

# Denmark

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## Introduction

### *Overview of Education System*

Education is compulsory in Denmark, and public schooling is free. Children are not required to attend school to receive their education (they can also be educated at home, though few parents make use of this option), but the education they receive must meet the same standard as that offered by the Danish public schools. Public school is called *folkeskolen* (literally, school for the people, normally translated into English as municipal primary and lower secondary school). Before compulsory schooling, children can attend preschool institutions. Public school is regulated by *Folkeskoleloven*<sup>1</sup> (the Folkeskole Act, part of the Education Act), which provides an overall framework for the school system. Public schools are administered by municipalities. Within the framework of the law, each of the 98 municipalities in Denmark is able to make decisions about its public schools, including decisions about economic resources and the structure of the school system within the municipality. The national curriculum is defined through the Common Objectives (further defined below), and each municipality is responsible for ensuring that its schools meet these objectives.<sup>2</sup> Each school has its own school board comprising mostly parents but also including students, teachers, school management, and, if desired, a representative from the municipality. The municipality can delegate decisions to the school board, but it must ensure that each school meets relevant legal requirements.<sup>3</sup> The school board conducts its activities within the objectives and framework set by the municipality and can establish general principles for all aspects of the school's activities except affairs concerning individual staff or students. A school may consist of two or more geographically separate departments that share a school principal and a school board.<sup>4</sup> The language of instruction is Danish.

Since the introduction of compulsory education in Denmark in 1814,<sup>5</sup> private schools have also formed part of the Danish education tradition. Private schools are regulated by the Private Independent Schools Act.<sup>6</sup> This act states that to receive public funding,<sup>a</sup> a private school must be economically independent (a self-governing institution), formulate its own core values, and make these values public. Private schools should provide education that meets the standard of public

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<sup>a</sup> According to the Private Independent Schools Act, provided they are independent and self-governing institutions, private schools receive an amount per full-time equivalent student. In the 2018–2019 school year, this amount was equivalent to 75 percent of the average funding for a student in public school.

education, as defined by the Folkeskole Act. They should deliver this education according to their own core values and within the framework defined by the Folkeskole Act and the Private Independent Schools Act. The Ministry of Education monitors whether private schools meet these requirements and can sanction a school by withdrawing public funding. Students in Grades 8 and 9 (ages 14 to 16) in private school are offered midterm examinations, and students in private school take the same school leaving examinations as students in public school, unless the school has notified the Ministry of Education that, because of its specific values, it does not conduct exams.

At the beginning of the 2018–2019 academic year, approximately 704,600 students were enrolled in primary and lower secondary schools in Denmark, including approximately 35,400 students in optional Grade 10. Among students in Grades 0 to 9, 78.8 percent attended public schools, 17.8 percent attended private independent schools, 1.4 percent attended continuation schools, and 2 percent received instruction in other education contexts (for example, in special education schools, in treatment centers, or at home).<sup>7</sup>

The Danish school system is comprehensive, as it includes preprimary (Grade 0 in Denmark, corresponding to a preschool or kindergarten class), primary (Grades 1 to 6, corresponding to International Standard Classification of Education [ISCED] Level 1),<sup>8</sup> and lower secondary (Grades 7 to 10, corresponding to ISCED Level 2) education. Although lower secondary education mostly covers Grades 7 to 9, primary and lower secondary education in Denmark include an optional Grade 10. Of the 49 percent of students who continued to optional Grade 10 in the 2018–2019 academic year, 24.9 percent did so at a public school, 8.0 did so at a private independent school, and 54.9 percent did so at a continuation school.<sup>9</sup> School grades are defined by age cohorts. There is no tracking and almost no grade retention. Excluding students in special needs classes or schools, the average class size overall was 21.2 students, with an average class size of 21.6 in public schools and 19.8 in private schools in the 2018–2019 academic year.<sup>10</sup> The average school size overall was 372 students (Grades 0 to 10), with an average school size of 491 students for public schools and 197 students across private independent schools and continuation schools.<sup>11</sup>

