Sweden

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Introduction

Overview of Education System

A fundamental principle of the Swedish education system is that all children and youth shall have equal access to education, regardless 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 national agencies, municipalities, and different institutions ensure that educational activities are implemented in line with the legislative framework. School budgets are largely funded by municipalities.[2]

The Swedish National Agency for Education monitors and supports the development of the quality of schools. The agency's mission can be summarized as follows: setting goals and knowledge requirements; providing support for the development of preschools and schools, as well as developing and disseminating new knowledge to benefit target groups; and communicating research results with the purpose of improving the quality of schools. In addition, the National Agency for Special Needs Education and Schools coordinates government support for special needs education in Sweden.[3] The Swedish Schools Inspectorate ensures that schools comply with legislation and regulations by carrying out school inspections and by assessing applications to establish independent schools.

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 are allowed to make a profit. Approximately 16% of all compulsory school students attended independent schools in 2022–2023.[5]

Preprimary education and care are provided at preschools and family day care centers. The aim of preprimary education is to create favorable learning opportunities that stimulate children's physical and mental development. In Sweden, almost 86% of all children ages 1 to 5 were enrolled in preschool in autumn 2022. The largest participation is among 4- and 5-year-olds; just under 96% of children in these age groups are enrolled in preschool.[6]

In Sweden, there is an introductory year preceding Grade 1 that is referred to as *Förskoleklass* (preschool class). Since 2018–2019, preschool class is compulsory for all children to attend the year they turn 6 years old.[7] Almost all 6-year-olds attended preschool class even

before it was made compulsory.[8] The preschool class aims to provide a sound base for the first grade of schooling.[9] After this introductory year, children continue compulsory school in Grades 1 to 9. In other words, Swedish compulsory education comprises 10 years of schooling for children ages 6 to 16. 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 attend 3-year upper secondary education. Upper secondary education provides a foundation for vocational activities or further studies. There are 18 national upper secondary programs, each lasting at least 3 years. These programs consist of foundation subjects that all students in upper secondary school take, such as Swedish, English, and mathematics; program-specific subjects; work-based vocational orientation; program specializations; and a diploma project.[11] In addition, there are four introductory programs for students who are not eligible for a national program.[12]

Universities and university colleges are free of charge and admission is based on grades, on a university admissions test, or a combination of interviews and tests. In addition, students can attend postsecondary vocational schools to prepare for a specific trade or occupation.[13]

Use and Impact of TIMSS

While Sweden's results in TIMSS and other international and national assessments have indicated a decline in student achievements, they have undeniably influenced the general school debate and have had a significant impact on different reforms.

The Mathematics Curriculum in Primary and Lower Secondary Grades

The national curriculum for compulsory school was implemented in 2011 and was revised in 2017, 2018, and 2022. It contains general goals, guidelines, syllabi, and knowledge requirements.[14]

The national mathematics curriculum for compulsory school begins with an overall statement of purpose describing the role of mathematics in society and human activity. It goes on to emphasize the importance of learning and teaching mathematics. Furthermore, the syllabus outlines overall goals for creating student learning opportunities in mathematics, which may be summarized as follows: Mathematics teaching shall provide students with the prerequisites for developing

- the ability to use and describe mathematical concepts and relationships between concepts,
- the ability to choose and use appropriate mathematical methods to perform calculations and solve routine tasks,

- the ability to formulate and solve problems using mathematics and to evaluate chosen strategies,
- the ability to make and follow the reasoning behind mathematical inferences, and
- the ability to use mathematical expressions to discuss and explain questions, calculations, and conclusions.

This first 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, which are the same for all three tiers: Understanding and Using 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 on the list of competencies presented above but that do not correlate with specific competencies. Few explicit references to core content occur in the assessment criteria. The criteria are formulated for three of the five levels in the grading system in a short and dense manner. One example of a formulation of assessment criteria for a passing grade in Grade 6 is "The student solves simple problems. The student contributes to a proposal for an alternative approach and evaluates the reasonableness of the results. The student presents and follows mathematical reasoning by presenting and responding to statements with simple mathematical arguments."

