Sweden

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Introduction

Overview of Education System

A fundamental principle of the Swedish education system is that all children and young persons shall have equal access to education, irrespective of gender, geographic residence, or financial circumstances. Parents pay a subsidized fee for preschool, but all education after preschool in Sweden is free of charge.[1]

The Swedish education system is highly decentralized. The parliament and government define a national curriculum, while central authorities, municipalities, and various institutions ensure that education activities are implemented in line with the legislative framework. The major part of school budgets is funded by municipalities.[2]

The Swedish National Agency for Education monitors and supports the local development of the quality of schools. The agency's mission can be summarized as follows: drawing up goals and knowledge requirements, providing support for the development of preschools and schools, developing and disseminating new knowledge to benefit target groups, and communicating for the purpose of improvement. The Swedish Schools Inspectorate provides supervision, and the National Agency for Special Needs Education and Schools coordinates government support for special needs education.[3]

Independent (private) schools must be approved by the Swedish Schools Inspectorate.[4] These schools receive municipal grants based on the number of students enrolled per academic year, and they are allowed to make a profit. Approximately 15 percent of all compulsory school students attended independent schools in 2018–2019.[5]

Preprimary education and care are provided at preschools and family daycare centers. The aim of preprimary education is to create favorable learning opportunities that stimulate children's physical and mental development. In Sweden, 85 percent of all children ages 1 to 5 were enrolled in preprimary education in 2018.[6]

Beginning with the 2018–2019 school year, a one-year preschool class is mandatory for all children in the year they turn 6 years old.[7] More than 95 percent of 6-year-olds attended preschool class even before it was made mandatory.[8] Preschool aims to provide a sound base for the first grade of compulsory schooling.[9]

Swedish compulsory education comprises nine years of schooling for children ages 7 to 16 (Grades 1 to 9), although children may start school at age 6 if parents prefer. The compulsory

education system also includes Sami schools for Sami-speaking children in Grades 1 to 6, special schools designed for children and adolescents who are deaf or hearing impaired and cannot attend regular schools, and schools for children with learning disabilities.[10]

All youth in Sweden who have completed compulsory education are entitled to three years of upper secondary education. Upper secondary education provides a foundation for vocational activities and further studies. There are 18 national upper secondary programs, each lasting at least three years. These programs comprise upper secondary school foundation subjects, program-specific subjects, work-based vocational orientations, program specializations, and a diploma project. In addition, there are five introductory programs for students who are not eligible for a national program.[11]

Universities and university colleges are free of charge, and admission is based on grades, a university admissions test, or a combination of interviews and tests. Students may attend post-secondary vocational schools to prepare for a specific trade or occupation.[12]

Use and Impact of TIMSS

When Sweden's results in TIMSS and other international and national assessments have indicated declining student achievement, they have influenced the general school debate and had impact on reforms.

The Mathematics Curriculum in Primary and Lower Secondary Grades

The national curriculum for compulsory school was implemented in 2011 and revised in 2017 and 2018. It contains general goals, guidelines, syllabi, and knowledge requirements.[13]

The national mathematics curriculum for compulsory school begins with an overall statement of purpose describing the role of mathematics in society and human activity and presenting arguments that defend the importance of learning and teaching mathematics. Furthermore, the syllabus outlines overall goals for creating student learning opportunities in mathematics that may be summarized as follows. Mathematics instruction should give students the opportunity to develop their ability to:

- Formulate and solve problems using mathematics and assess selected strategies and methods
- Use and analyze mathematical concepts and their interrelationships
- Choose and use appropriate mathematical methods to perform calculations and solve routine tasks
- Apply and follow mathematical reasoning
- Use mathematical forms of expression to discuss, reason, and give an account of questions, calculations, and conclusions

This part of the syllabus is the same for Grades 1 to 9. The next part of the syllabus, a description of core content, is divided into three tiers: Grades 1 to 3, Grades 4 to 6, and Grades 7 to 9. Core

content descriptions are short, and the syllabus does not prescribe the order in which content should be covered or introduced within each tier. The syllabus presents content in six categories that are the same for all three tiers: Understanding and Use of Numbers; Algebra; Geometry; Probability and Statistics; Relationships and Change; and Problem Solving. The syllabus emphasizes problem solving, identifying it as part of the overall aim that guides teachers in creating learning opportunities, and as a component of core content. The specific core content for each tier is presented below.