Since August 2009, compulsory education in Denmark has started at Grade 0. The school year starts in August, and children start Grade 0 in the calendar year in which they turn 6.<sup>12</sup> After Grade 0, compulsory education continues for another nine years. Once they have completed Grade 9 or 10, students can choose from a variety of youth education programs at ISCED Level 3 (preparatory study or professional qualification programs) that are academically or vocationally oriented, or both. The academically oriented track takes three years (Grades 10, 11, 12) and qualifies students for bachelor's programs at university or professional bachelor's programs at university colleges (these latter programs include teacher training). The vocationally oriented tracks have varying durations; they qualify students to work in a professional area and, in some cases, to embark on further education in professional bachelor's programs and academy profession programs.<sup>13</sup>

### *Use and Impact of TIMSS*

Since 2007, Denmark has participated in every cycle of TIMSS at Grade 4. All the cycles have been conducted by a research team at the Danish School of Education and, since 2011, they have been partly financed by the Danish Ministry of Education. Based on each cycle, a national report is published (in Danish) that presents the main findings from Denmark.<sup>14,15,16</sup> The Ministry of Education uses these reports as one of many resources to inform policy decisions. Secondary analyses of Danish results have been relatively sparse, and in the Danish education system, TIMSS has had considerably less influence on mathematics and science than the 1992 IEA reading literacy study and the subsequent and ongoing Progress In International Reading Literacy Study (PIRLS) have had on Danish literacy teaching.<sup>17,18</sup>

### The Mathematics Curriculum in Primary and Lower Secondary Grades

The current national policies on mathematics were published in the 2015 version of the Common Objectives. Overall, students are expected to develop mathematical skills and knowledge and to be able to apply these skills in everyday life in relation to further education, work, and community demands. They are expected to recognize the role of mathematics in historical, cultural, and social contexts and to take a critical stance to mathematics applications to effectively fulfill their civic and democratic responsibilities. Student learning should be based on both independent and cooperative experiences of how mathematics requires and promotes creativity, and how it involves instruments for problem solving, argumentation, and communication.<sup>19</sup>

The Common Objectives define the overall teaching objectives for mathematics at the end of Grades 3, 6, and 9. These objectives are divided into four fields of competence with corresponding competence goals (see Exhibit 1). In 2018, some of the objectives leading to the competence goals in the curriculum were changed from binding to indicative, though the overall objectives were maintained.<sup>20</sup> Because the intermediate achievement goals for Grade 6 are required national goals, they also serve as the guidelines for Grade 4 mathematics instruction. Within the framework of the Common Objectives, students may encounter specific skills, such as division, at different points of time within the grade range addressed by the competency goals in the curriculum, depending on the decisions made for the local curriculum by the municipality, the school board, or the teacher. In practice, the order in which the textbook presents the content often determines the order in which the student encounters specific skills.<sup>21</sup>

### Exhibit 1: Competence Goals, Mathematics

| Field of Competence         | After Grade 3   | After Grade 6  | After Grade 9  |
|-----------------------------|---|--|--|
| Mathematical Qualifications | Students are able to apply mathematics in real situations.                                  | Students are able to apply mathematics with comprehensive understanding in complex situations. | Students are able to apply mathematics with judgment in complex situations.                |
| Number and Algebra          | Students are able to develop methods of calculation with natural numbers.                   | Students are able to apply rational numbers and variables in descriptions and calculations.    | Students are able to apply real numbers and algebraic expressions in mathematical studies. |
| Geometry and Measurement    | Students are able to apply geometric concepts and measurements.                             | Students are able to apply geometric methods and calculate simple measurements.                | Students are able to explain geometric contexts and calculate measurements.                |
| Statistics and Probability  | Students are able to perform simple statistical surveys and express intuitive chance sizes. | Students are able to perform statistical surveys and determine statistical probabilities.      | Students are able to evaluate statistical surveys and apply probability.                   |

