Belgium (Flemish)

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Introduction

Overview of Education System

Belgium is a federal state with three regions (Flanders, Wallonia, and Brussels) and three communities (Flemish, Francophone, and German-speaking). The federal government's education responsibilities are limited to determining the start and end ages for compulsory education, defining minimum requirements for diplomas, and regulating pensions for education staff. The communities organize education in Belgium, with the Flemish Ministry of Education and Training managing education within the Flemish community.[1]

Compulsory education starts at age 5 and ends at 18, comprising 1 year of preschool education, 6 years of primary education, and 6 years of secondary education. Full-time education is mandatory until age 15 or 16, after which students may switch to part-time education in combination with an apprenticeship. However, enrollment in this part-time option is limited. Homeschooling is allowed. Nearly all children in Flanders attend preschool (ages 2½ to 6), and primary school admission requires at least 290 half days of preschool attendance in the year a child turns 6. If this requirement is unmet, the primary school's class council decides on the child's primary education enrollment or additional preschool education. Flanders has a well-established system of special needs education in all stages of compulsory education for children requiring specific temporary or permanent support due to disabilities, serious behavioral or emotional problems, or severe learning disabilities. In some cases, children unable to attend school, primarily due to severe disabilities, may be exempted from compulsory education.[2]

Freedom of education and schooling in Belgium is constitutionally protected. This leads to three education networks in Flanders (see Exhibit 1): official government-funded education (GO! Education of the Flemish Community), official subsidized education (POV [*Provinciaal Onderwijs Vlaanderen*] education organized by provinces and OVSG [Onderwijs Van Steden en Gemeenten] education organized by municipalities), and free education (organized by private

entities and subsidized by the Flemish government). Within the network of free education, Catholic schools are the majority. Nevertheless, other (non)confessional schools exist, such as Protestant schools or schools organized around a specific pedagogical, nonconfessional vision, e.g., Waldorf schools. While individual schools have freedom to determine their own pedagogy and curriculum, many align with umbrella organizations (such as GO!, POV, OVSG, or Catholic education). This diversity in education networks and curricula results in varying objectives across schools and grades.

Exhibit 1: Overview of Education Networks in Flanders

Official Education		Free Education
Directly Financed	**Subsidized**	
GO! Education of the Flemish Community	Organized by public government: • provinces (POV) • cities and municipalities (OVSG)	Free subsidized education: • Catholic education • nonconfessional schools • other

The Flemish government sets quality control and quality promotion. The attainment goals are determined by the Flemish government, and the Flemish School Inspectorate subjects every school to at least one inspection every 6 years. Additionally, pedagogical counseling services organized by education umbrella organizations, linked to the education networks, support schools in realizing their pedagogical projects and promoting quality education.

Use and Impact of TIMSS

Flanders has participated in TIMSS since 1995, initially in eighth grade and later in fourth grade. TIMSS results, alongside results from other international large-scale assessments, receive significant media attention and are highly valued by policymakers to assess the quality of education in Flanders. In recent years, the focus on education in science, technology, engineering, and mathematics (STEM) has increased, partially due to TIMSS results. However, the impact on daily educational practices is not directly observed. Past cycles of these studies prompted debates on education quality, especially after a decline in math and science scores in TIMSS 2019.[3]

The Mathematics Curriculum in Primary and Lower Secondary Grades

Fourth-Grade Mathematics Curriculum

In primary schools, mathematics education includes several areas described in the Flemish attainment goals for primary education and that apply to all schools in their respective umbrella organizations.[4] The Flemish attainment goals for mathematics aim to achieve the following goals for students:

- acquire basic mathematical knowledge, insights, and skills (such as symbols, terms, concepts, and procedures) that are necessary to function adequately in society and form an essential basis for future study or a future career
- apply acquired mathematical knowledge, insights, and skills in meaningful concrete and real-world situations, as well as in other learning areas
- understand the language of mathematics
- develop an inquisitive attitude and skills that can help them discover and investigate mathematical relationships, patterns, and structures
- use appropriate research strategies to solve mathematical problems
- learn to regulate their own mathematical reasoning and learning processes and to reflect on them
- develop a constructive critical attitude toward mathematics in general
- develop a positive attitude toward mathematics as a learning area

The Flemish attainment goals for mathematics are organized according to three content domains and two overarching domains. The content domains are Numbers, Measurement, and Geometry. Each content domain has two rubrics. The first rubric involves conceptual understanding, mathematical language, and factual knowledge. The second rubric relates to procedures and application.[5]

