or the calculation of its probability.

As in fourth grade, the new curriculum of the current law in force (LOMLOE) will be implemented in the 2023–2024 academic year for eighth grade.[24] The specific competencies contained in this curriculum are linked to and represent a more in-depth exploration of those acquired by students in the area of mathematics during primary education, providing continuity in mathematics learning that respects the psychological development and cognitive progress of the students. They are interrelated and have been grouped around the same five competence blocks as in primary education: problem-solving, reasoning and proof, connections, communication and representation, and socioaffective skills. The acquisition of specific competencies throughout the stage is assessed through the assessment criteria and is carried out by mobilizing a set of basic knowledge that integrates knowledge, skills, and attitudes. The specific competences for mathematics in secondary education are as follows:

- interpret, model, and solve everyday life and mathematical problems, applying different strategies and ways of reasoning, in order to explore different ways of proceeding and obtaining possible solutions
- analyze the solutions to a problem using different techniques and tools, evaluating the answers obtained, in order to verify their validity and suitability from a mathematical point of view and their global repercussions
- formulate and check simple conjectures and pose problems independently, recognizing the value of reasoning and argumentation for generating new knowledge
- use the principles of computational thinking, organizing data, deconstructing into parts, recognizing patterns, interpreting, modifying, and creating algorithms in order to model situations and solve problems efficiently
- recognize and use connections between different mathematical elements, interconnecting concepts, and procedures to develop a view of mathematics as an integrated whole
- identify the mathematics involved in other subjects and real situations that can be tackled in mathematical terms, interrelating concepts and procedures in order to apply them in a variety of situations
- represent, individually and collectively, mathematical concepts, procedures, information, and results, using different technologies, in order to visualize ideas and structure mathematical processes
- communicate, individually and collectively, mathematical concepts, procedures, and arguments, using oral, written, and graphic language with appropriate mathematical terminology in order to give meaning and coherence to mathematical ideas
- develop personal skills, identifying and managing emotions, putting into practice strategies for accepting mistakes as part of the learning process, and adapting to situations of uncertainty, in order to improve perseverance in the achievement of objectives and enjoyment in the learning of mathematics

- develop social skills, recognizing and respecting the emotions and experiences of others, participating actively and reflectively in projects in heterogeneous teams with assigned roles, in order to build a positive identity as a mathematics learner, foster personal and group well-being, and create healthy relationships

The Science Curriculum in Primary and Lower Secondary Grades

Fourth-Grade Science Curriculum

At the primary level, science content is mainly included in natural science but also in social science, both of which are core subjects. Overall, the science curriculum included in the National Core Curriculum published in March 2014 is explicitly designed to provide the foundation for science education in later stages, through topics such as raising awareness about the world around the students, understanding their natural environment, and recognizing the scientific and technological advances in everyday life.[25]

In natural science, the content blocks are built around certain fundamental concepts: Introduction to Scientific Activity; The Human Being and Health; The Living Things; Matter and Energy; and Technology, Objects, and Machines. Their implementation must enable students to progress in the acquisition of scientific knowledge in its organization and structuring as a whole. The evaluation criteria and the learning standards provided in the core curriculum constitute a measurable wording of the skills expressed in the general objectives of primary education and state the competencies that students should acquire.

Natural science at the primary level includes the content blocks outlined for all six years of primary education as a whole. Exhibit 2 summarizes their main topics.

Exhibit 2: Natural Science in Primary Education

Content Block	Topics
1. Introduction to Scientific Activity	• scientific activity initiation, experimental approach to simple experiments and investigations • use of different information sources (direct and indirect); using ICT for obtaining and selecting information, simulating processes, and making conclusions • use of different materials, considering safety rules • individual and group work, work and study techniques, developing work habits, effort and responsibility • project planning and reporting of presentation, project implementation

Exhibit 2: Natural Science in Primary Education (Continued)