The final part of the mathematics curriculum contains assessment criteria that are based comprehensively on the list of competencies presented above but not correlated to separate competencies. Few explicit references to core content occur in the assessment criteria. Criteria are formulated for three of the five levels in the grading system, in a short and dense way. One example of a formulation of assessment criteria for a passing grade is, "Pupils can solve simple problems in familiar situations by choosing and applying a strategy with some adaptation to the type of problem. Pupils describe their approach and give simple assessments of the plausibility of results."

The core content of the mathematics curriculum in Sweden may be summarized as follows:

Grades 1 to 3

- Understanding and Use of Numbers
  - Natural numbers and their properties, how numbers can be divided, and how they can be used to specify quantities and order
  - How the positioning system can be used to describe natural numbers; symbols for numbers and the historical development of symbols in some different cultures through history
  - Parts of a whole and parts of a number; how parts are named and expressed as simple fractions and how simple fractions are related to natural numbers
  - Natural numbers and simple numbers as fractions and their use in everyday situations
  - Properties of the four operations; their relationships and use in different situations
  - Main methods of calculating using natural numbers when calculating mental arithmetic and approximate estimates, and calculations using written methods and digital tools; using these methods in different situations
  - Assessing plausibility when using simple calculations and estimates
- Algebra
  - Mathematical similarities and the importance of the equals sign
  - How simple patterns in number sequences and simple geometrical forms can be constructed, described, and expressed
  - How unambiguous, step-by-step instructions can be constructed, described, and followed as a basis for programming; use of symbols in step-by-step instructions

- Geometry
  - Basic geometrical objects, including points, lines, distances, quadrilaterals, triangles, circles, spheres, cones, cylinders, cuboids, and their relationships; basic geometrical properties of these objects
  - Construction of geometrical objects; scale for simple enlargement and reduction
  - Common terms to describe an object's position in space
  - Symmetry, for example, in pictures and nature, and how symmetry can be constructed
  - Comparisons and estimates of mathematical quantities; measurement of length, mass, volume, and time in common contemporary and older measurement units
- Probability and Statistics
  - Random events in experiments and games
  - Simple tables and diagrams and how they can be used to categorize data and describe results from simple investigations, both with and without digital tools
- Relationships and Change
  - Different proportional relationships, including doubling and halving
- Problem Solving
  - Strategies for mathematical problem solving in simple situations
  - Mathematical formulation of questions based on simple, everyday situations

Grades 4 to 6

- Understanding and Use of Numbers
  - Rational numbers and their properties
  - The positioning system of numbers in decimal form
  - The binary number system and how it can be applied in digital technology, as well as number systems used in some cultures through history, such as Babylon
  - Numbers in fraction and decimal form and their use in everyday situations
  - Numbers in percentage form and their relation to numbers in fraction and decimal form
  - Main methods of calculating using natural numbers and simple numbers in decimal form when calculating approximations, mental arithmetic, and calculations using written methods and digital tools; using the methods in different situations
  - Plausibility assessments when estimating and making calculations in everyday situations

- Algebra
  - Unknown numbers and their properties and also situations where there is a need to represent an unknown number by a symbol
  - Simple algebraic expressions and equations in situations that are relevant for students
  - Methods of solving simple equations
  - How patterns in number sequences and geometrical patterns can be constructed, described, and expressed
  - How algorithms can be created and used in programming; programming in visual programming environments
- Geometry
  - Basic geometrical objects, such as polygons, circles, spheres, cones, cylinders, pyramids, cuboids, and their relationships; basic geometrical properties of these objects
  - Construction of geometrical objects, both with and without digital tools; scale and its use in everyday situations
  - Symmetry in everyday life, arts, and nature and how symmetry can be constructed
  - Methods for determining and estimating circumference and areas of two-dimensional geometrical figures
  - Comparing, estimating, and measuring length, area, volume, mass, time, and angles using common units of measurement; measurements using contemporary and older methods
- Probability and Statistics
  - Probability, chance, and risk based on observations, simulations, or statistical material from everyday situations; comparisons of probability in different random trials
  - Simple combinatorial analysis in concrete situations
  - Tables and diagrams to describe the results of investigations, both with and without digital tools; interpretation of data in tables and diagrams
  - Measures of central tendency; average, mode, and median, and how they are used in statistical investigations
- Relationships and Change
  - Proportionality and percentage and their relationship
  - Graphs for expressing different types of proportional relationships in simple investigations
  - The coordinate system and strategies for scaling coordinate axes
- Problem Solving
  - Strategies for mathematical problem-solving in everyday situations
  - Mathematical formulation of questions based on everyday situations