In the content domain of Numbers, which is the most extensive domain, acquiring knowledge and insight into the concept of quantity in general and different ways of expressing numbers (natural numbers, fractions, decimals, proportions, percentages, etc.) is central. Furthermore, this domain entails the manipulation of numbers through traditional operations such as addition, subtraction, multiplication, and division. In addition to these conventional topics, other objectives focus on estimating and utilizing a calculator. The second content domain, Measurement, focuses on measuring physical quantities such as distance, speed, angle size, mass, time, and temperature in a concrete context. Attainment goals also include using a scale, measuring geometric quantities (perimeter, area, volume, etc.), estimating, counting with money, and using and interpreting units of measurement. In this, a specific level of precision and an understanding of the relationship between the unit of measurement and the numerical value are required. The third content domain, Geometry, includes attainment goals about concept formation regarding orientation and localization in a two-dimensional space, recognizing and naming shapes, reasoning with geometric properties, finding connections between shape and size, and making simple geometric constructions.[6]

The first overarching domain is Strategies and Problem-Solving Skills. The attainment goals within this domain focus on applying acquired insights and concepts, understanding the practical utility of mathematics, appreciating mathematics, and developing problem-solving skills.[7]

Finally, the overarching domain of Attitudes involves attainment goals around critical thinking in a mathematical context and reflection.

As stated, curricula and objectives can differ across education networks and schools depending on the curriculum of the umbrella organization the school is affiliated with. The following paragraphs describe the general focus within the curricula for mathematics of the two largest umbrella organizations: Catholic Education Flanders and GO! Education of the Flemish Community. Attainment goal 2.12, "The students can read clocks (analog and digital) and calculate time intervals. They are familiar with the relationship between seconds, minutes, and hours," is used as an example of how different curricula support this goal. Within the curricula of the umbrella organizations, attention is often devoted to the pedagogical principles in addition to the learning content itself.

The curriculum of Catholic Education Flanders, which is the largest umbrella organization for schools, is called ZILL, which stands for "Zin in Leren! Zin in Leven!" (Joy in Learning! Joy in Living!).[8] ZILL focuses on developing basic skills such as estimation, mental calculation, utilizing reference measures, interpreting diagrams in real-life situations, and problem-solving. The subject of mathematics is divided into the following five development themes:

- logical and mathematical thinking
- numbers
- numerical proficiency
- geometry
- measurement and measurement-based calculation

In Grade 4, students are expected to be able to read both digital and analog clocks, see the connection between digital and analog clocks, and calculate time (from one time to another time) in days, months, and years.[9]

GO! Education of the Flemish Community developed a vision where personalized collaborative learning is central to STEM education.[10] The main idea of the STEM curriculum in GO! is that society is too advanced to be grasped fully: Learners can't have the same knowledge of everything. Teachers and students are thus required to formulate their own goals. Additionally, GO! still provides a primary education curriculum for affiliated schools with learning lines (i.e., sequence of learning activities; for example, Grade 1 students learn numbers from 0 to 20, Grade 2 students learn numbers from 20 to 100, Grade 3 students learn numbers from 100 to 1,000, etc.) and goals to be achieved. Within this document, grade-specific learning goals are formulated and linked to attainment goals.[11] Using the example of attainment goal 2.12 within the GO! curriculum, Grade 4 students are expected to be able to calculate time (from one time to another time) in hours, quarters, minutes, and seconds, as well as in days, weeks, months, and years.

As the example of attainment goal 2.12 illustrates, different topics are introduced in different grades depending on the umbrella organization the school is affiliated with. As a result, students might be unprepared for some of the fourth-grade TIMSS items and underperform during the assessment.

Exhibit 2 presents a summary of the domains and attainment goals in the mathematics curriculum at the primary level (Grades 1 to 6) as set by the Flemish government.[12] Attainment goals are expected to be met by the end of primary school (Grade 6).

Exhibit 2: Summary of Domains and Attainment Goals in the Mathematics Curriculum in Primary School