Each field of competence is divided into two to six fields of skills and knowledge with a progression in difficulty level from Grade 3 to Grade 9. As not all students are expected to meet the requirements of the Common Objectives, some of the elements in the fields of skills and knowledge are highlighted as priority points (in Danish, *Opmærksomhedspunkter*; in English, literally, points for attention). These points are deemed the most important in the Common Objectives, and every student is expected to meet them.<sup>22</sup>

As Exhibit 1 shows, mathematics is divided into four fields of competence. These fields are divided into several subcategories, which are in turn divided into three phases (the end of Grades 3, 6, and 9, respectively). For subcategories including one or more priority points in the list below, an asterisk (\*) indicates that the subcategory should be addressed by Grade 3, a dagger (†) indicates it should be addressed by Grade 6, and a double dagger (‡) indicates it should be addressed by Grade 9:<sup>b,23,24</sup>

- Mathematical Qualifications:
  - Problem solving
  - Modeling
  - Reasoning and thinking
  - Representation and treatment of symbols
  - Communication†
  - Mathematical tools

<sup>b</sup> For a more comprehensive description of each area, please refer to the Common Objectives or the translation of the elements herein described in the TIMSS 2015 Encyclopedia entry for Denmark, as these areas were unchanged when TIMSS 2019 was conducted.

- Numbers and Algebra
  - Numbers\*‡
  - Methods of calculation\*†
  - Algebra (Grades 3 and 6)
  - Equations (Grade 9)
  - Formulas and algebraic expressions (Grade 9)‡
  - Functions (Grade 9)
- Geometry and Measurement
  - Geometric properties and relationships
  - Geometric drawing
  - Location and movement in the coordinate plane
  - Measurement\*
- Statistics and Probability
  - Statistics
  - Probability

## The Science Curriculum in Primary and Lower Secondary Grades

In primary school (Grades 1 to 6), science is taught in the integrated subject Nature and Technology (*Natur/Teknologi*). After Grade 6, science is no longer taught as an integrated subject; in Grades 7 to 9, students are taught geography, biology, and physics/chemistry as three separate subjects, building on the teaching in the previous science subject (*Natur/Teknologi*).<sup>25</sup>

In the 2015 version of the Common Objectives, the curricula for Nature and Technology are defined as teaching objectives. Yet in 2018, some of the objectives leading to the competence goals were changed from binding to indicative.<sup>26</sup> The teaching objectives for Nature and Technology are organized in pairs of grades: Grades 1 to 2, Grades 3 to 4, and Grades 5 to 6.

The overall aim of Nature and Technology is that students develop competencies within the subject and thereby gain an insight into how science contributes to our understanding of the world. Teaching should build on the students' own experiences, observations, and experiments to provide them with practical skills, creativity, and the ability to cooperate. This process should develop the students' understanding of the interaction between humans and nature and encourage them to engage and act in relation to sustainable development.<sup>27</sup>

Learning objectives in Nature and Technology are organized according to the following four fields of competence:<sup>c</sup>

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<sup>c</sup> Please note that the Common Objectives for science (*Natur/Teknologi*, Grades 1 to 6; biology, geography, or physics/chemistry, Grades 7 to 9) do not include specific priority points (*Opmærksomhedspunkter*), as it is the case for mathematics as described above.