Content Block	Topics
2. The Human Being and Health	• the human body and its function, anatomy and physiology, body systems • vital body functions: relation, nutrition, and reproductive function • health and illness, identifying and assessing healthy habits for the prevention of illnesses, recognizing the damaging effects of the consumption of alcohol and drugs • developing identity and personal autonomy, relationships with others, making decisions: criteria and consequences, the peaceful resolution of conflicts • equality between men and women
3. The Living Things	• living and nonliving things, differentiation • the inner organization of living things; the structure of living beings: cells, tissues, organs, and systems; main characteristics and functions • living beings: characteristics, classification, and types • vertebrates and invertebrates, animals, characteristics and classification • plants: structure and physiology, photosynthesis and its importance for life on Earth • relationship between living things; food chains; populations, communities, and ecosystems; characteristics and components of an ecosystem; the biosphere and the different habitats of the living things • use of technology for studying living things
4. Matter and Energy	• studying and classifying materials according to their properties • using different procedures to measure the mass and volume of objects • explaining observable physical phenomena in terms of density differences, the flotation quality of liquids • making predictions of changes in the motion or shape of an object due to the effect of forces • the concept of energy; different forms of energy; energy sources and raw material: origin; renewable and nonrenewable energies • light as an energy source; electricity: electric current; electrical circuits; magnetism: terrestrial magnetism; the magnet: the compass; attraction and repulsion of electric charges • separation of the components of a mixture by distillation, filtration, evaporation, or dissolution • chemical reactions: combustion, oxidation, and fermentation

Exhibit 2: Natural Science in Primary Education (Continued)

Content Block	Topics
5. Technology, Objects, and Machines	• machines and devices, different kinds of machines in daily life and their utility • making simple structures that fulfill a function or condition to solve a problem from modulated pieces • electricity in machine development, electrical circuits, effects of electricity, conductors and insulators • relation between electricity and magnetism • science: present and future of society • remarkable discoveries and inventions • word processing, guided searching for information on the Internet, time management and responsible use of ICT

In primary education, different disciplines are integrated in social science. The second block of the core curriculum for this subject includes contents related to the universe, the representation of Earth and its orientation in space, water and its responsible consumption, weather and climate change, and landscape and human intervention.

LOMLOE, implemented in fourth grade in the 2023–2024 academic year, includes a subject called Knowledge of the Natural, Social, and Cultural Environment.[26] This subject is aimed at helping children to become active, responsible, and respectful people who respect the world in which they live and can transform it in accordance with ethical and sustainable principles based on democratic values. The Knowledge of the Natural, Social, and Cultural Environment subject encompasses different disciplines and is related to other areas of the curriculum, favoring holistic and competence learning. To determine the specific competencies, which are the backbone of the curriculum, the general objectives of the stage and the Exit Profile of the students at the end of basic education have been taken as a reference. The basic knowledge is structured into three blocks: scientific culture, technology and digitalization, and societies and territories. The specific competencies of this subject are as follows:

- use digital devices and resources in a safe, responsible, and efficient way to search for information, communicate, and work individually, in teams, and in networks, and to rework and create digital content in accordance with the digital needs of the education context
- ask and answer simple scientific questions, using different techniques, tools, and models of scientific thought, in order to interpret and explain facts and phenomena that occur in the natural, social, and cultural environment
- solve problems by designing projects and applying computational thinking in order to cooperatively generate a creative and innovative product that responds to specific needs

- know and become aware of one's own body, as well as one's own and other people's emotions and feelings, applying scientific knowledge to develop healthy habits and achieve physical, emotional, and social well-being
- identify the characteristics of different elements or systems of the natural, social, and cultural environment, analyzing their organization and properties and establishing relationships between them, in order to recognize the value of cultural and natural heritage, protect and improve this heritage, and implement actions for the responsible use of this heritage
- identify the causes and consequences of human intervention in the environment from social, economic, cultural, technological, and environmental perspectives in order to improve one's ability to face problems and to implement sustainable lifestyles that are consistent with respect for, care for, and the protection of people and the planet
- observe, understand, and interpret continuities and changes in the social and cultural environment, analyzing relationships of causality, simultaneity, and succession, in order to explain and value the relationships between different elements and events
- recognize and value diversity and gender equality, showing empathy and respect for other cultures and reflecting on ethical issues, in order to contribute to the individual and collective well-being of a society in continuous transformation and to achieve the values of European integration
- participate in both the environment and social life in an effective and constructive way based on respect for democratic values, human and children's rights, and the principles and values of the Spanish Constitution and the EU, valuing the role of the state and its institutions in the maintenance of peace and comprehensive citizen security

Eighth-Grade Science Curriculum

In secondary education, the science curriculum included in the National Core Curriculum that was in effect in the 2022–2023 academic year is organized into subjects.[27] During the first 3 years of compulsory secondary education (first cycle), the science subjects are arranged as follows: Biology-Geology in Grade 7; Physics-Chemistry in Grade 8; and both subjects, which are compulsory in Grade 9.