Domain	Rubric	Attainment Goal
1. Numbers	Conceptual Understanding - Mathematical Language - Factual Knowledge	1.1 The students can count forward and backward in units, pairs, fives, and powers of 10. 1.2 The students can recognize and verbalize the different functions of natural numbers. 1.3 The students can understand the meanings of addition, subtraction, multiplication, division, multiples, divisors, common divisor, greatest common divisor, least common multiple, percent, sum, difference, product, quotient, and remainder, and provide correct examples and explain when to use them. 1.4 The students can recognize that fractions can be explained as a part (portion) of a ratio, a distribution, a division, a multiplication factor (operator), a number (with a place on a number line), and a representation of chance. The students can use the following terminology: numerator, denominator, fraction line (the line between a fraction's numerator and denominator), like, equivalent. 1.5 The students can read, record, order, and place natural numbers up to 10 digits, decimals (with three decimal places), simple fractions, and simple percentages on a number line. 1.6 The students can name, record, and use the symbols =, ≠, <, >, +, –, ×, :, /, ÷, %, and ( ) in operations. 1.7 The students can demonstrate through examples from their environment that throughout history and also in non-Western cultures, other mathematical systems related to numbers have been and are practiced. 1.8 The students can read and interpret varied quantity indications. 1.9 The students can use learned symbols, terminology, notations, and conventions in conversations. 1.10 The students can use mental math to immediately provide correct results in addition and subtraction up to 10, multiplication tables up to 10, and corresponding division tables.

Exhibit 2: Summary of Domains and Attainment Goals in the Mathematics Curriculum in Primary School (Continued)

Domain	Rubric	Attainment Goal
1. Numbers	Procedures	1.11 The students can understand the relationships between operations. 1.12 The students can discover order and regularity in number patterns to understand the characteristics of divisibility by 2, 3, 5, 9, and 10, and apply them. 1.13 The students perform exercises mentally, choosing an efficient solution path based on an understanding of the properties of operations and the structure of numbers: • addition and subtraction up to 100 • addition and subtraction with large numbers ending in zeros • multiplication and division by analogy with the multiplication tables 1.14 The students can verbally express and apply the following properties of operations in a concrete way: changing places, switching, splitting, and distributing. 1.15 The students can round numbers. The degree of accuracy is determined by the purpose of rounding and the context. 1.16 The students can approximate the result of a calculation. 1.17 The students can find estimation procedures for data that are not precisely determined or cannot be precisely determined. 1.18 The students can determine and clarify the equivalence between decimal numbers, fractions, and percentages in simple numbers through conversions. 1.19 The students can find the divisors of a natural number (≤100); they can find the (largest) common divisor(s) of two such numbers. 1.20 The students can find the multiples of a natural number (≤20); they can find the (smallest) common multiple of two such numbers. 1.21 The students can establish, compare, and assess the equivalence of simple ratios, and calculate the missing ratio in concrete situations (including between magnitudes).

Exhibit 2: Summary of Domains and Attainment Goals in the Mathematics Curriculum in Primary School (Continued)

Domain	Rubric	Attainment Goal
1. Numbers	Procedures	1.22 The students can make simple fractions equivalent for the addition and subtraction of fractions or the ordering and comparison of fractions. 1.23 The students can add and subtract simple fractions and decimal numbers in a meaningful context. They can also multiply a simple fraction by a natural number. 1.24 The students are familiar with the digit algorithms. They can perform four arithmetic operations with natural and decimal numbers using digits: addition with a maximum of five numbers: the sum < 10,000,000 subtraction: subtracted number < 10,000,000 and a maximum of eight digits multiplication: multiplier consists of a maximum of three digits; the product = a maximum of eight digits (two digits after the decimal point) division: divisor consists of a maximum of three digits; quotient a maximum of two digits after the decimal point 1.25 The students can make simple percentage calculations related to practical situations. 1.26 The students can use the pocket calculator efficiently for basic operations (see also 1.24). 1.27 The students can verify performed operations, including using the pocket calculator. 1.28 The students can determine in contexts which mathematical operations related to numbers are applicable and which are the most appropriate and economical. 1.29 The students are willing to use sensible search strategies that help address mathematical problems related to numbers, measurement, spatial orientation, and geometry.
2. Measurement		2.1 The students know the main quantities and units of measurement for length, area, volume, weight (mass), time, speed, temperature, and angle size and can establish the relationship between the quantity and the unit.

Exhibit 2: Summary of Domains and Attainment Goals in the Mathematics Curriculum in Primary School (Continued)

Domain	Rubric	Attainment Goal
2. Measurement	Conceptual Understanding - Mathematical Language - Factual Knowledge	2.2 The students are familiar with the symbols, notations, and conventions of the standard units of measurement and can record and group measurement results in various ways. 2.3 The students can relate common measures to meaningful situations. 2.4 The students can articulate the function of the concepts “scale” and “average” with concrete examples. 2.5 The students know that 0 °C is the freezing point in temperature measurement, and temperatures below freezing are indicated with a negative number.
	Procedures	2.6 The students can perceive various relationships, patterns, and structures between and with magnitudes and numerical values, and they can perform meaningful reductions. 2.7 The students can perform meaningful reductions with the standard units of measurement. 2.8 The students can estimate using reference points. 2.9 The students can concretely indicate how they can determine the area and perimeter of an arbitrary flat figure and a polygon. 2.10 The students can concretely indicate how to determine the volume of a rectangular prism. 2.11 The students can perform calculations with money and monetary values in real situations. 2.12 The students can read clocks (analog and digital) and calculate time intervals. They are familiar with the relationship between seconds, minutes, and hours.
3. Geometry	Conceptual Understanding - Mathematical Language - Factual Knowledge	3.1 The students can explain concepts and notations that determine space geometrically through concrete examples. 3.2 Based on the following properties, the students can recognize and name the following geometric objects: • in the plane: points, lines, angles, and flat figures (triangles, quadrilaterals, circles) • in space: polyhedra (cube, rectangular prism, pyramid) and sphere and cylinder