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

- Understanding and Using Numbers
  - rational numbers, including negative numbers, and their properties and how they can be divided and used
  - the positional system and how it is used to describe whole numbers and numbers in decimal form
  - different number systems and some number systems used in different cultures throughout history
  - numbers in percentage form and their relationship with numbers in fraction and decimal form
  - how fractions and decimals can be used in everyday situations
  - the four arithmetic operations and rules for their use in natural number calculations
  - methods for calculating with natural numbers and simple fractions and decimals in rough estimates, mental arithmetic, and written calculations; use of digital tools in calculations
  - assessment of plausibility in estimations and calculations

- Algebra
  - mathematical equality and how the equals sign is used to represent simple equations
  - variables and their use in simple algebraic expressions and equations
  - methods, including algebraic ones, for solving simple equations
  - patterns in number sequences and geometric patterns, and how they are constructed, described, and expressed
  - programming in visual programming environments; how algorithms are created and used in programming
- Geometry
  - basic geometric two- and three-dimensional objects, along with their properties and interrelationships; construction of geometric objects, both with and without digital tools
  - comparison, estimation, and measurement of length, area, mass, volume, time, and angle using standardized measurement units and related unit changes
  - methods for determining and estimating the perimeter and area of various two-dimensional geometric figures
  - scale in reduction and enlargement, and the use of scale in situations relevant to students
  - symmetry in the plane and how symmetry can be constructed
- Probability and Statistics
  - random events, chance and risk based on observations, simulations, and statistical material; comparison of probability in different random experiments
  - simple combinatorics in concrete situations
  - tables and diagrams to describe the results of investigations, both with and without digital tools; interpretation of data in tables and graphs
  - the position measures mean, mode, and median, and how they are used in statistical analyses
- Relationships and Change
  - proportionality and how proportional relationships are expressed in fraction, decimal, and percentage form
  - coordinate systems and scale of coordinate axes
  - graphs to express proportional relationships
- Problem-Solving
  - strategies for solving mathematical problems in situations relevant to students
  - formulation of mathematical questions based on everyday situations

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

- Understanding and Using Numbers
  - real numbers and their properties, as well as their use in mathematical situations

- development of the number system from natural numbers to real numbers
- numbers in exponential form; basic exponents for expressing small and large numbers, as well as the use of prefixes
- mathematical laws and rules and their use in calculations with fractions, decimals, and exponents
- methods for calculating with fractions and decimals in rough estimates, mental arithmetic, and written calculations; use of digital tools in calculations
- assessment of plausibility in estimations and calculations

- Algebra
  - mathematical equality and how the equals sign is used to represent equations and functions
  - use of variables in algebraic expressions, formulas, equations, and functions
  - methods for solving linear equations and simple quadratic equations
  - patterns in number sequences and geometric patterns, and how they are generally constructed, described, and expressed
  - programming in a visual and text-based programming environment; how algorithms are created, tested, and improved in programming
- Geometry
  - geometric objects, along with their properties and interrelationships; construction of geometric objects, both with and without digital tools
  - methods for calculating area, perimeter, and volume of geometric objects, and related unit changes
  - geometric theorems and formulas, and arguments for their validity
  - scale in reducing and enlarging two- and three-dimensional objects
  - similarity and congruence
- Probability and Statistics
  - probability and methods for calculating probability in different situations; assessments of risks and chances based on computer simulations and statistical material
  - combinatorial principles and how they can be used in different situations
  - tables, diagrams, and graphs and how they are interpreted and used to describe one's own investigation results and those of others, both with and without digital tools
  - position measures and dispersion measures, and how they are used to assess the results of statistics analyses
- Relationships and Change
  - proportionality and how it is used to express scale, uniformity, and change
  - derived units, such as km/h and SEK/kg
  - percentage and change factors to express change, as well as calculations with percentages in everyday situations and in different subject areas

- straight line equation and rate of change; use of the straight line equation to describe relationships
- functions and how they are used to describe relationships and change and to investigate rates of change; how functions are expressed in the form of graphs, tables, and function expressions

