Norway

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Introduction

Overview of Education System

Norway has a centralized curriculum comprising all subjects for Grades 1 to 13. Parliament initiates curriculum reforms, and the Ministry of Education and Research carries out the reforms through the Directorate for Education and Training. Several interest and expert groups are involved in developing and revising the curriculum. A new curriculum for all subjects in primary and lower secondary schools was established as a regulation in November 2019 and implemented in August 2020. Within the frameworks set by the curriculum, local schools and teachers have considerable freedom to make their own decisions regarding their organization and instruction methods.

Kindergarten is neither compulsory nor free in Norway, though every child has a right to attend. Ninety-three percent of children ages 1 to 5 attend kindergarten in Norway. Among children ages 3 to 5, 97% attend kindergarten.[1] Children enter first grade in August of the year they reach age 6. Most students are enrolled in public schools. Private schools play a minor role in Norway's education system.[2]

Ten years of compulsory education is a right and a duty in Norway and consists of primary school (Grades 1 to 7) and lower secondary school (Grades 8 to 10). There are only a few alternative subjects to choose from in lower secondary school and no streaming, and almost all students are taught together in inclusive classrooms. This system is based on a broad political agreement to minimize differences among children.

The final three grades, Grades 11 to 13, constitute upper secondary school. Although education at this level is not compulsory, 98% of the youth cohort in Norway attends.[3] While certain basic subjects are common to all students, students can choose from five general study programs that prepare them for tertiary studies or can choose from 10 vocational programs.

In 2020, the National Curriculum for Knowledge Promotion 2020 was introduced. This curriculum retains the basic education vision of previous curricula while providing renewed content to answer the demands of rapidly changing work and societal life. Fully implemented by 2022, the curriculum includes central values, core elements, interdisciplinary topics, basic skills (literacies), and competence aims. The central values, the five basic skills, and the three interdisciplinary topics permeate the curriculum across all subjects where they are relevant.[4,5]

Mathematics is a prominent subject in the Norwegian school curriculum and is the second largest subject after Norwegian (based on the amount of instruction time for each subject). At the end of 10th grade, students must take a national written final exam in one of three possible subjects: Norwegian, mathematics, and English. Science has half the instruction time as mathematics, one third of instruction time as Norwegian, and roughly the same amount of instruction time as English. There is no national written examination for science in 10th grade. Students must do one local oral exam, and science is one of the possible subjects students can draw for the oral exam.

Use and Impact of TIMSS

Norway participated in TIMSS 1995, TIMSS 2003, TIMSS 2007, TIMSS 2011, TIMSS 2015, and TIMSS 2019, as well as in TIMSS Advanced in 1995, 2008, and 2015. Norway also takes part in the Programme for International Student Assessment (PISA), PIRLS, the International Computer and Information Literacy Study (ICILS), the International Civic and Citizenship Education Study (ICCS), the Teaching and Learning International Survey (TALIS), and the TALIS Starting Strong Survey. Outcomes from these studies have received publicity, attracting professional, political, and public interest. At present, these international studies play an important role in the national evaluation of education quality.

Generally, these studies have been influential in setting the agenda for education discussions in Norway, as well as for actions taken to improve student achievement in mathematics and science.

An important curricular goal in Norway is for all students to receive instruction in accordance with their potential for learning. A recent example of how TIMSS results have influenced education policy in Norway is the increased awareness of the importance of supporting high-achieving students.

The Mathematics Curriculum in Primary and Lower Secondary Grades

The Norwegian curriculum in mathematics is organized by grade, and curriculum goals specify competencies to be attained by the end of Grades 2 through 10. For each school subject, the curriculum includes an introduction outlining the general relevance and central values of the subject, the core elements of the subject, how the subject relates to defined interdisciplinary topics, specifications for basic skills in that subject, a list of competency aims, and statements

regarding assessment. A brief overview of the mathematics curriculum for Grades 1 to 10 follows.

The first sentence of the curriculum states, "Mathematics is an important subject for understanding the patterns and relationships within society and nature through the use of modelling and applications."[6] The curriculum emphasizes the broad range of mathematics applications and utilities, with emphasis on learning "precise language for reasoning, critical thinking, and communication through abstraction and generalization."[7] It goes on to introduce certain concrete and practical, as well as abstract and theoretical, aspects of mathematics, which have an essential place in the teaching and learning of the subject.