Grades 7 to 9

- Understanding and Use of Numbers
  - Real numbers and their properties and also their use in everyday and mathematical situations
  - Development of the number system from natural numbers to real numbers; methods of calculation used in different historical and cultural contexts
  - Numbers as powers; numbers in scientific notation to express small and large numbers and the use of prefixes
  - Main methods for calculating numbers in fractions and decimals when making approximations, mental arithmetic, and calculations using written methods and digital technology; using the methods in different situations
  - Plausibility assessments when estimating and making calculations in everyday and mathematical situations, and in other subject areas
- Algebra
  - Meaning of the concept of variable and its use in algebraic expressions, formulas, and equations
  - Algebraic expressions, formulas, and equations in situations relevant to students
  - Methods for solving equations
  - How patterns in sequences of numbers and geometric patterns can be constructed, designed, and expressed in general
  - How algorithms can be created and used in programming; programming in different programming environments
- Geometry
  - Geometrical objects and their relationships; geometrical properties of these objects
  - Depiction and construction of geometrical objects, both with and without digital tools; scales for reducing and increasing two- and three-dimensional objects
  - Similarity and plane symmetry
  - Methods of calculating area, circumference, and volume of geometrical objects, and converting between units
  - Geometrical theorems and formulas and the need to argue for their validity
- Probability and Statistics
  - Standard probability and methods of calculating probability in everyday situations
  - How combinatorial principles can be used in simple everyday and mathematical problems
  - Tables, diagrams, and graphs, and how they can be interpreted and used to describe the results of the students' own and others' investigations, both with and without digital tools; how measures of central tendency and measures of dispersion can be used for assessing results of statistical studies
  - Assessment of risk and chance based on computer simulations and statistical material

- Relationships and Change
  - Percentage as a means of expressing change and rate of change; calculations using percentages in everyday situations and in situations in different subject areas
  - Functions and linear equations—how functions can be used, both with and without digital tools, to examine change, rate of change and relationships
- Problem Solving
  - Strategies for problem solving in everyday situations and in different subject areas; evaluation of chosen strategies and methods
  - Mathematical formulation of questions based on everyday situations and different subject areas
  - Simple mathematical models and how they can be used in different situations
  - How algorithms can be created, tested, and improved when programming for mathematical problem solving

The Science Curriculum in Primary and Lower Secondary Grades

The national curriculum for compulsory school was implemented in 2011 and has been revised in 2017 and 2018. It contains general goals, guidelines, syllabi, and knowledge requirements.[14]

In the Swedish curriculum, science is separated into three subjects: biology, chemistry, and physics. Different aims, core content, and knowledge requirements for these subjects are presented in the curriculum from 2018. Summaries of aim and core content for each subject are presented below.

The 2018 science curriculum in Sweden stipulates that science instruction should meet the following aims.

- In biology, instruction should give students the opportunity to develop their ability to:
  - Use knowledge of biology to examine information, communicate, and form an opinion on questions concerning health, natural resource use, and ecological sustainability
  - Carry out systematic studies in biology
  - Use concepts of biology, its models, and its theories to describe and explain biological relationships in the human body, nature, and society
- In chemistry, instruction should give students the opportunity to develop their ability to:
  - Use knowledge of chemistry to examine information, communicate, and form an opinion on questions concerning energy, the environment, health, and society
  - Carry out systematic studies in chemistry
  - Use concepts of chemistry, its models, and its theories to describe and explain chemical relationships in the human body, society, and nature

- In physics, instruction should give students the opportunity to develop their ability to:
  - Use knowledge of physics to examine information, communicate and take a view on questions concerning energy, technology, the environment, and society
  - Carry out systematic studies in physics
  - Use concepts of physics, its models, and its theories to describe and explain physics relationships in nature and society

The core content of the 2018 science curriculum in Sweden may be summarized as follows.