- Problem-Solving
  - strategies for solving mathematical problems in different situations and within different subject areas, and evaluation of chosen strategies and methods
  - formulation of mathematical questions based on different situations and subject areas
  - simple mathematical models and how they can be used in different situations

The Science Curriculum in Primary and Lower Secondary Grades

As mentioned above, the national curriculum for compulsory school was implemented in 2011 and was revised in 2017, 2018, and 2022. It contains general goals, guidelines, syllabi, and knowledge requirements.[15]

In the Swedish curriculum, science is separated into three subjects: biology, physics, and chemistry. Each subject is introduced with an overall statement of purpose describing the role of the specific subject in society and human activity and emphasizes the importance of learning and teaching the subject. Different aims, core content, and knowledge requirements for these subjects are then presented.

Just as for mathematics, the syllabus for each subject 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 different categories.

The final part of each subject contains assessment criteria that are based on the list of competencies presented below but that do not correlate with specific 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 in biology in Grade 6 is “The student seeks answers to questions by performing systematic investigations in a safe and generally functional manner. The student evaluates the results and describes the investigations in a simple manner.”

The specific aim of each subject and the core content of each tier are presented below.

- Biology teaching shall provide students with the prerequisites for developing the following:
  - knowledge of biology concepts and explanatory models for describing and explaining relationships in nature and the human body; the ability to use biology to scrutinize information, communicate, and take a position on issues related to the environment and health; the ability to conduct systematic investigations in biology

- Physics teaching shall provide students with the prerequisites for developing the following:
  - knowledge of physics concepts and explanatory models for describing and explaining relationships in nature and society; the ability to use physics to scrutinize information, communicate, and take a position on issues related to energy, technology, and the environment; the ability to conduct systematic investigations in physics
- Chemistry teaching shall provide students with the prerequisites for developing the following:
  - knowledge of chemistry concepts and explanatory models for describing and explaining relationships in nature, society, and the human body; the ability to use chemistry to scrutinize information, communicate, and form opinions on issues related to the environment and health; the ability to conduct systematic investigations in chemistry

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

- Nature and Environment—what life is and how the development of life can be explained by the theory of evolution; biodiversity and how organisms adapt to the environment; food chains and cycles in the local environment; the interplay between animals, plants, and fungi, and how some environmental factors affect them; photosynthesis and cellular respiration; how animals, plants, and fungi can be identified and grouped in a systematic way, and the names of some common species; human dependence on and impact on nature, with links to the use of natural resources, sustainable development, and ecosystem services; nature as a resource and our responsibilities when using it
- Body and Health—human organ systems; the names, appearance, location, function, and interaction of some organs; some common diseases and how they can be prevented and treated; how mental and physical health is affected by living conditions, diet, sleep, hygiene, exercise, and addictive substances; human puberty, reproduction, sexuality, and identity, and issues related to relationships, love, and responsibility
- Systematic Investigations and Evaluation of Information—field studies and experiments using both analog and digital tools; planning, performance, evaluation of results, and documentation with words, images, and tables; some discoveries in the field of biology and their impact on human living conditions and view of nature; critical evaluation and use of information related to biology

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

- Nature and Environment—the origin, development, and diversity of life and the mechanisms of evolution; the properties of genetic material and the relationship between heredity and the environment; some genetic engineering methods and the opportunities, risks, and ethical issues associated with genetic engineering; local and

global ecosystems; the relationships between populations and available resources; photosynthesis, cellular respiration, material cycles, and energy flows; human impact on nature locally and globally, and how to promote sustainable development at the individual and societal level; the importance of biodiversity and ecosystem services

- Body and Health—the cells of the body as well as the structure, function, and interaction of some organs and organ systems; viruses, bacteria, infections, disease transmission, and resistance to antibiotics; how infectious diseases can be prevented and treated; how mental and physical health is affected by living conditions, diet, sleep, exercise, stress, and addictive substances, and how health problems can be minimized at the individual and societal level; human reproduction, sexuality, and identity, and issues related to relationships, love, responsibility, consent, and reciprocity; sexually transmitted diseases and contraception
- Systematic Investigations and Evaluation of Information—field studies and experiments using both analog and digital tools; formulation of research questions, planning, performance, evaluation of results, and documentation with images, tables, diagrams, and reports; the relationship between biological investigations and the development of concepts and explanatory models; the historical development, applicability, and changeability of biology explanatory models; searches, critical evaluation, and use of information related to biology; argumentation and position-taking on current environmental and health issues