## Exhibit 2: Fields of Competence in Science

| Fields of Competence | After Grade 2   | After Grade 4  | After Grade 6  |
|----------------------|---|--|--|
| Inquiring            | Students can conduct simple experiments based on his/her own and others' questions. | Students can conduct simple inquiries based on his/her own expectations.     | Students can design experiments based on emerging hypothesis formation.            |
| Modeling             | Students can use lifelike models.   | Students can apply models with an increasing level of abstraction.           | Students can design simple models.   |
| Perspectivizing      | Students can recognize nature and technology in everyday life.                      | Students can relate nature and technology to other contexts.                 | Students can relate nature and technology to the outside world and current events. |
| Communicating        | Students can describe his/her own examinations and models.                          | Students can describe simple problems within natural science and technology. | Students can communicate about nature and technology.                              |

Each field of competence is divided into three to six fields of skills and knowledge (*færdigheds- og vidensområder*) with teaching objectives for and expected progression between Grades 2, 4, and 6. Some fields of skills and knowledge occur in only one field of competence, and some occur in more than one.<sup>28,29</sup>

- Across fields of competence (Inquiring, Modeling, Perspectivizing)
  - Inquiring/modeling/perspectivizing in science
  - Technology and resources
  - Human beings
  - Organisms (Grade 2)
  - Nature, locally and globally (Grade 4)
  - Nature and environment (Grade 6)
  - Water, air, and weather (Grades 2 and 4)
  - Matter and energy (Grade 6)
- Across fields of competence (Modeling, Perspectivizing)
  - The Earth and the Solar System (Grade 4)
  - Transformation of the Earth (Grade 6)
- Communicating
  - Presentation
  - Knowledge of subject-specific vocabulary
  - Academic reading and writing

Geography, biology, and physics/chemistry, which are taught from Grades 7 to 9, are included in the final exams that complete *folkeskolen*.<sup>30</sup> Through these subjects, the students should develop competencies within the discipline and thereby gain an insight into how each subject contributes to our understanding of the world. The three subjects ought to extend the students' learning from prior instruction in Nature and Technology. Teaching should build on the students' own

observations and investigations, including through field work, and foster their interest and curiosity in the subject and in science and technology in general so that they are keen to learn more. Students should come to the realization that science and technology are part of our culture and worldview and thereby further develop their sense of responsibility for nature and the use of natural resources. In this way, students can increase their confidence in their ability to decide and act in relation to sustainable development and human interaction with nature.<sup>31,32,33</sup>

## Professional Development Requirements and Programs

There are no official requirements for the ongoing professional development of teachers. The university colleges provide a range of further education courses ranging from one-day workshops to diploma and master's programs constituting 15 or 60 ECTS points. Private consultants also provide a wide array of short courses, though these are often less directed at specific subject content. The provision of these professional development opportunities is primarily determined by the budget allocated to these kinds of activities at the specific school or municipality.

Although the Education Act states that teachers in public schools (*folkeskoler*) must hold a professional bachelor of education degree approved by the Danish Ministry of Education,<sup>34</sup> in recent years, there has been an increasing focus on the number of teachers without relevant teaching qualifications in the academic subjects they teach. In the 2018–2019 academic year, 87.6 percent of classes taught in public schools were taught by a teacher with relevant qualifications in the specific subject, yet this number disguises a significant amount of variation between subjects. In mathematics, 93.8 percent of teachers had relevant qualifications in the subject, while, in Nature and Technology, this figure was 69.7 percent. For the lower secondary science classes (Grades 7 to 9), the numbers varied for the three subjects: 97.2 percent in physics/chemistry, 86.9 percent in biology, and 77.1 percent in geography. The 2018–2019 figure of 87.6 percent represents an increase from 79.6 percent in 2012–2013.<sup>35</sup> This increase can be partly explained by the fact that school principals are able to assess whether a teacher has the necessary qualifications to teach a specific subject, and they can make this decision based on formal and informal qualifications. For example, if a teacher has not studied a specific subject as part of his/her bachelor's degree but has many years' of teaching experience in the subject, he/she can still be deemed qualified to teach the subject based on experience.<sup>36</sup>