Exhibit 2: Summary of Domains and Attainment Goals in the Mathematics Curriculum in Primary School (Continued)

Domain	Rubric	Attainment Goal
3. Geometry	Conceptual Understanding - Mathematical Language - Factual Knowledge	3.3 The students can read and notate the symbols of perpendicularity and parallelism. 3.4 The students can classify different types of angles and different types of quadrilaterals based on sides and angles. They can also concretely represent these. 3.5 The students can use a compass to draw a circle. 3.6 The students can discover the concepts of symmetry, similarity, and equality in reality. They can also create simple geometric figures. 3.7 The students are capable of: • spatial orientation based on floor plans, maps, photos, and data about distance and direction • mentally moving in space and verbalizing what they see
4. Strategies and Problem-Solving Skills		4.1 The students can demonstrate with concrete examples that for the same mathematical problem related to numbers, measurement, geometry, and spatial orientation, there are sometimes multiple solution paths, and occasionally multiple solutions are possible depending on how the problem is perceived. 4.2 The students are capable of efficiently applying the learned concepts, insights, and procedures related to numbers, measurement, and geometry, as specified in the respective end terms, in meaningful application situations, both inside and outside the classroom. 4.3 The students can provide concrete examples from their daily lives to indicate the role and practical utility of mathematics in society.
5. Attitudes		5.1 The students express appreciation for mathematics as a dimension of human ingenuity. 5.2 The students develop a critical attitude toward various numerical data, tables, and calculations consciously or unconsciously used in their environment to inform, convince, or deceive people.

Exhibit 2: Summary of Domains and Attainment Goals in the Mathematics Curriculum in Primary School (Continued)

Domain	Rubric	Attainment Goal
5. Attitudes		5.3 The students realize that engaging with mathematics is an active and constructive process that can grow and expand through their own thinking and learning activities. Consequently, they develop the belief that all students can acquire mathematical proficiency that can lead to studies and professions involving mathematics. 5.4 The students are willing to ask themselves questions about their approach before, during, and after solving a mathematical problem and are willing to adjust their approach based on these questions.

Eighth-Grade Mathematics Curriculum

Secondary education consists of three phases with two grades.[13] Students can also opt for a supplementary grade in the third phase, providing opportunities for further qualification. The first phase is divided into Streams A and B. Most Stream A students receive a certificate of primary education. Stream B is for students without a certificate of primary education or students who prefer vocational education. After the first grade of secondary education, Stream B students can continue to the second grade of secondary education in a vocational track or move to the first Stream A grade (subject to favorable decision of the admission class council). As of September 1, 2019, both streams have new attainment goals. This set of goals was subject to revision and was reapproved by the Flemish Parliament in 2023. The education goals for mathematics are grouped into a STEM cluster. These education goals consist of the following categories:

- attainment goals: to be achieved by the population of Flemish students
- attainment goals related to basic literacy: to be reached by each student

For mathematics, attainment goals are developed across a framework consisting of four large components: Numbers, Geometry and Measurement, Relations and Change, and Data and Uncertainty. Each of these components has corresponding mathematical terminology, procedural knowledge, and underlying reasoning. The Numbers component is focused on computations with natural, whole, and rational numbers. The Geometry and Measurement component focuses on analyzing and understanding geometric relationships and properties of geometric objects in 2D and 3D representations. The Relations and Change component emphasizes modeling relations and changes analytically and algebraically. Finally, the Data and Uncertainty component includes identifying and summarizing data and focuses on different ways the data can be presented. There is, however, a difference in how these components are acquired depending on the education stream (A or B). Stream A is oriented toward theoretical

concepts, while Stream B places a greater emphasis on practical, real-world scenarios. Moreover, the following topics are only seen in Stream A: operations of exponentiation and square root, homothetics, algebraic arithmetic, connections, and first-degree equations.