With regard to Biology-Geology, during the first cycle of compulsory secondary education, the subject revolves around living things and their interaction with Earth, putting special emphasis on the importance of the conservation of the environment for all living things. Health and its promotion are also essential topics during this cycle. The main objective is for students to gain skills and competencies that will allow them to take care of their bodies, both physically and mentally, as well as assess and have a critical attitude toward information and social mindset that may have negative consequences on their physical, social, and psychological development. Thus, ninth-grade students are expected to do the following in terms of the evaluation criteria provided for each content block:

- Abilities, Skills, and Strategies: Scientific Methodology—Students will have learned how to search for, select, and interpret scientific information and use this information to form their own opinion, discussing problems related to the natural environment and health. They also should have carried out an experimental project with the help of laboratory or field practice guidelines, describing the method and interpreting their results.
- Earth in the Universe—Students will have studied the main ideas about the origin of the universe and the formation and evolution of galaxies; the movements of Earth, the Moon, and the Sun; and Earth's materials according to their abundance and distribution in Earth's main layers and the properties and characteristics of minerals and rocks. They also should know the characteristics and composition of the atmosphere and the properties of air and water and their importance for the existence of life.
- Biodiversity on Planet Earth—Students will have studied that living things are made up of cells and will have learned the characteristics that distinguish them from inert matter and their functions, distinguishing between autotrophic and heterotrophic nutrition. They also should be able to describe the general characteristics of the large taxonomic groups, characterize the main groups of vertebrates and invertebrates, determine through observation the adaptations that allow plants and animals to survive in certain ecosystems, and the vital functions of plants.
- People and Health: Health Promotion—Students will have studied the different levels of organization of living things; the concept of health and disease; the basic functioning of the immune system; the difference between food and nutrition; components and functions of the digestive, circulatory, respiratory, and excretory systems; the nervous system; main endocrine glands; and basic aspects of the reproductive system.
- The Relief of Earth and Its Evolution—Students will have learned how to link external geological processes with energy; analyze and predict the action of surface water, identifying the most characteristic forms of erosion and deposition; and additionally, have learned about marine dynamics, the action of the wind, the geological action of glaciers, and volcanic activity.
- Ecosystems—Students will have studied how to distinguish the different components of an ecosystem, recognize and share actions that promote the conservation of the environment, and analyze the components of soil.
- Research Project—Students should know how to develop hypotheses and contrast them through experimentation or observation, use a variety of sources of information, and explain their research project publicly.

The teaching of Physics-Chemistry, as a scientific discipline, has the added responsibility of providing students with specific tools that will allow them to look into the future confidently, participating in the economic and social development to which the scientific, technological,

and innovative capacity of society itself is linked. In the first cycle of compulsory secondary education, the knowledge acquired by students in primary education about life science should be consolidated and broadened. The approach to introduce concepts must be fundamentally phenomenological; as such, the subject is presented as the logical explanation of everything that the student is used to and knows. It is important to point out that this may be the final cycle in which Physics-Chemistry is studied, so the main objective of the subject must be to contribute to the foundation of a basic scientific culture. Therefore, the following concepts summarize the evaluation criteria students should have achieved by the end of ninth grade for each content block:

- Scientific Activity—Students will have learned how to recognize and identify the characteristics of the scientific method, appreciate scientific research and its impact on industry and in the development of society, and develop small research projects that put into practice the application of the scientific method and the use of ICT.
- Matter—Students will have studied the general properties and specific characteristics of matter linking them with its nature and applications, the relationships between the variables on which the state of a gas depends using graphs and/or tables of results obtained in laboratory experiments or computer simulations, and the methods of separation of the components of a mixture. They should also be able to interpret the arrangement of the elements in the periodic table and recognize the most relevant elements from their symbols, distinguish between atoms/molecules and elements/compounds, and formulate and name binary compounds according to International Union of Pure and Applied Chemistry (IUPAC) standards.
- Changes—Students will have learned how to distinguish between physical and chemical changes through simple experiments, characterize chemical reactions as changes from one substance to another, test the influence of certain factors on the speed of chemical reactions by carrying out simple laboratory experiments, and appreciate the importance of the chemical industry in society and its influence on the environment.
- Motion and Forces—Students will have studied the role of forces in causing changes in the state of motion and deformations, the speed of an object and the usefulness of simple machines in transforming one movement into a different one, and reducing the necessary applied force. They should also know about gravitational force (as responsible for the weight of objects, orbital movements, and different levels of grouping in the universe), the electric charge model, and magnetic phenomena.
- Energy—Students will have learned how to identify different types of energy exhibited in everyday phenomena and in simple experiments carried out in the laboratory; connect the concepts of energy, heat, and temperature; appreciate the importance of responsible use of energy sources; and explain the physical phenomenon of electric current. They should be able to appreciate the importance of electrical and electronic circuits in electrical installations and everyday instruments, describing their basic function and identifying their various components.