## Monitoring Student Progress in Mathematics and Science

Over the last two decades, there has been an increased focus on monitoring student progress in public schools in Denmark.<sup>37</sup> The current Folkeskole Act (*Folkeskoleloven*) provides regulations for monitoring the individual student's progress and communicating this progress to the student's parents. The act also provides regulations for the general monitoring of progress in relation to the individual public school and the administrative unit of the school system, the local municipalities.<sup>38</sup>

According to the Education Act, the student and his or her parents should be regularly notified about the student's overall progress by the teachers, and, if relevant, also by the school principal. This information includes a written presentation of the student's results in national tests.<sup>39</sup> In mathematics, national tests take place in Grades 3, 6, and 8, and, in physics/chemistry, they take place in Grade 8. Schools have the opportunity to use the national test system for optional tests in biology and geography in Grade 8. There is no national test in Nature and Technology. As part of their teaching, schools are obliged to continuously evaluate the progress of each student in relation to the curriculum described by the Common Objectives and to use this information as a tool to formatively guide the student. Notification of the parents must be based on this ongoing monitoring of student progress. Furthermore, the continuous monitoring of students should be included in the development of the individual student plans, introduced in 2009, which describe how each student can benefit from classroom instruction and how parents and the school can support each student's educational development.<sup>40</sup>

From Grade 8, student monitoring includes term marks at least twice a year until the final exams at the end of Grade 9 (or Grade 10 for students taking the optional extra year).<sup>41</sup> It also includes national test results and a national student well-being survey, which form the basis for monitoring at school and municipality level. According to the Education Act, the Minister of Education must report school level results in national tests to the school and the municipality, including results corrected to reflect students' social backgrounds. The construction and function of these national tests has been the subject of intense debate in recent years, and the Minister of Education has announced that she intends to change the test system.<sup>42</sup> However, the details of these changes were however not available at the time of writing.

Along with national test results and the well-being survey, many municipalities and schools monitor students' progress in other ways. The design of these monitoring systems varies between municipalities and can also vary between schools within a municipality. However, the monitoring systems tend to focus on literacy and numeracy and only include science subjects to a minimal degree (if at all). They are often based on locally used test systems that are commercially available standardized tests in mathematics.<sup>43</sup>

## Special Initiatives in Mathematics and Science Education

In 2018, the Danish government launched a National Science Strategy with the purpose of aligning teaching in the science subjects across primary, secondary, and tertiary education. The strategy also aimed to strengthen the collaboration between education and industry. One of the strategy's objectives is to increase the number of students who choose science, technology, engineering, and mathematics (STEM) subjects in secondary school and pursue STEM-oriented vocational training programs. Another objective is to increase the number of students who achieve a high proficiency level in STEM subjects in compulsory education. The strategy includes several initiatives at the different education levels. At primary level, the main initiatives are to increase the focus on general educational aspects of science, including introducing students to the basic principles of natural

science, important natural scientists, and landmark discoveries and interventions, and to strengthen teacher training in the natural science subjects.<sup>44</sup>

As part of the strategy, a new subject called understanding technology (*teknologiforståelse*) has been introduced as a test subject in 46 public schools for the 2018–2019 and 2020–2021 academic years. This new subject encompasses four areas of competence: Digital Empowerment; Computational Thinking; Digital Design; and Technological Capacity.<sup>45</sup>

In December 2019, the Ministry of Children and Education announced the creation and financing of a new research center focusing on the development of mathematics teaching, *Nationalt center for udvikling af matematikundervisning*.<sup>46</sup> This new center is based at the Danish School of Education, Aarhus University, and will be financed for a period of five years.<sup>47</sup>

Besides public initiatives, some private foundations have also launched initiatives to strengthen teaching in STEM subjects or improve teachers' continuing and further education in these subjects.<sup>d</sup>

## Suggested Readings

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<sup>d</sup> Besides general funding opportunities, private funding counts larger donations for development of teaching and learning. See, for example, <https://life.dk/om-life/>, <https://www.apmollerfonde.dk/folkeskolen/om-donationen/>

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