Streams A and B attainment goals include modeling and solving problems by analyzing, (de)mathematizing, or applying heuristics, and developing insight in the components described above. An attainment goal for Stream A only is constructing arguments and making them abstract, considering the coherence and structure of mathematics.

Some examples of attainment goals related to basic literacy include being able to perform calculations with information and communications technology (ICT) aids (e.g., calculator) or obtaining information from diagrams. The emphasis here is that these actions are performed in a functional context.

The Science Curriculum in Primary and Lower Secondary Grades

The Flemish government sets the attainment goals for the science curriculum. These are to be understood as the minimum goals to be achieved. In primary education, science was embedded in attainment goals for the subject area world orientation. This subject aimed to provide students with a comprehensive understanding of the world around them and consisted of six domains: Nature, Technology, Humankind, Society, Time, and Space. The subject had a convex learning trajectory commencing close to the child's living environment in the early grades and progressively expanded throughout. On September 1, 2015, the Flemish government organized world orientation into two new subject areas: Science and Technology (comprising nature, health environment, and technology) and Humankind and Society (comprising topics related to sociology, time, space, and use of references, among others). This change was only nominal; the contents and attainment goals set by the Flemish government stayed the same from when they were first implemented in 1998 and are now divided across the two subjects.[14] Many schools still use the terminology and language from the previous world orientation subject area. The Flemish attainment goals for science aim to achieve the following goals for students:

- develop basic competencies that enable learners to confidently and progressively explore themselves and their environment in depth in the field of Science and Technology
- develop an interest in Science and Technology, both in the present and the past, and both locally and globally
- develop a foundational attitude of openness and respect toward Science and Technology
- develop basic skills to independently manage information related to Science and Technology

The attainment goals for Science and Technology can be further divided into the domain of Nature and the domain of Technology. In the domain of Nature, students acquire knowledge, understanding, skills, and attitudes about living nature and inanimate nature, health, and the

environment, for example, "the students can illustrate that a substance can change state" (attainment goal 1.15).[15] For the Technology domain, students acquire insight into the interplay between systems, processes, tools, and decisions in technology. Through the attainment goals, students also gain insight in technology as a human activity (i.e., finding technical solutions for a problem, why humans need and use technology) and will understand the interplay between technology and society, for example, "the students can illustrate that technical systems evolve and improve" (attainment goal 2.5).

Exhibit 3 presents a summary of the subject areas and domains in the science curriculum at the primary level (Grades 1 to 6) as set by the Flemish government.[16] Attainment goals for Science and Technology are expected to be met by the end of primary school (Grade 6).[17]

Exhibit 3: Summary of Domains and Attainment Goals in the Science Curriculum in Primary School

Subject Area	Domain	Attainment Goal
1. Nature	General Skills	1.1 The students can observe systematically with all senses and systematically record observations. 1.2 The students can, with guidance, test at least one natural phenomenon observed through a simple investigation against a hypothesis.
	Animate and Inanimate Nature	1.3 The students can discover similarities and differences in a limited collection of organisms and common materials, and create and justify their classification based on at least one criterion. 1.4 The students can recognize and name two different biotopes in their environment, identifying some common organisms. 1.5 The students can indicate characteristics in organisms that illustrate their adaptation to the environment. 1.6 The students can illustrate how humans influence the presence of organisms. 1.7 The students can illustrate the law of eating and being eaten using at least two connected food chains. 1.8 The students can articulate, in a simple manner, the function of major organs involved in respiration, digestion, and circulation in the human body. 1.9 The students can articulate, in a simple manner, the function of the senses, the skeleton, and muscles. 1.10 The students can recognize physical changes in themselves and peers as normal aspects of development. 1.11 The students can measure, compare, and describe weather elements at a specific moment and over a limited period.

Exhibit 3: Summary of Domains and Attainment Goals in the Science Curriculum in Primary School (Continued)

Subject Area	Domain	Attainment Goal
1. Nature	Animate and Inanimate Nature	1.12 The students can illustrate the relationship between human habits and the climate in which they live. 1.13 The students can demonstrate how Earth rotates on its axis, the consequences for day and night rhythms in their environment, and the movements of Earth, the Sun, and the Moon in relation to each other. 1.14 The students can demonstrate some properties of common materials in their environment. 1.15 The students can illustrate that a substance can change state. 1.16 The students can demonstrate, with examples, that energy is necessary for the functioning of living and nonliving systems and can name their energy sources.
	Health	1.17 The students can relate healthy and unhealthy habits to what they know about the functioning of their bodies. 1.18 The students are aware that certain disease symptoms and disabilities cannot always be avoided. 1.19 The students realize that taking precautions reduces the chance of diseases and accidents. 1.20 The students can seek the help of an adult in an emergency. 1.21 The students can administer basic first aid for burns.
	Environment	1.22 The students can independently perform basic actions in the care of animals and plants in their environment. 1.23 The students show in their behavior a willingness to handle waste, energy, paper, food, and water carefully in their class and school. 1.24 The students can illustrate with concrete examples from their environment how people deal with the environment positively and negatively. 1.25 The students can illustrate with concrete examples from their environment that conflicting interests often underlie environmental problems. 1.26 The students show respect and care for nature, understanding that human needs depend on the natural environment.