LOMLOE, implemented in eighth grade in the 2023–2024 academic year, includes the subject of Biology-Geology as a continuation of the Knowledge of the Natural, Social, and Cultural Environment subject in primary education.[28] This subject is aimed at developing curiosity and a critical attitude, allowing students to learn about their own bodies and their environment in order to adopt habits that help them to maintain and improve their health, care for the environment, respect other living beings, and appreciate public commitment to the common good. The six specific competencies included in the subject are as follows:

- interpret and transmit scientific information and data, making arguments and using different formats, in order to analyze concepts and processes in biological and geological sciences
- identify, locate, and select information, contrasting its veracity, organizing it, and critically evaluating it, in order to solve questions related to biological and geological sciences
- plan and develop research projects, following the steps involved in scientific methods and cooperating when necessary, in order to investigate aspects related to geological and biological sciences
- use reasoning and computational thinking, critically analyzing the answers and solutions and reformulating the procedure, if necessary, to solve problems or explain everyday life processes related to biology and geology
- analyze the effects of certain actions on the environment and health, based on the fundamentals of biological and Earth sciences, in order to promote and adopt habits that avoid or minimize negative environmental impacts, are compatible with sustainable development, and allow for the maintenance and improvement of individual and collective health
- analyze the elements of a specific landscape, appreciating it as natural heritage and using knowledge of geology and Earth sciences to explain its geological history, propose actions for its protection, and identify possible natural hazards

As part of this scientific literacy, the subject of Physics-Chemistry helps students to understand how the universe works and provides the knowledge, skills, and attitudes of science that enable them to function with informed judgment in a world in continuous scientific, technological, economic, and social development. The specific competencies that are assessed that take into account the assessment criteria are as follows:

- understand and connect the reasons why the main environmental physical-chemical phenomena occur, explaining them in terms of appropriate scientific laws and theories, in order to solve problems with the aim of applying them to improve the reality around them and the quality of human life
- express observations made by the students in the form of questions, formulating hypotheses to explain them, and demonstrating these hypotheses through scientific experimentation, inquiry, and the search for evidence, in order to develop the

reasoning inherent in scientific thought and improve skills related to the use of scientific methodologies

- be fluent in the basic rules of physics and chemistry with regard to the language of IUPAC, the safe use of the laboratory, and the interpretation and production of data and information in different formats and sources
- critically, efficiently, and safely use digital platforms and varied resources, both for individual and group work, to foster creativity, personal development, and individual and social learning, by consulting information, creating materials, and communicating effectively in different learning environments
- use collaborative work strategies, promoting growth among peers as the entrepreneurial basis of a critical, ethical, and efficient scientific community, to understand the importance of science in the improvement of society, the applications of scientific advances, the preservation of health, and the sustainable conservation of the environment
- understand and value science as a collective construction that is constantly changing and evolving, in which not only the people dedicated to it participate, but that also requires interaction with the rest of society, in order to obtain results that influence technological, economic, environmental, and social progress

Teacher Professional Development Requirements and Programs

As defined by the education legislation in force, teachers have the right and the duty to participate in professional development activities.[29] In addition to postgraduate courses, education training schools in various communities may offer classroom workshops, online courses, and support for novice teachers; seminars and working groups; or a combination of these options. Moreover, teachers can participate in professional development activities organized by unions, associations, educational institutions, universities, etc., outside of the state or regional teacher education network. Teachers in public education are eligible to receive financial incentives for participating in professional development activities every 6 years.