In Grades 1 to 3, the core content in biology, chemistry, and physics is integrated as one science subject, comprising the following topics:

- Seasons of the Year in Nature—Motion of the Earth, Sun, and Moon in relation to each other; phases of the Moon; constellations and the appearance of the sky at night during different seasons of the year; seasonal changes in nature and how to recognize the seasons; life cycles of animals and plants and their adaptation to different seasons of the year; local animals and plants and how they can be categorized, grouped, and their species determined; names of common species; simple food chains describing the relationship between organisms in ecosystems
- Body and Health—Importance of food, sleep, hygiene, exercise, and social relations to feel good; parts of the human body, their names, and functions; people's experiences of light, sound, temperature, taste, and smell using all the different senses
- Forces and Motion—Gravity and friction that can be observed during play and movement, such as on swings and slides; balance, center of gravity, and equilibrium in play and movement, such as when balancing and on a seesaw
- Materials and Substances in Our Surroundings—Properties of materials and how materials and objects can be categorized on the basis of such properties as appearance, magnetism, conductivity, and whether they float or sink; use and development of materials throughout history; materials used to manufacture daily objects and how they can be recycled; states of water (solid, liquid, gas); evaporation, boiling, condensation, melting, and solidification; basic properties of air and how they can be observed; simple solutions and mixtures and how they can be divided into different constituents, such as through evaporation and filtering
- Narratives about Nature and Science—Fiction, myths, and art dealing with nature and people; narratives about science from earlier times, and different cultures' attempts to understand and explain phenomena in nature
- Scientific Methods—Simple field studies and observations in the local environment; simple scientific studies; documentation of science studies using text, pictures, and other forms of expression, both with and without digital tools

In Grades 4 to 6, the biology curriculum in Sweden comprises the following core content:

- Nature and Society—Dependence on nature and the impact on nature and sustainable development; ecosystem services, such as decomposition, pollination, and purification of water and air; animals, plants, and other organisms; photosynthesis, combustion, and ecological relationships; the importance of knowledge with regard to agriculture and fishery; local ecosystems, relationships between organisms, and the names of common species; relationships between organisms and the nonliving environment; nature as a resource for recreation; human experiences and what responsibilities in nature
- Body and Health—How mental and physical health are affected by sleep, diet, movement, social relationships, and addictive substances; common diseases, prevention, and treatment; human organ systems (names of organs, appearance, location, function, and interaction); puberty, sexuality, and reproduction; identity, gender equality, relationships, love and responsibility
- Biology and World Views—Discoveries in biology and their importance to human living conditions and views on nature; descriptions and explanations of nature in fiction, myths, art, and earlier science; development of life and adaptation to different habitats
- Biology Methods—Planning, executing, and evaluating simple field studies and experiments; identifying, categorizing, and grouping animals, plants, and other organisms; documenting simple studies using tables, pictures, and simple written reports, both with and without digital tools; interpreting and examining information with links to biology, such as in newspapers articles and digital media films

In Grades 7 to 9, the biology curriculum in Sweden comprises the following core content:

- Nature and Society—Impact of people on nature, locally and globally; opportunities for consumers and citizens of society to contribute to sustainable development; energy flow of ecosystems and recycling of materials; photosynthesis, combustion, and other ecosystem services; biological diversity and factors threatening and favoring it; public discussions on biological diversity, such as in the relationship between forestry and hunting; local ecosystems and how they can be studied from an ecological perspective; relationships between populations and resources available in ecosystems; local ecosystems in comparison with regional or global ecosystems; current societal issues involving biology
- Body and Health—How physical and mental health is affected by sleep, diet, exercise, social relationships, and addictive substances; common diseases, prevention, and treatment; viruses, bacteria, infection, and spread of infections; antibiotics and resistant bacteria; cells, organs, and organ systems and their structure, functions, and interactions; comparisons from an evolutionary perspective between humans and other organisms; human sexuality and reproduction; questions concerning identity, gender equality, relationships, love, and responsibility; methods for preventing sexually transferable diseases and unwanted pregnancy at individual and global levels, and from a historical

perspective; evolutionary mechanisms and their outcomes; heredity and the environment; genetic engineering opportunities, risks, and ethical questions

