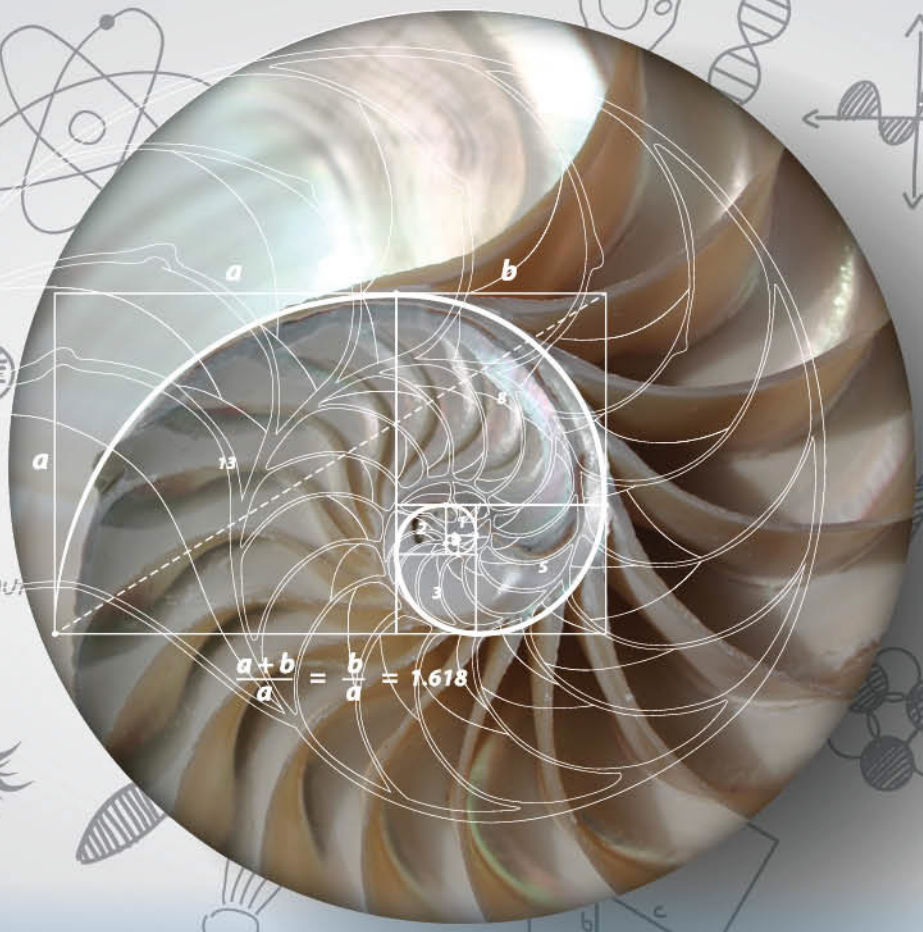
European Commission

Increasing achievement and motivation in mathematics and science learning in schools

Eurydice report



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CHAPTER 3: INSTRUCTION TIME

Learning requires time. Time is an essential aspect of the 'Carroll model' of school achievement (see Carroll, 1989), in which three of the five explanatory variables can be expressed in terms of time: (1) the time a student needs to accomplish a task or learning unit (aptitude), (2) the time that is provided for learning, by the school curriculum for instance (opportunity), and (3) the time a student is willing to spend on a task or learning unit (perseverance).

This chapter focuses on the time allocated by education authorities to teach mathematics and science. In other words, it concerns the 'opportunity to learn' – to use Carroll's term – provided by education authorities. More precisely, it examines how much time schools are required to devote to teaching mathematics and science, as set by law (Phelps et al., 2012).

Although there is no doubt that time is important for learning, there is very little evidence on the optimal instruction time to be allocated to curriculum subjects in general and to mathematics and science in particular (Prendergast and O'Meara, 2016). Nonetheless, a few empirical studies have looked into the effect of instruction time for mathematics or science on students' academic achievement. These studies can be categorised into three groups (Meyer and Klaveren, 2013).

The first group of studies relate instruction time differences to variations in student achievement. Lavy (2015), for example, using Programme for International Student Assessment (PISA) 2006 data, shows that instruction time has a positive and significant relationship with students' academic achievement. The same study also reveals that the effect of instruction time is larger for girls, students with a migrant background and students from a low socioeconomic background. Further analyses indicate that the productivity of instruction time is higher in schools operating under accountability measures and in schools with autonomy in budgetary decisions and the recruitment/dismissal of teachers (Lavy, 2015).

The second group comprises studies that take advantage of policy changes to conduct comparative analysis. Jensen's (2013) empirical research carried out in Denmark analyses the effect of increased instruction time in reading and mathematics on student achievement in these subjects following a policy reform in 2003. The findings show that the increase in instruction time had a positive effect on student achievement in mathematics, but not in reading. To explain this result, Jensen suggests that, as opposed to reading, educational exercises in mathematics mostly take place in school, which makes students' academic achievement in this subject more sensitive to variations in instruction time (Jensen, 2013).