Exhibit 3: Summary of Domains and Attainment Goals in the Science Curriculum in Primary School (Continued)

Subject Area	Domain	Attainment Goal
2. Technology	Core Concepts of Technology Core Concepts of Technology	2.1 The students can identify the raw materials from which technical systems in their environment are made. 2.2 The students can investigate specific functions of parts in simple technical systems by handling, assembling, or disassembling. 2.3 The students can investigate why a self-used technical system does not function or poorly functions. 2.4 The students can illustrate that some technical systems need maintenance. 2.5 The students can illustrate that technical systems evolve and improve. 2.6 The students can illustrate how technical systems are based, among other things, on knowledge of the properties of materials or natural phenomena. 2.7 The students can recognize steps of the technical process in concrete experiences (defining problems, developing solutions, making, commissioning, evaluating). 2.8 The students can recognize technical systems, the technical process, tools, and choices within different application areas of technology.
	Technology as a Human Activity	2.9 The students can solve a problem arising from a need technically by going through different steps of the technical process. 2.10 The students can determine the requirements that the technical system they want to use or realize must meet. 2.11 The students can generate ideas for the design of a technical system. 2.12 The students can make choices when using or realizing a technical system, considering the need, requirements, and available tools. 2.13 The students can execute a simple working drawing or manual step-by-step. 2.14 The students can compare working methods and technical systems and formulate judgments on both based on criteria. 2.15 The students can use and/or realize technical systems in different application areas of technology. 2.16 The students are willing to work hygienically, accurately, safely, and carefully.

Exhibit 3: Summary of Domains and Attainment Goals in the Science Curriculum in Primary School (Continued)

Subject Area	Domain	Attainment Goal
2. Technology	Technology and Society	2.17 The students can illustrate that technology and society influence each other. 2.18 The students can illustrate, with examples from different application areas of technology, that technical systems can be useful, dangerous, and/or harmful to themselves, others, or nature and the environment.

As stated above, curricula and objectives can differ across education networks and schools. The following paragraphs describe the general focus within the curricula for science of Catholic Education Flanders and GO! Education of the Flemish Community. Attainment goal 1.3, "The students can discover similarities and differences in a limited collection of organisms and materials, and create and justify their classification based on at least one criterion," is used as an example of how different curricula support this goal. Curricula of umbrella organizations often contain learning content related to their pedagogical principles.

Fourth-Grade Science Curriculum

The curriculum of Catholic Education Flanders, ZILL, focuses on technology (with a distinction between technology and science) and nature. For technology, there is a focus on understanding, applying, and explaining. For nature, there is a focus on exploring, experiencing, and observing. Attainment goal 1.3 is implemented using two separate goals: "Perceiving, investigating, and recognizing natural phenomena and common materials in the environment" (OWna8)[a] and "Observing, investigating, naming, and categorizing organisms commonly found in different biotopes" (OWna2).[18] At a fourth-grade level, students should be able to observe, investigate, and interact with characteristics of biotopes. They should be able to recognize two different biotopes in their surroundings and identify and name commonly occurring organisms in these biotopes (OWna2). They should be able to observe, investigate, determine, and express that the state of substances can change, using the correct wording: gaseous, liquid, or solid. Additionally, they should be able to explore and determine similarities and differences in a limited collection of common materials and substances, establish their classification based on at least one criterion, and justify their classification (OWna8).[19]

As with mathematics, the science curriculum of GO! Education of the Flemish Community is embedded in an overarching vision of STEM education next to the curriculum with grade-specific learning goals that are linked to attainment goals.[20] For attainment goal 1.3, fourth-grade students in GO! schools should be able to recognize and name common plants and fungi from their environment, identify and name the main parts of plants (root, stem, branch, bud,

a See https://zill.katholiekonderwijs.vlaanderen/?newsitem=4e2ebf39-4ec9-42ec-b02a-e9637f0d2c21%22%20\l%20%22!/bib/concordanties#!/ for more information about these curriculum codes.

leaf/needle, bulb, tuber), and explain their functions in their own words. They should also be able to compare plants based on at least one given criterion (e.g., shape, color, location, fruits, flowers, edible/nonedible, useful/not useful for humans) and create a classification of plants and justify this classification. They are also required to compare different animals from their environment based on at least one given criterion, such as appearance (skin covering, legs, etc.), diet (herbivores, carnivores, omnivores), and reproduction (live birth, egg-laying, etc.).