- Biology and World Views—Discoveries in biology and their importance for society, people's living conditions, and views of nature and the natural sciences; current research areas in biology, such as biotechnology; scientific theories about the origins of life; the development of life and diversity from evolutionary theory perspectives; theories and models of biology, their limitations, validity, and variability
- Biology Methods—Field studies, experiments, and how simulations can be used as support in modeling; formulating simple questions; planning, executing, and evaluating studies; identifying, categorizing, and grouping organisms based on relationships between species and their evolution; the relationship between biological studies and the development of concepts, models, and theories; documenting studies using tables, diagrams, pictures, and written reports, both with and without digital tools; critically examining sources of information and arguments in various sources and social discussions related to biology, in both digital and other media

In Grades 4 to 6, the chemistry curriculum in Sweden comprises the following core content:

- Chemistry in Nature—Simple particle models; structure, recycling, and indestructibility of matter; movement of particles and transitions between solids, liquids, and gases; classification of substances and material based on properties' appearance, conductivity, solubility, combustibility, and acidity; properties and circulation of water; properties and composition of air; photosynthesis, combustion, and other basic chemical reactions
- Chemistry in Everyday Life and Society—Cultivating raw materials and converting them into products; waste that is handled and returned to nature; food and the importance of nutrients for health; historical and contemporary methods for extending the shelf life of food; common chemicals in the home and society, their use, and their impact on health and the environment; labeling and handling chemicals; fossil and renewable fuels, their importance in energy use, and their impact on climate
- Chemistry and World Views—Discoveries in chemistry and their importance to living conditions and views on the world; descriptions from the past of the structure of matter; transition from magic and mystery to modern science; descriptions and explanations of nature in fiction, myths, and art in different cultures, as well as earlier science
- Chemistry Methods—Planning, executing, and evaluating simple systematic studies; methods for dissolving solutions and mixtures into their components; documenting simple studies using tables, pictures, and simple written reports, both with and without digital tools; interpreting and examining information with links to chemistry, such as in newspaper articles and in digital media films

In Grades 7 to 9, the chemistry curriculum in Sweden comprises the following core content:

- Chemistry in Nature—Particle models to describe and explain the structure, recycling, and indestructibility of matter; atoms, electrons, and nuclear particles; chemical compounds and formation of atoms into molecular and ionic compounds through chemical reactions; particle models to describe and explain the properties of phases, phase transitions, and distribution processes for matter in air, water, and the ground; water as a solvent and carrier of substances in the ground, plants, and the human body; solutions, deposits, acids, bases, and pH values; chemical processes in the ground, air, and water from environmental and health perspectives; properties of carbon atoms and their function as the building blocks of all living organisms; circulation of carbon atoms; photosynthesis, combustion, and energy conversion in these reactions
- Chemistry in Everyday Life and Society—Use of energy and natural resources, locally and globally, and sustainable development; chemical processes in the manufacturing and recycling of metals, paper, and plastics; lifecycle analysis of common products; factors that enable materials such as iron and plastic to be broken down and how this can be prevented; purifying drinking water and waste water, locally and globally; food and beverages and their importance for health; chemical processes in the human body, such as the digestion; common chemicals in the home and in society, such as cleaning products, cosmetics, paints, and fuels, and how they affect health and the environment; handling chemicals and flammable substances safely; current societal issues involving chemistry
- Chemistry and World Views—Discoveries in chemistry and their importance in technology, the environment, society, and human living conditions; current research areas, such as development of materials and nanotechnology; theories and models of chemistry, their usefulness, limitations, validity, and variability; grouping of atoms from a historical perspective
- Chemistry Methods—Systematic studies; formulating simple questions, planning, execution, and evaluation; models for separation and analysis, such as distillation and identification of substances; documentation of studies using tables, diagrams, pictures, and written reports, both with and without digital tools; critical examination of sources of information and arguments in various sources and social discussions related to chemistry, in both digital and other media