The mathematics curriculum is organized according to the following core elements for Grades 1 to 10: Exploration and Problem-Solving, Modeling and Applications, Reasoning and Argumentation, Representation and Communication, Abstraction and Generalization, and Mathematical Fields of Knowledge.

The curriculum defines five basic areas of skill across all subjects and at all grade levels. For mathematics, these skill areas include the following:

- oral skills—create meaning through dialogue by communicating ideas and discussing mathematical problems, strategies, and solutions; progress from everyday language toward a more precise mathematical language
- writing—describe and explain relationships, discoveries, and ideas using suitable representations; use tools for developing own thoughts and learning; present solutions adapted to audience and situation; progress from everyday language toward a more precise mathematical language
- reading—create meaning in texts by being able to sort information, analyze, and evaluate its form and content; be able to summarize information in multimodal texts; find and use information from increasingly complex texts with advanced symbolic language and use of concepts
- numeracy—use mathematical representations, concepts, and approaches to do calculations; evaluate validity of solutions; recognize problems that can be solved using numeracy skills; formulate questions; analyze and solve increasingly complex problems with effective and suitable concepts, symbols, methods, and strategies
- digital skills—use graphical tools, spreadsheets, computer algebra system (CAS), dynamic geometry software, and programming to explore and solve mathematical problems; find, analyze, process, and present information using digital tools; progress in choosing and using suitable digital tools as aids for exploring, solving, and presenting mathematical problems

Exhibits 1 and 2 present a summary of the competencies that students are expected to attain in mathematics in Grades 5 and 9, respectively.

Exhibit 1: Expected Competencies in Mathematics, Grade 5 (abbreviated)[8]

Grade(s)	Core Element	Expected Competencies
5	Exploration and Problem-Solving	• explore and explain relationships between fractions, decimal numbers, and percentages, and use these in mental arithmetic • formulate and solve problems from one's own everyday life that are related to fractions • discuss randomness and probability in games and practical situations and relate these to fractions • solve equations and inequalities through logical reasoning and explain what it means that a number is a solution to an equation • create and program algorithms with the use of variables, conditions, and loops
	Modeling and Applications	• develop and use different strategies for calculations with positive numbers and fractions, and explain one's own thought processes • create and solve tasks in a spreadsheet related to personal finance • formulate and solve problems from one's own everyday life that are related to time
	Reasoning and Argumentation	• discuss randomness and probability in games and practical situations and relate these to fractions • solve equations and inequalities through logical reasoning and explain what it means that a number is a solution to an equation
	Representation and Communication	• describe fractions as parts of the whole, as part of a set, and as numbers on a number line, and evaluate and name quantities • represent fractions in different ways and switch between the different representations • create and solve tasks in a spreadsheet related to personal finance
	Abstraction and Generalization	• explore and explain relationships between fractions, decimal numbers, and percentages, and use these in mental arithmetic • create and program algorithms with the use of variables, conditions, and loops

Exhibit 1: Expected Competencies in Mathematics, Grade 5 (abbreviated) (Continued)

Grade(s)	Core Element	Expected Competencies
1–10	Mathematical Fields of Knowledge	• understanding numbers, algebra, functions, geometry, statistics, and probability • numbers: strong concept of numbers and develop a variety of numeracy strategies • algebra: exploring structures, patterns, and relationships • functions: tool for studying and modeling change and development • geometry: develop good spatial understanding • statistics and probability: foundation for making choices in own lives, in society, and in working life • basis for developing mathematical understanding by exploring relationships within and between the mathematical fields of knowledge

Exhibit 2: Expected Competencies in Mathematics, Grade 9 (abbreviated)[9]

Grade(s)	Core Element	Expected Competencies
9	Exploration and Problem-Solving	• explore, describe, and argue for relationships between the length of sides in triangles • explore and argue for how changing the conditions in a geometric problem affects the solutions • explore and argue for formulas for area and volume of three-dimensional figures • explore and argue for how representations of numbers and data can be used to promote different points of view • simulate outcomes in random events and calculate the probability that something will occur by using programming
	Modeling and Applications	• interpret and critically evaluate statistical representations found in media and the local community • find and discuss measures of central tendency and measures of variability in real datasets

Exhibit 2: Expected Competencies in Mathematics, Grade 9 (abbreviated) (Continued)