There are professional development programs to increase teacher training specifically in STEM-related areas through the dissemination of best practices, resources, and the promotion of active methodologies (for example, the STEMadrid scheme).[30]

The International Centre for STEM Education (ICSE) promotes different programs to help improve STEM education across Europe in which the Ministry of Education, Vocational Training, and Sports is involved. One of them is MaSDiV,[f] an education research project focused on assessment (included in Erasmus+ Key Action 3).[g] This project aims to help teachers facilitate and enhance the learning of mathematics and science, as well as link this learning to the instruction of core values in multicultural and diverse classrooms. MaSDiV encompasses the

f See https://icse.eu/international-projects/masdiv/ for more information.

g See https://erasmus-plus.ec.europa.eu/programme-guide/part-b/key-action-3 for more information.

development, implementation, and evaluation of professional development courses for science and mathematics teachers.

The National Institute of Technology and Professional Development (INTEF) at the Ministry of Education, Vocational Training, and Sports actively participates as a national center in the coordination, development, and delivery or promotion of the professional development of STEM teachers. INTEF is also the contact point for Scientix (the community for the teaching of sciences in Europe)[31] and promotes other STEM projects, such as the STEM Alliance project.[h] More information about these and other projects is provided on its website.[32]

Monitoring Student Progress in Mathematics and Science

External large-scale evaluation studies are well established in Spain. Currently, LOMLOE has established two kinds of examinations of the education system without academic consequences: diagnostic assessments and general assessment of the education system.

The diagnostic assessments are administered in Grades 4 and 8. These assessments are census based and serve a formative and diagnostic purpose. They must assess, at a minimum, students' skills in linguistic and mathematical competencies. These assessments will begin being administered in the 2023–2024 academic year. The implementation of these assessments is the responsibility of the regional education administrations, and they are carried out by the schools.

The general assessment of the education system is administered in Grades 6 and 10. It is a sample-based and multiannual assessment. This assessment allows for measuring equity within the education system and gathering information about the system by assessing the competencies acquired by students in relation to their socioeconomic and family background. Furthermore, its results are intended to promote innovation processes and commitments to review and improve the education system. INEE, in collaboration with the autonomous communities, has designed the framework and the basic methodological and scientific standards of this assessment and is responsible for carrying out the evaluations that allow for obtaining representative data, not only of the students and the centers of the autonomous communities but also of the whole state. In the 2022–2023 academic year, a field test of this assessment was performed in Grade 6. The first edition of this assessment will occur in the 2024–2025 academic year for Grade 6, evaluating linguistic, STEM, digital, and multilingual competencies.

In addition, at the end of Grade 12, there are evaluations only used for the purpose of university admission.

Primary and secondary education teachers are responsible for evaluating individual student progress. The evaluation of student achievement is ongoing and considers student progress in all aspects of the curriculum. Teachers use the evaluation criteria specified for a content area as

h See http://www.stemalliance.eu/home for more information.

the basis for determining students' levels of competency. Primary and secondary schools use qualitative grades to inform students and their parents about their learning progress at the end of each term. When a student's progress is inadequate, schools must adopt remedial measures as soon as difficulties are detected. These measures are designed to guarantee the acquisition of essential skills so all students can progress within the education system.

Special Initiatives in Mathematics and Science Education

There are many educational initiatives to raise the attractiveness of science education and scientific careers and boost the interest of young people in STEM. Some examples at the national and regional levels include a Science and Innovation Week held in Madrid every year since 2001, the Spanish mathematics Olympics, and a spring mathematics competition.[33,34,35]

The Ministry of Education, Vocational Training, and Sports takes part in European projects, such as Scientix, that are aimed at teachers, researchers, policymakers, and parents to facilitate the constant dissemination and exchange of technical knowledge and practical examples in science teaching in the EU.[36]

One program to promote STEAM vocations in girls is the Steam Alliance for Female Talent, an initiative of the Ministry of Education, Vocational Training, and Sports that aims to reduce the gender gap in STEAM careers. This program regularly promotes several activities such as mentorships, talks, workshops, and meetings.[37]

The education law in force also considers support for students with special education needs. It is the responsibility of the education authorities to ensure necessary resources for students that require educational attention different from the standard. Curricular support or enrichment activities are implemented in schools for this reason. There are also special programs promoted by the government, such as the recent Program for Orientation, Advancement, and Educational Enrichment (PROA+),[38] and/or by the autonomous communities.

Suggested Reading

Abril Gallego, A. M., Blanco López, Á., & Franco Mariscal, A. J. (Coords.). (2021). *Enseñanza de las ciencias en tiempos de COVID-19: De la investigación didáctica al aula* [Science education in times of COVID-19: From didactic research to the classroom] (Vol. 44). Graó.