Several topics included in the fourth-grade TIMSS assessment are introduced in fifth or sixth grade in Flanders and therefore are not part of the fourth-grade curriculum. This can, however, differ slightly across schools as a result of different curricula across different umbrella organizations. As a result, students might not be familiar with some of the fourth-grade TIMSS science items and underperform on them during the assessment.

Eighth-Grade Science Curriculum

As mentioned above, secondary education consists of three phases with two grades. The first phase is divided into Streams A and B. As of September 1, 2019, both streams have new attainment goals that were revised and reapproved by the Flemish Parliament in 2023. The attainment goals for science, mathematics, technology, and STEM are clustered within one key competence and consist of the same categories as for mathematics:[21]

- attainment goals: to be achieved by the population of Flemish students
- attainment goals related to core competencies: to be reached by each student

These include developing insight into the following:[22]

- the construction, structure, and properties of matter in living and nonliving systems
- the manifestations of energy, the interaction between matter and energy, and the consequences thereof
- the basic properties of living systems
- technical systems and processes and their relationship to different technological domains and to other domains (sciences, mathematics, etc.)
- designing, implementing, deploying, and evaluating technical systems, considering fundamental social, scientific, and technological aspects
- using natural science and technological and mathematical concepts and methods to solve problems and to investigate and understand objects, systems, and their interactions

Teacher Professional Development Requirements and Programs

Primary school teachers in Flanders are trained in all subjects taught in primary school. Therefore, there are no subject-specific teachers for mathematics or science in primary education. Teachers in secondary education are trained and qualified in two core subjects. In contrast with primary education, there are subject-specific teachers in secondary education.

In 2012, the Flemish government outlined a general framework of an action plan to promote careers in mathematics, exact sciences, and technology (known as the STEM Action Plan 2012–2020; see the Special Initiatives in Mathematics and Science Education section for more information). This plan has led to an increase in initiatives to support professional development for teachers related to mathematics and science education.[23,24]

The Flemish government has created two major plans to increase interest in STEM: the STEM Action Plan 2012–2020 and the STEM Agenda 2030, which also involves teacher professional development. The STEM Agenda 2030 was proposed in July 2021 and is continuously updated and reviewed. Collaboration by the government, education partners, schools, and media is vital to achieve the goals in these plans.[25,26,27]

In addition to the initial teacher training, a coherent process of initial guidance and continuous further training and professionalization is essential to guarantee and support the quality of teaching. In 2009, a decree on the quality of education was developed[28] that outlines professionalization within the context of different approaches: formal and informal, external and internal, request driven, and offer driven. This decree stipulates that each school needs to have a professional development plan for its school team. The expectations concerning professional development are outlined in the reference framework for quality education. Schools receive a yearly budget for professional development that they can use autonomously. They make their own choices regarding topics, methods, and partners, which makes it possible for the schools to align professional development opportunities with local context and needs. A fixed number of professionalization hours or particular targets to reach are not stipulated in the regulation. Since 2019, the only obligation is to offer induction to starting teachers.

Most schools rely on the support of pedagogical advisory services connected to the different Flemish education networks. But schools can also partner with external organizations or organize professional development in a more informal manner via networking with other schools (e.g., STEM networks) or with colleagues within the school.

Monitoring Student Progress in Mathematics and Science

Flemish schools have the highest degree of autonomy among all Organisation for Economic Co-operation and Development (OECD) countries when it comes to the assessment and evaluation of students.[29] While umbrella organizations provide pedagogical guidance for student evaluation, schools are not obliged to implement these recommendations. Schools generally adopt the curriculum designed by the umbrella organizations. They also have the option to develop their own curriculum and have it validated by the government. Since the 2018–2019 academic year, Flemish primary schools must conduct a validated test in at least three subject areas at the culmination of primary education for each student. Schools enjoy the freedom to select the test, with the Ministry of Education and Training offering a toolkit of three validated tests that are designed as low-stakes, sample-based assessments, two of which are developed by the umbrella organizations.[30] These sample-based assessments measure the extent to which the attainment goals for primary education are met at the school level and are intended for internal quality control.