In Grades 4 to 6, the physics curriculum in Sweden comprises the following core content:

- Physics in Nature and Society—Indestructibility of energy and flows, energy sources and their impact on the environment, use of energy in society; simple metrological phenomena and their causes, such as how wind occurs; how weather can be observed by means of measurements over time
- Physics and Everyday Life—Energy flows between objects with different temperatures; how the flow of energy can be affected by such means as clothes, thermoses, and house insulation; electrical circuits with batteries and how they can be linked and used in common electrical equipment, such as flashlights; properties of magnets and their use in

the home and society; forces and motion in everyday situations, how they are experienced and can be described, such as when cycling; how sound occurs, is transmitted, and is understood ; distribution of light from common sources of light and how it explains areas of light, shadows, and size; how the eye perceives light

- Physics and World Views—Discoveries in physics and their importance for people's living conditions and views on the world; descriptions and explanations of nature in fiction, myths and art in different cultures, and earlier science; the Solar System and planets' motion in relation to each other; how day, night, months, years, and seasons can be explained; humans in space and the use of satellites; measuring time in different ways, from sundials to atomic clocks
- Physics Methods—Planning, executing, and evaluating simple systematic studies; measurements and measuring instruments, such as clocks, tape measures, and scales, and how they are used in studies; documentation of simple studies using tables, pictures, and simple written reports, both with and without digital tools; interpretation and examination of information with links to physics, such as articles in newspapers and films in digital media

In Grades 7 to 9, the physics curriculum in Sweden comprises the following core content:

- Physics in Nature and Society—Energy flows from the sun through nature and society; ways of storing energy; types of energy quality and their advantages and disadvantages for the environment; electricity production, distribution, and use in society; supply and use of energy (historically, currently, and possibilities and limitations in the future); weather phenomena and their causes; concepts of physics used in meteorology and communicated in weather forecasts; models in physics to describe and explain the Earth's radiation balance, the greenhouse effect, and climate change; models of physics to describe and explain the occurrence of particle radiation and electromagnetic radiation, and the impact of radiation on living organisms; how radiation can be used in modern technology, such as in health care and information technology; particle models for describing and explaining the properties and phase transitions, pressure, volume, density, and temperature; how the motion of particles can explain the distribution of matter in nature; current societal issues involving physics
- Physics and Everyday Life—Forces, motion, and changes in motion in daily situations and how this knowledge can be used, such as to address traffic safety; levers and gearing in tools and devices, such as scissors, levers, blocks, and pulleys; how sound occurs, is transmitted, and can be recorded in different ways; the properties of sound and the impact of sound on health; propagation of light, reflection, and refraction in everyday contexts; explanatory models of how the eye perceives colors; relationship between voltage, current, resistance, and output in electrical circuits and how they are used in everyday contexts; relationship between electricity and magnetism and how it can be used in common electrical equipment
- Physics and World Views—Historical and contemporary discoveries in the area of physics and how they have been shaped and formed by world views; the importance of

discoveries for technology, the environment, society, and human living conditions; current areas of research in physics, such as elementary particle physics and nanotechnology; scientific theories about the origins of the universe in comparison with other descriptions; development of the universe, the occurrence of atoms, development of the stars; structure of the universe with planets, solar systems, and galaxies, and their movements and distances between them; theories and models of physics, their usefulness, limitations, validity, and variability

- Physics Methods—Systematic studies and how simulations can be used as support in modeling; formulating simple questions, planning, execution, and evaluation; measurements; measuring instruments and how they can be combined to measure magnitudes, such as speed, pressure, and output; electrical sensors for measuring and registering properties in the environment; relationship between physics studies and the development of concepts, models, and theories; documentation of studies using tables, diagrams, pictures, and written reports, both with and without digital tools; critical examination of sources of information and arguments in various sources and social discussions related to physics, in both digital and other media

Professional Development Requirements and Programs

In 2007, the Continuing Professional Development Program for Teachers was introduced to raise student achievement levels by improving teacher competence. Teachers were given the opportunity to deepen their competence in subjects in which they already had a degree, as well as broaden their competence in subjects in which they lacked education. Upon completion of the program, teachers could apply for new subject accreditation. The National Agency for Education organized program courses in cooperation with universities, and municipalities could apply for government grants to help cover the cost of reducing teaching hours for teachers who attended these courses.[15]