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

- Physics in Nature and Society—how day, night, seasons, and years can be explained by the movements of the celestial bodies in the solar system; common weather phenomena and their causes, such as how winds and precipitation occur; forms of energy, as well as different types of energy sources and their impact on the environment; energy flows between objects that have different temperatures; how energy flows can be influenced by using different heat-conducting and insulating materials; how light and sound propagate and can be reflected; electrical circuits with batteries; how circuits can be connected and how they can be used in everyday electrical equipment; forces and motion that can be observed and measured in everyday situations; some instruments and how they are used to measure physical quantities, such as temperature and force
- Systematic Investigations and Evaluation of Information—observations and experiments using both analog and digital tools; planning, performance, evaluation of results, and documentation with words, images, and tables; some discoveries in the field of physics and their impact on human living conditions and view of nature; critical evaluation and use of information related to physics

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

- Physics in Nature and Society—the origin, structure, and evolution of the universe and the conditions for finding planets and life in other solar systems; particle model of the properties of matter, as well as phase transitions, pressure, volume, density, and temperature; physics explanatory models of Earth's radiation balance, the greenhouse effect, and climate change; the flow and indestructibility of energy and the quality of different types of energy; different types of energy sources and their advantages and disadvantages for society and the environment; particle radiation and electromagnetic radiation, along with their uses and risks; how light is propagated, reflected, and refracted; how sound originates, propagates, and can be detected in different ways; the relationship between electricity and magnetism and between current and voltage in electrical circuits; how these circuits can be used in electrical equipment; forces, motion, and changes in motion, as well as how this knowledge can be used, for example, in road safety issues; some instruments for measuring physical quantities, such as force and current; use of measurement values in simple calculations, such as density and velocity calculations
- Systematic Investigations and Evaluation Information—observations and experiments using both analog and digital tools; formulation of research questions, planning, performance, evaluation of results, and documentation with images, tables, diagrams, and reports; the relationship between investigations of physical phenomena and the development of concepts and explanatory models; the historical development, applicability, and changeability of physics explanatory models; searches, critical evaluation, and use of information related to physics; argumentation and position-taking on current issues related to energy, technology, and the environment

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

- Chemistry in Nature, Society, and the Human Body—the structure of matter visualized using simple particle models; classification of substances and materials according to their solubility, conductivity, acidity, or alkalinity; the properties of water and the water cycle; the properties and composition of air; photosynthesis and combustion as examples of chemical reactions in nature; fossil and renewable fuels and their impact on the climate; food content and the role of nutrients in health; common household chemicals, their use and impact on the environment and humans, and how they are labeled and should be handled; the processing of raw materials into products, such as metals, paper, and plastics; how products can be reused or recycled
- Systematic Investigations and Evaluation of Information—observations and experiments using both analog and digital tools; planning, performance, evaluation of results, and documentation with words, images, and tables; some discoveries in the field of chemistry and their impact on human living conditions and view of nature; critical evaluation and use of information related to chemistry

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

- Chemistry in Nature, Society, and the Human Body—the structure, cycle, and indestructibility of matter visualized using particle models; elements, molecular and ionic compounds, and how substances are transformed through chemical reactions; atoms, electrons, and nuclear particles; separation and analysis methods, such as filtration, precipitation, pH measurement, and identification of substances; water as a solvent and transporter of substances, for example, in soil, plants, and the human body; some chemical processes in soil, air, and water and their connection to environmental and health issues, such as the greenhouse effect, water purification, and the spread of environmental toxins; the properties and cycles of the carbon atom in nature, society, and the human body; carbohydrates, proteins, and fats and their functions in the human body; development of products and materials, such as medicines, sportswear, and batteries; life cycles of some products and their impact on the environment
- Systematic Investigations and Evaluation of Information—observations and experiments using both analog and digital tools; formulation of research questions, planning, performance, evaluation of results, and documentation with images, tables, diagrams, and reports; the relationship between chemical investigations and the development of concepts and explanatory models; the historical development, applicability, and changeability of chemistry explanatory models; searches, critical evaluation, and use of information related to chemistry; argumentation and position-taking on current environmental and health issues