The first benchmarking study, known as *Peilingsonderzoek*, was a collaboration between the University of Antwerp and KU Leuven and was commissioned by the Flemish government. However, this collaboration was discontinued by the Flemish government in 2022.[31] Additionally, Catholic Education Flanders conducts annual interdiocesan tests for fourth- and sixth-grade students. Only schools adhering to the curriculum of Catholic Education Flanders can participate.[32] Schools from the official education network can also engage in the OVSG test, a comprehensive assessment covering all subjects in the curriculum.[33] None of these assessments have a high-stakes impact on schools or students.

On a system level, Flanders did not have a centralized system for monitoring student progress until 2024. Starting in 2024, Flanders will implement a system of central tests in all Flemish schools. The central tests will assess the degree to which students reach the attainment goals for Dutch and mathematics. This initiative is a response to the decline in achievement of Flemish students in international assessment studies and the overall decline in education quality. Students will participate in the assessment at four different times, in primary school in Grades 4 and 6 and in the second and third grades of secondary school. The results of the central tests will be used to monitor education quality and provide guidance to schools where needed. Thus, in comparison with other education systems, the central tests in Flanders will have a developmental-oriented perspective.[34]

At the school and classroom level, there is a very high degree of liberty in developing a strategy to monitor student progress. Each school can decide for itself how it monitors student progress. Teachers often use pen-and-paper tests that they develop on their own or that accompany the text- and workbooks. The tests and assessments used (and developed) by the school and teachers serve as the primary source of information in monitoring student progress. The schools and class council decide whether or not a student has reached the attainment goals.[35]

Special Initiatives in Mathematics and Science Education

Regarding mathematics and science education, the Department of Education & Training (within the Ministry of Education and Training), directly implements several initiatives or supports these initiatives with subsidies.

In recent years, a lot of attention has been devoted to STEM education to combat the shortage of recent graduates with a technical and scientific profile.[36] The Flemish government addressed this issue with the STEM Action Plan 2012–2020, followed by the STEM Agenda 2030, which were developed to encourage young people to choose STEM-related subjects at school and, ultimately, pursue a STEM career. The action plan advocates for innovative and thematically challenging STEM education that accomplishes the following eight objectives:

- organize attractive STEM education
- support teachers, trainers, and mentors
- improve the study and career choice process

- attract more girls to STEM courses and professions
- focus on excellence
- adjust the courses provided
- encourage sectors, companies, and knowledge institutions
- enhance society's appreciation of STEM professions

The STEM Action Plan 2012–2020 provided schools with a framework to help them integrate mathematics, science, and technology so that important STEM concepts and practices are understood and applied in an interdisciplinary manner. Furthermore, communities of practice were developed in preschool, primary, and secondary education, where teachers inform and encourage each other about STEM.[37,38,39] The Flemish School Inspectorate evaluated the quality of preschool, primary, and secondary STEM education using a quality framework that inspires assessment of existing practices while describing a potential growth path. The mission of the STEM Agenda 2030 is to connect existing policy initiatives and combat fragmentation and overlap. The STEM Agenda 2030 focuses on four strategic objectives:[40,41]

- persuasion—increase awareness of the importance of STEM competencies in society (STEM skills and knowledge for the future) and the importance for individuals, businesses, and society. It includes initiatives to communicate the benefits of STEM education and careers and promote STEM literacy.
- attraction—ensure that anyone with an interest and talent in STEM is able to find a suitable STEM education, make STEM education more accessible and inclusive, and provide more support for teachers and students
- innovation—adapt STEM education and training to the constant evolution and transition in business, research, and society; and ensure that STEM education and training meets the needs of the labor market and the changing world
- action—ensure that STEM competencies are used as much as possible in line with the needs and evolution and transition occurring in business, research, and society

Within the framework of the STEM Agenda 2030, the Department of Education & Training subsidizes two learning networks, one for primary education and one for secondary education.4243 They support schools and set up initiatives for teachers regarding integrated STEM didactics. Furthermore, regional technological centers support schools in STEM, and teachers can find a range of learning resources on the STEM subsite of KlasCement.

Apart from formal education, more than 60 out-of-school STEM academies are active and offer interactive STEM activities in an informal setting.[44]

In Flanders, competitions (Olympiads) for both mathematics, science, and STEM are organized for students in secondary education. These are supported by the Flemish government.[45,46,47]

After the COVID-19 pandemic, the Department of Education & Training invested in a broad implementation of a system of summer schools to combat the learning loss caused

by the lockdown and school closures. The summer schools strongly focus on language and mathematics with more traditional school and classroom activities in the morning and a more animation-oriented activity in the afternoon that incorporates elements of the school subjects.[48]

Suggested Reading

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