A new career reform program for teachers was introduced in 2013, offering a substantial increase in salary for appointed teachers, paid by the government. Teachers who are admitted to the program must have credentials from their principals and well documented experiences.[16]

Within the established types of programs mentioned above, the National Agency for Education continues to offer courses for teachers, principals, and other school staff. Courses and programs cover school subjects and also more general areas, such as assessments and grading, outdoor instruction, sustainability, equality, and gender aspects. One area that has been a focus of recent courses is digitalization, including programming, teaching, and learning in a digital world and using digital tools. There has also been a focus on how to guide teachers to help students that come to Sweden from other countries.[17]

Monitoring Student Progress in Mathematics and Science

Sweden monitors and assesses students in compulsory school through a system of national tests, diagnostic materials, and written reports with individual development plans and grades. The national tests provide support for teachers in monitoring student progress according to the curriculum and syllabus and support teachers in assigning grades. The tests have been developed and constructed at several of the country's universities on behalf of the National Agency for Education. National tests are provided for students in Grade 3 in the subjects of Swedish, Swedish as a second language, and mathematics; in Grade 6 in the subjects of Swedish, Swedish as a second language, mathematics, and English; and in Grade 9 in the subjects of Swedish, Swedish as a second language, mathematics, English, one of the three science subjects (biology, physics, or chemistry), and one of the four social science subjects (civics, history, religion, or geography).[18]

The National Agency for Education also provides diagnostic materials, tests, and individual test items that are intended to highlight individual student strengths and weaknesses, to help teachers monitor student progress and make impartial judgments.

Each school decides how to assess progress further in different subjects. At least once a semester, students and their parents receive progress reports and meet with teachers to discuss student progress and how learning can be stimulated and supported (development dialogues). Progress reports are regulated by law. Parent-teacher meetings on student progress serve as a substitute for annual progress reports and grading until School Year 6 and continue throughout compulsory school.[19]

Grade promotion in compulsory school is automatic, and students are not required to pass examinations at any point before being promoted to the next level. Grades are awarded after every semester from the sixth year of compulsory school onward and reflect student abilities relative to national goals and grading criteria stated in the syllabus for each subject. As of 2011, grades are given on a five-grade scale: A, B, C, D, and E, where E is a passing grade and A is the highest grade. Students who fail a subject receive a grade of F. The five grades are related to national criteria (knowledge requirements) established by the Swedish National Agency for Education.[20]

Special Initiatives in Mathematics and Science Education

In 2012, an extensive in-service training initiative was launched, aiming to reach all teachers of mathematics in primary, secondary, and adult education in Sweden with a one year program. The initiative also targets preschool teachers and teachers in preschool classes. Teachers were given time to work collaboratively on modules presented in a web-based portal. The modules focus on different aspects of mathematics education and comprise different activities (e.g., reading texts, watching classroom films developed for the program, discussing material with colleagues, and trying out ideas in the classroom). Groups of teachers work through the modules together, supported by tutors who are skilled mathematics teachers trained to support the program. The initiative also included a five-day course for school leaders. Preliminary evaluations show that the

initiative has been successful and reached the vast majority of Swedish mathematics teachers (approximately 80 percent) by the end of 2016. Although the project ended in 2016, the Web-based portal is still maintained, and it is clear that teachers still continue to use the material. New modules are developed over time and offered for teachers (e.g., programming, math instruction in a digital world).[21]

A similar program for science teachers was introduced in 2013, providing in-service training in science education research and school development for science teachers from different municipalities. Participating teachers were responsible for establishing local networks, in-service training, and coaching of their science teacher colleagues.[22]

Within the programs of professional development that are offered there are initiatives specific to both science and mathematics teachers. These programs can include longer courses at universities and shorter conferences for which the National Agency for Education cooperates with universities in different focus areas (e.g., digitalization, assessments).[23]

Suggested Reading

National Agency for Education. (2018). *Curriculum for the compulsory school, preschool class and school-age educare (revised 2018).* (English version). Stockholm: Author. Retrieved from https://www.skolverket.se/publikationer?id=3984

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