Albarración, L., & Badillo, E. (2018). *Aprender a enseñar matemáticas en la educación primaria* [Learning to teach mathematics in primary education]. Editorial Síntesis.

Arce Sánchez, M., & Conejo Garrote, L. (2019). *Aprendizaje y enseñanza de las matemáticas* [Learning and teaching mathematics]. Síntesis.

González Jara, D., Cuetos Revuelta, M. J., & Serna Romera, A. I. (2015). *Didáctica de las ciencias naturales en Educación Primaria* [Teaching life science in primary education]. UNIR Editorial. Retrieved from https://reunir.unir.net/handle/123456789/4151

Herce, M. P., Román-González, M., & Jiménez, C. (2020). *Calidad metodológica, características y desafíos en la investigación sobre el desarrollo del talento STEM en la educación obligatoria* [Methodological quality, characteristics and challenges in research on STEM talent development in compulsory education]. In M. P. Bermúdez (Ed.), *Proceedings of the 8th international congress of educational sciences and development* (pp. 206–207). Asociación Española de Psicología Conductual (AEPC).

Lamblin, C., & Viver Barri, N. (2018). *Juegos para entrenar la inteligencia matemática* [Games to train mathematical intelligence]. Editorial Terapias verdes. Terapias Juegos Didácticos.

Martín del Pozo, A., Solís Ramírez, R., Porlán Ariza, E., & Rivero García, R. (2017). *Didáctica de las ciencias experimentales en Educación Primaria* [Teaching experimental science in primary education]. Editorial Síntesis.

References

1 *Constitución Española* [Spanish Constitution]. (1978). Retrieved from https://www.boe.es/eli/es/c/1978/12/27/(1)

2 *Ley Orgánica 2/2006, de 3 de mayo, de Educación* [Organic Law of Education]. (2006). Retrieved from https://www.boe.es/eli/es/lo/2006/05/03/2/con

3 *Ley Orgánica 3/2020, de 29 de diciembre, por la que se modifica la Ley Orgánica 2/2006, de 3 de mayo, de Educación* [Organic Law for the modification of Organic Law of Education]. (2020). Retrieved from https://www.boe.es/eli/es/lo/2020/12/29/3

4 *Real Decreto 157/2022, de 1 de marzo, por el que se establecen la ordenación y las enseñanzas mínimas de la Educación Primaria* [RD 157/2022 establishing the organization and minimum teaching requirements for primary education]. (2022). Retrieved from https://www.boe.es/eli/es/rd/2022/03/01/157/con

5 *Real Decreto 217/2022, de 29 de marzo, por el que se establece la ordenación y las enseñanzas mínimas de la Educación Secundaria Obligatoria* [RD 217/2022 establishing the organization and minimum teaching requirements for secondary education]. (2022). Retrieved from https://www.boe.es/eli/es/rd/2022/03/29/217/con

6 Ministerio de Educación y Formación Profesional. (2023). *Estadística de las Enseñanzas no universitarias* [Nonuniversity education statistics]. Retrieved from http://www.educacionyfp.gob.es/servicios-al-ciudadano/estadisticas/no-universitaria.html

7 UNESCO. (2012). *ISCED 2011: International standard classification of education*. http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf

8 Ministerio de Educación y Formación Profesional. (2020). *TIMSS 2019. Estudio Internacional de Tendencias en Matemáticas y Ciencias. Informe español* [TIMSS 2019. Trends in international mathematics and science study. Spanish report]. Retrieved from https://www.libreria.educacion.gob.es/libro/timss-2019-estudio-internacional-de-tendencias-en-matematicas-y-ciencias-informe-espanol_170122/edicion/pdf-184025/

[9] Instituto Nacional de Evaluación Educativa. (2020). *TIMSS 2019. Informe español (I). Resultados en matemáticas y ciencias. Boletín de Educación n.º 66* [TIMSS 2019. Spanish report (I). Results in mathematics and science. Official educational newsletter nº. 66]. Retrieved from https://www.libreria.educacion.gob.es/libro/boletin-de-educacion-educainee-no-66-timss-2019-informe-espanol-i-resultados-en-matematicas-y-ciencias_182115/

[10] Instituto Nacional de Evaluación Educativa. (2020). *TIMSS 2019. Informe español (II). Contexto de aprendizaje familiar, escolar y del aula. Boletín de Educación n.º 67* [TIMSS 2019. Spanish report (II). Home, school and classroom learning background. Official educational newsletter nº. 67]. Retrieved from https://www.libreria.educacion.gob.es/libro/boletin-de-educacion-educainee-no-67-timss-2019-informe-espanol-ii-contexto-de-aprendizaje-familiar-escolar-y-del-aula_182114/