Grade(s)	Core Element	Expected Competencies
9	Reasoning and Argumentation	• explore, describe, and argue for relationships between the length of sides in triangles • explore and argue for how changing the conditions in a geometric problem affects the solutions • interpret and critically evaluate statistical representations found in media and the local community • explore and argue for how representations of numbers and data can be used to promote different points of view
	Representation and Communication	• describe, explain, and present structures and progressions in geometric and numerical patterns • interpret and critically evaluate statistical representations found in media and the local community • explore and argue for how representations of numbers and data can be used to promote different points of view • calculate and evaluate probability in statistics and games
	Abstraction and Generalization	• describe, explain, and present structures and progressions in geometric and numerical patterns • explore the properties of different polygons and explain the concepts similarity and congruence
1–10	Mathematical Fields of Knowledge	• understanding numbers, algebra, functions, geometry, statistics, and probability • numbers: strong concept of numbers and develop a variety of numeracy strategies • algebra: exploring structures, patterns, and relationships • functions: tool for studying and modeling change and development • geometry: develop good spatial understanding • statistics and probability: foundation for making choices in own lives, in society, and in working life • basis for developing mathematical understanding by exploring relationships within and between the mathematical fields of knowledge

The Science Curriculum in Primary and Lower Secondary Grades

The Norwegian curriculum in natural science is grouped by grades, and curriculum aims specify competencies to be attained by the end of Grades 2, 4, 7, and 10. As mentioned, for each school subject, the curriculum includes an introduction outlining the general relevance and central values of the subject, the core elements of the subject, how the subject relates to defined interdisciplinary topics, specifications for basic skills in that subject, a list of competency aims, and statements regarding assessment. A brief overview of the natural science curriculum for Grades 1 to 10 follows.

The subject of natural science aims to "contribute to the pupils' sense of wonder, curiosity, inventiveness, engagement and innovation by opening for them to work in the subject in a practical and exploratory manner."[10] Furthermore, the curriculum highlights the practical implementation of natural science terminology and natural science methods, practices, and approaches in order for students to obtain a foundation for understanding how natural science knowledge is used and developed. With a focus on developing critical thinking and encouraging conscious decision-making, the subject highlights the interaction between nature, individuals, technology, and society.

The natural science curriculum is organized according to the following five core elements for Grades 1 to 10: Natural Science Practices and Approaches, Technology, Energy and Matter, Earth and Life on Earth, and Body and Health.[11] Additionally, five basic skills across all grades and subjects are defined in relation to the natural science curriculum as follows:[12]

- oral skills—share and develop knowledge with natural science content based on observations, experiences, and information from the field; use natural science terminology and concepts to describe, demonstrate understanding, present knowledge, develop questions, argue, explain, reflect, and give grounds for one's own attitudes and decisions
- writing—formulate questions and hypotheses and write natural science explanations based on evidence and sources; describe observations and experiences, as well as formulate and argue in favor of points of view
- reading—understand natural science concepts, symbols, figures, and arguments by working with natural science texts; explore, identify, interpret, and use information from different types of texts to critically assess how natural science information is presented and used in argumentation
- numeracy—collect, adapt, and present relevant statistics; compare, assess, and argue whether calculations, results, and presentations are valid or not; choose suitable measuring instruments, measuring units, and formulas to solve natural science problems
- digital skills—use digital tools to explore, register, calculate, visualize, program, model, document, and publish data from experiments, fieldwork, and studies by others; use search engines, master search strategies, critically assess sources, and select relevant information on natural science topics

Exhibits 3 and 4 present a summary of the competencies that students are expected to attain in natural science as grouped for Grades 5 to 7 and 8 to 10, respectively.