Teacher Professional Development Requirements and Programs

Professional Development Requirements

There are neither compulsory national programs nor a specific number of hours set aside for teacher professional development at the national level. Rather, school principals are responsible for ensuring that teachers in their respective schools get the professional development they need. Occasionally, certain courses become necessary for some groups of teachers in the wake of new legislation.[16] However, within the regulated working time, time is set aside for competence development based on the benchmark of 104 hours per full-time employee and year. This time is distributed between the employees. Competence development refers to efforts aimed at developing teachers' ability to create good conditions for students' learning.[17]

Ongoing Professional Development Programs

In 2007, a campaign called the Continuing Professional Development Program for Teachers was introduced. The program aims to improve student achievement by improving teacher competence. Teachers are given the opportunity to strengthen their competence in subjects in which they already have a degree, as well as broaden their competence subjects in which they lack education. Upon completion of the program, teachers can apply for new subject

accreditation. The National Agency for Education organizes program courses in cooperation with universities, and municipalities can apply for government grants to help cover the cost of reducing teaching hours for teachers who attend these courses.[18]

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 principal and well-documented experience.[19]

Within these established types of programs, the National Agency for Education continues to offer different types of courses for teachers, principals, and other school staff in different areas. The content of the courses and programs pertains to different school subjects but also to more general areas such as assessment and grading students, outdoor instruction, sustainability, equality, and gender equality. One area of focus in recent years is digitalization, including programming, teaching and learning in a digital world, and using digital tools. There has also been a lot of focus on how to guide teachers in assisting students who have recently arrived in Sweden from other countries.[20]

Monitoring Student Progress in Mathematics and Science

In Sweden, students in compulsory school are monitored and assessed 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 in Grade 3 and support teachers in assigning grades in Grades 6 and 9. The tests have been developed and constructed by 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 four social science subjects (civic studies, history, religion, or geography).[21]

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

Each school decides how to further assess progress 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 to stimulate and support their learning (these meetings are referred to as 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 Grade 6 and continue throughout compulsory school.[22]

Grade promotion in compulsory school is automatic, and students are not required to pass examinations at any point before being promoted to the next grade. Grades are awarded after every semester from the sixth year of compulsory school onward and reflect students' abilities

in relation to national goals and grading criteria stated in the syllabus for each subject. As of 2011, a 6-point grading system has been used: A, B, C, D, and E, where E is a passing grade and A is the highest grade. If students fail a subject, they receive an F grade in that subject. The grades are related to national criteria (knowledge requirements) established by the Swedish National Agency for Education.[23]

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 1-year program. The initiative also targeted preschool teachers and teachers in preschool classes. Teachers were given time to work collaboratively on modules presented in a Web-based portal. The modules focused on different aspects of mathematics education and consisted of different activities (e.g., reading texts, watching classroom films developed specifically for the program, discussing materials with colleagues, and trying out ideas in the classroom). Groups of teachers worked through the modules together, supported by tutors who were skilled mathematics teachers trained specifically to support the program. The initiative also included a 5-day course for school leaders. Evaluations show that the initiative was successful and reached most Swedish mathematics teachers (approximately 80%) by the end of 2016. While the project ended in 2016, the Web-based portal is still maintained, and teachers continue to use the materials. New modules are developed over time (e.g., on programming and mathematics instruction in a digital world).[24]

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, for in-service training, and for coaching of their science teacher colleagues.[25]

Within the programs of professional development that are offered, there are specific initiatives for both science and mathematics teachers. These programs can include longer university courses but also shorter conferences where the National Agency for Education cooperates with different universities in different focus areas (e.g., digitalization or assessments).[26]

Suggested Reading

Skolverket. (2022). *Curriculum for compulsory school, preschool class and school-age educare* (revised 2022). Retrieved from https://www.skolverket.se/getFile?file=13128

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