[11] Instituto Nacional de Evaluación Educativa. (2021). TIMSS 2019. *Temas tratados en la clase de matemáticas. Boletín de Educación n.º 70* [TIMSS 2019. Topics covered in mathematics lessons. Official educational newsletter nº. 70]. Retrieved from https://www.libreria.educacion.gob.es/libro/boletin-de-educacion-educainee-no-70-timss-2019-temas-tratados-en-la-clase-de-matematicas-resultados_169283/

[12] Instituto Nacional de Evaluación Educativa. (2021). *TIMSS 2019. Temas tratados en la clase de ciencias. Boletín de Educación n.º 73* [TIMSS 2019. Topics covered in science lessons. Official educational newsletter nº. 73]. Retrieved from https://www.libreria.educacion.gob.es/libro/boletin-de-educacion-educainee-no-73-timss-2019-temas-tratados-en-la-clase-de-ciencias-y-resultados_172645/

[13] Instituto Nacional de Evaluación Educativa. (2022). *TIMSS 2019. Resultados sobre conciencia medioambiental. Boletín de Educación n.º 74* [TIMSS 2019. Findings on environmental awareness. Official educational newsletter nº. 74]. Retrieved from https://www.libreria.educacion.gob.es/libro/boletin-de-educacion-educainee-no-74-timss-2019-resultados-sobre-conciencia-medioambiental_173365/

[14] Instituto Nacional de Evaluación Educativa. (n.d.). *Ítems liberados* [Released items]. Retrieved from https://www.educacionyfp.gob.es/inee/publicaciones/items-liberados.html

[15] Instituto Nacional de Evaluación Educativa. (2013). *Síguenos en directo: información al minuto desde Comillas (Cantabria) sobre el seminario de preguntas liberadas PISA, TIMSS y PIRLS. ¿Aprobarías un examen de PISA?* [Follow us live: Live information from Comillas (Cantabria) about the seminar of released items from PISA, TIMSS and PIRLS. Will you pass a PISA test?] [Blog post]. Retrieved from https://blog.intef.es/inee/2013/09/06/siguenos-en-directo-informacion-al-minuto-desde-comillas-cantabria-sobre-el-seminario-de-preguntas-liberadas-pisa-timss-y-pirls-aprobarias-un-examen-de-pisa/

[16] Ministerio de Educación, Cultura, y Deporte. (2017). *Curso: Claves para la mejora educativa. Una lectura de las evaluaciones internacionales* [Keys to improving education: An overview of the international assessments]. https://www.educacionfpydeportes.gob.es/inee/dam/jcr:5fb3306b-5291-4364-93ea-6d0a6dead996/programaclavesmejorav14.pdf

[17] Instituto Nacional de Evaluación Educativa. (2017). *Curso: El desafío de las ciencias, una mirada a las evaluaciones internacionales* [The science challenge, international assessments at a glance]. https://inee.educacion.es/wp-content/uploads/2017/05/Programa_Desafio_Ciencias_v19.pdf

[18] Instituto Nacional de Evaluación Educativa, Cambridge English Language Assessment, & Consejería de Educación de la Junta de Castilla y León. (2017). *Simposio: Ciencias e Inglés en la Evaluación Internacional 2017* [Science and English in international assessment]. Retrieved from https://www.educacionyfp.gob.es/inee/divulgacion/jornadas/simposio.html

[19] Instituto Nacional de Evaluación Educativa, Cambridge English Language Assessment, & Consejería de Educación de la Junta de Castilla-La Mancha. (2018). *Simposio: Ciencias e Inglés en la Evaluación Internacional 2018* [Science and English in international assessment]. Retrieved from https://www.educacionyfp.gob.es/inee/divulgacion/jornadas/simposio-3.html

[20] *Ley Orgánica 8/2013, de 9 de diciembre, para la mejora de la calidad educativa* [Organic Law for the Improvement of Educational Quality]. (2013). Retrieved from https://www.boe.es/eli/es/lo/2013/12/09/8

[21] *Real Decreto 126/2014, de 28 de febrero, por el que se establece el currículo básico de la Educación Primaria* [RD 126/2014 establishing the core curriculum for primary education]. (2014). Retrieved from https://www.boe.es/eli/es/rd/2014/02/28/126