Exhibit 3: Expected Competencies in Natural Science, Grades 5 to 7 (abbreviated)[13]

Grades	Core Element	Expected Competencies
5–7	Natural Science Practices and Approaches	• ask questions and formulate hypotheses about natural science phenomena, identify variables, and collect data to find answers • distinguish between observations and conclusions, structure data, use cause-and-effect arguments, draw conclusions, assess sources of errors, and present findings • give examples of how natural science knowledge has developed and continues to develop • explain how the geological cycle, plate tectonics, and external forces help shape and change different landscapes
	Technology	• explore, make, and program technological systems that consist of parts that work together • design and make a product based on user needs • reflect on how technology can solve challenges, create opportunities, and lead to new dilemmas • explore electric and magnetic forces through experiments and talk about how people exploit electric energy in everyday life
	Energy and Matter	• explore phase transitions and chemical reactions and describe their properties • use the particle model to explain phase transitions and the properties of solids, liquids, and gases • explore electric and magnetic forces through experiments and talk about how people exploit electric energy in everyday life
	Earth and Life on Earth	• explain how organisms can be divided into main groups and give examples of the special features of different organisms • explore and describe different food cycles and use this to discuss synergy in nature • describe and visualize how day and night, phases of the Moon, and seasons arise, and talk about the effect on life on Earth
	Body and Health	• explain physical and mental changes during puberty and talk about how these can affect emotions, actions, and sexuality • describe some of the body's organ systems and describe how the systems work together

Exhibit 4: Expected Competencies in Natural Science, Grades 8 to 10 (abbreviated)[14]

Grades	Core Element	Expected Competencies
8–10	Natural Science Practices and Approaches	• ask questions and formulate hypotheses about natural science phenomena, identify dependent and independent variables, and collect data to find answers • analyze and use collected data to make explanations, discuss the explanations in light of the relevant theory, and assess the quality of one's own and others' explorations • use and make models to predict or describe natural science processes and systems and explain the strengths and limitations of the models • participate in risk assessments in relation to experiments and comply with safety measures • give examples of current research and explain how new knowledge is generated through collaboration and a critical approach to existing knowledge • describe how researchers have arrived at evolution theory and use it to explain the development of biological diversity
	Technology	• explore, understand, and make technological systems that have a transmitter and receiver • use programming to explore natural science phenomena • explain energy conservation and energy quality and explore different ways to convert, transport, and store energy • explain how energy production and energy use can affect the environment locally and globally
	Energy and Matter	• explore chemical reactions, explain mass conservation, and explain the importance of some combustion reactions • use atomic models and the periodic table to explain the properties of elements and chemical compounds • explain energy conservation and energy quality and explore different ways to convert, transport, and store energy • explain how energy production and energy use can affect the environment locally and globally
	Earth and Life on Earth	• explain how photosynthesis and cellular respiration produce energy for all living organisms throughout the carbon cycle • use plate tectonic theory to explain the development of Earth over time and give examples of observations that support this theory

Exhibit 4: Expected Competencies in Natural Science, Grades 8 to 10 (abbreviated)

Grades	Core Element	Expected Competencies
8–10	Body and Health	• describe the body's immune system and how vaccines work and explain the importance of vaccines for public health • discuss questions relating to sexual and reproductive health

Teacher Professional Development Requirements and Programs

In 2010, the general teacher education program for basic school was reformed and divided into two types of programs: The first focused on educating general teachers in Grades 1 to 7, and the second focused on preparing subject teachers in Grades 5 to 10. Both program types were 4 years long and included a minimum of 100 days of teaching practice. Starting in 2017, all teacher education programs were extended to include a fifth year. This means that students completing the program receive a master's degree.[15] Teacher professional development is the responsibility of school administrators (i.e., municipalities or counties), often supported by government funding.

University-educated teachers are qualified to teach specific subjects (usually two) in lower and upper secondary school (Grades 8 to 10 and 11 to 13, respectively) as subject teachers. Teachers pursuing further education can be enrolled in a 5-year master's program, which includes 75 to 85 days of teaching practice. Alternatively, they have the option to add a year of further education to a bachelor's or a master's degree, which includes pedagogy, subject matter didactics, and 60 days of teaching practice.

In 2014, teacher employment regulations were expanded. In addition to general employment requirements, teachers in primary school are now required to hold a minimum of 30 credits in some subjects to teach those subjects. In lower secondary school, teachers are required to hold 60 credits in mathematics and 30 credits in science in order to teach these subjects. Since these new regulations came into effect, teachers who have not fulfilled them and wish to continue teaching are required to undertake further education by the end of 2025.[16] Professional development (PD) courses for teachers most often are offered by universities and university colleges.

In 2005, an initiative was taken by the Ministry of Education and Research to strengthen the PD programs for teachers in primary, lower secondary, and upper secondary schools. This has been done in several stages through the elaboration of strategies over a 20-year time span (2005–2025).[17]

Through these PD programs, teachers are given the opportunity to earn European Credit Transfer and Accumulation System (ECTS) credits that extend their formal qualifications. In addition, the Ministry of Education and Research has funded smaller-scale PD programs not linked to ECTS credits. Several organizations representing different stakeholders—

including school owners, teacher organizations, and national advisory committees for teacher education—were invited to participate in forming the main principles for these programs. The motivation for this comprehensive cooperation was to ensure that all relevant interest groups were represented. A major goal for this strategy is increased learning outcomes for all students through improved teaching quality. For teachers, three goals were formulated. Increased opportunities for PD should do the following:

- contribute to improved pedagogical and subject-related competence for teachers
- ensure that all teachers fulfill the requirements for teaching the relevant subjects
- contribute to the development of communities of learning in all schools

In particular, PD courses should aim at improving the specific teaching competencies considered necessary to teach a subject, and such courses should be prioritized to a larger degree than previously. Colleges and universities, in cooperation with school owners and teacher organizations, have been given responsibility for maintaining and further developing appropriate PD courses. School owners have been asked to develop plans to ensure that their teachers are given the opportunity to participate in relevant PD courses to fulfill the new teaching requirements. The Norwegian government is responsible for funding the expenses of the PD courses by granting 75% of the total costs for PD courses in science and mathematics and 60% of the expenditures for PD courses in other subjects. This difference in how expenses are covered also demonstrates the importance assigned to the quality of teaching in science and mathematics. Finally, all groups involved have been encouraged to cooperate closely to ensure the success of this endeavor.

Monitoring Student Progress in Mathematics and Science

At the end of compulsory schooling (Grade 10), students receive one overall achievement grade in each subject, determined by their teachers. In addition, students are selected to sit for one written examination. Approximately one third of students are selected to sit for an examination in mathematics, one third for an examination in Norwegian, and one third for an examination in English. These written examinations are prepared and graded at the national level. Students also may be selected for an oral examination that is prepared and graded locally, for which science and mathematics are among certain eligible subjects.

Norway administers national tests in numeracy, reading, and English early in Grades 5, 8, and 9. These tests are constructed and organized at the national level. The students' subject teachers score the national tests locally. Since 2014, the design of the national tests has allowed for trend analyses.

Even though grades are not given until lower secondary school, teachers develop local tests to monitor student progress in earlier grades as well. Lower secondary school teachers might use suggested tests found in commercial textbooks. Teachers at all grade levels (1 to 10) regularly write individual progress reports for their students, and students, together with their parents, are summoned for meetings in school at least twice each school year.

Special Initiatives in Mathematics and Science Education

The Norwegian Centre for Mathematics Education was established in 2002, and its primary task is to lead and coordinate the development of new and improved working methods and learning strategies in mathematics education for kindergarten teachers up through teacher educators in Norway.[a]

The Norwegian Centre for Science Education, established in 2003, contributes to improvements in the quality of science education. The center's primary target groups are teachers, education personnel in kindergartens, teacher educators, school directors, and kindergarten and school owners. The center develops resources for teachers,[b] students,[c] and kindergarten teachers[d] that focus on promoting children and youth's deeper learning, motivation, and interest in science. The center also provides various types of research-based in-service teacher training in science education that integrates resources from the center's web pages.[e] A website developed by both the Norwegian Centre for Mathematics Education and the Norwegian Centre for Science Education provides resources in science education that are tailored for professional development in learning communities both in kindergarten and basic school.[f]

In addition, the political strategy aims to provide professional development for science, technology, engineering, and mathematics (STEM) teachers so that these teachers will fulfill the expanded employment requirements by 2025 (see the Teacher Professional Development Requirements and Programs section). Mathematics is one of the subjects prioritized for teachers' continuing education.

Norwegian municipalities may allow high-achieving students in Grades 8 to 10 to join upper secondary school classes in certain subjects, with mathematics being the most common. These cases are considered on an individual basis, and decisions are subject to the consent of students or their parents.[18] Certain universities allow high-achieving students in Grades 11 to 13 to attend mathematics courses at the university.

a See https://www.matematikksenteret.no/english for more information.
b See https://www.naturfag.no/ for more information.
c See https://www.viten.no/nob/ for more information.
d See https://www.xn--forskerfr-t8a.no/ for more information.
e See https://www.naturfagsenteret.no/ for more information.
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