[22] *Real Decreto 157/2022, de 1 de marzo, por el que se establecen la ordenación y las enseñanzas mínimas de la Educación Primaria* [RD 157/2022 establishing the organization and minimum teaching requirements for primary education]. (2022). Retrieved from https://www.boe.es/eli/es/rd/2022/03/01/157/con

[23] *Real Decreto 1105/2014, de 26 de diciembre, por el que se establece el currículo básico de la Educación Secundaria Obligatoria y del Bachillerato* [RD 1105/2014 establishing the core curriculum for compulsory secondary education and baccalaureate]. (2014). Retrieved from https://www.boe.es/eli/es/rd/2014/12/26/1105/con

[24] *Real Decreto 217/2022, de 29 de marzo, por el que se establece la ordenación y las enseñanzas mínimas de la Educación Secundaria Obligatoria* [RD 217/2022 establishing the organization and minimum teaching requirements for secondary education]. (2022). Retrieved from https://www.boe.es/eli/es/rd/2022/03/29/217/con

[25] *Real Decreto 126/2014, de 28 de febrero, por el que se establece el currículo básico de la Educación Primaria* [RD 126/2014 establishing the core curriculum for primary education]. (2014). Retrieved from https://www.boe.es/eli/es/rd/2014/02/28/126

[26] *Real Decreto 157/2022, de 1 de marzo, por el que se establecen la ordenación y las enseñanzas mínimas de la Educación Primaria* [RD 157/2022 establishing the organization and minimum teaching requirements for primary education]. (2022). Retrieved from https://www.boe.es/eli/es/rd/2022/03/01/157/con

[27] *Real Decreto 1105/2014, de 26 de diciembre, por el que se establece el currículo básico de la Educación Secundaria Obligatoria y del Bachillerato* [RD 1105/2014 establishing the core curriculum for compulsory secondary education and baccalaureate]. (2014). Retrieved from https://www.boe.es/eli/es/rd/2014/12/26/1105/con

[28] *Real Decreto 217/2022, de 29 de marzo, por el que se establece la ordenación y las enseñanzas mínimas de la Educación Secundaria Obligatoria* [RD 217/2022 establishing the organization and minimum teaching requirements for secondary education]. (2022). Retrieved from https://www.boe.es/eli/es/rd/2022/03/29/217/con

[29] *Ley Orgánica 2/2006, de 3 de mayo, de educación* [Organic Law of Education]. (2006). Retrieved from https://www.boe.es/eli/es/lo/2006/05/03/2/con

[30] Comunidad de Madrid. Consejería de Educación e Investigación. (2018). *STEMadrid*. Retrieved from http://www.comunidad.madrid/servicios/educacion/es-stemadrid

[31] Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado. (n.d.). *Scientix*. Retrieved from https://intef.es/iniciativas/scientix/

[32] Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado. (n.d.). *Proyectos STEM en Europa* [STEM projects in Europe]. Retrieved from https://intef.es/

[33] Fundación para el Conocimiento madri+d. (n.d.). *Semana de la ciencia e innovación* [Science and innovation week]. Retrieved from https://www.madrimasd.org/semanacienciaeinnovacion/

[34] Federación Española de sociedades de Profesores de matemáticas. (n.d.). *Olimpiada Matemática* [Mathematics olympics]. Retrieved from https://fespm.es/index.php/olimpiada-matematica/

[35] Asociación Matemática Concurso de Primavera y la Facultad de Matemáticas de la UCM. (n.d.). *Concurso de Primavera de Matemáticas* [Spring mathematics competition]. Retrieved from https://www.concursoprimavera.es/#concurso

[36] Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado. (n.d.). *Scientix*. Retrieved from https://intef.es/iniciativas/scientix/

[37] Ministerio de Educación, Formación Profesional y Deportes. (n.d.). *Niñas en pie de ciencia. Alianza STEAM por el talento femenino* [Girls standing up for science. STEAM alliance for female talent]. Retrieved from https://alianzasteam.educacionyfp.gob.es/inicio.html

[38] Ministerio de Educación, Cultura, y Deporte. (n.d.). *Programa para la orientación, avance y enriquecimiento educativo #PROA+* [Program for orientation, advancement and educational enrichment #PROA+]. Retrieved from https://www.educacionyfp.gob.es/mc/sgctie/cooperacion-territorial/programas-cooperacion/proa.html