The last empirical research group contains studies that evaluate the effect of specific education programmes that increase instruction time (e.g. extended-day or extended-year programmes). The study by Battistin and Meroni (2016) investigates the short-term effects of a large-scale intervention, which provided additional instruction time in mathematics and Italian language to non-randomly selected classes in particularly low-achieving lower secondary schools in southern Italy. The study came to similar conclusions to Jensen's (2013): this intervention had positive effects on average test scores in mathematics, but not in reading literacy. The findings suggest that additional instruction time helps students increase their basic knowledge, which they can use more successfully in normal teaching hours.

Conversely, Meyer and Klaveren (2013) found that an extended-day programme applied in seven Dutch elementary schools for 3 months had no significant effect on student achievement in either mathematics or reading. They hypothesise that the short duration of the programme could partly explain its ineffectiveness. They also stress the importance of appropriate educational practices for the

success of such educational interventions. However, before drawing any definite conclusions, Mayer and Klaveren (2013) suggest that such extended-day / extended-year programmes should be implemented in different educational contexts and carefully evaluated.

Overall, research evidence seems to point to the positive effect of increased instruction time, particularly in mathematics. However, the significance of such an outcome must be carefully weighed against the limited number of research studies, especially those investigating science. Furthermore, instruction time alone cannot account for students' academic achievement. As highlighted by Carroll (1989, p. 27), quoting Gage (1978), 'time is, in a sense, a psychologically empty concept'. What matters is what happens during the lessons. Scholars investigating the relationships between instruction time and students' academic achievement emphasise the quality of teaching as a key factor in students' successful learning (Lavy, 2015; Meyer and Klaveren, 2013; Phelps et al., 2012). In other words, as stated by Prendergast and O'Meara (2016, p. 15), 'adding hours to the school day or days to the school year could have limited return if the time is not used efficiently'.

The quality of teaching depends on a wide range of factors, including appropriate teaching methods and material, an adequate curriculum, and well-trained teachers and school leaders. Some of these aspects are reviewed in other parts of this report. The significance of the time factor, which is addressed in this chapter, is particularly interesting in relation to teaching. If learning takes time, teaching does too, especially when adopting particular teaching approaches. For example, teaching methods such as student-centred approaches placing students at the centre of the teaching process, as opposed to the more traditional frontal and teacher-centred approach, require more time (Leong and Chick, 2011). The same applies to teaching methods focusing on learning processes rather than learning outputs (Prendergast and O'Meara, 2016).

This chapter investigates the instruction time allocated to the teaching of mathematics and science in schools in the different European education systems. The data relate to the intended instruction time, i.e. instruction time determined by top-level education authorities in official documents such as the national curriculum or other similar steering documents for primary and lower secondary education ([49]). In order to fully comprehend the data, this chapter also briefly touches upon issues relating to curriculum organisation (i.e. whether mathematics and/or science are taught as subjects on their own or part of broader knowledge areas; see also Chapter 4, Section 4.1) and how top-level education authorities and schools share the responsibility for designing the curriculum ([50]).

The chapter will present instruction time as it was originally planned by education authorities for the 2020/2021 school year. The effect of school closures due to the COVID-19 pandemic is only included in the figures if the change in instruction time was incorporated in legislation already before the start of the school year (see Chapter 2 for more details on school closures and distance learning). This is the

([49]) The data are collected jointly by Eurydice and the Organisation for Economic Co-operation and Development (OECD) Network for the Collection and Adjudication of System-Level Descriptive Information on Educational Structures, Policies and Practices (NESLI) on a biennial basis. The data presented in this report come from the 2020/2021 data collection. In addition, data for Luxembourg (*enseignement secondaire général*), Slovakia (*8-ročné gymnázium*) and Switzerland were collected by Eurydice for the purpose of this report.

The data for Spain are based on national and regional regulations on the curriculum and school calendars. Statistics on the number of students per grade and autonomous community are used to calculate the weighted averages, as reported by the statistics office of the Ministry of Education and Vocational Training (2018/2019 reference year).

The data for Germany are based on a weighted average and are calculated by the Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the *Länder*. The *Länder* provide data on the compulsory core curriculum. The averages are weighted by the number of students across each type of school. Data from Lower Saxony and North Rhine-Westphalia (only for primary education) are missing in the calculation.

([50]) For additional information on instruction time in schools in Europe, please consult the biennial Eurydice report on this topic (European Commission / EACEA / Eurydice, 2021a).

case of three countries: Malta, Portugal and North Macedonia, where the school year started later than usual (European Commission / EACEA / Eurydice, 2021a, p. 15). For other systems with some periods of complete school closure (see Figure 2.1), changes in instruction time are not included in the figures.

3.1. School autonomy in allocating instruction time

The instruction time allocated to subjects is an important feature of the school curriculum. In all European countries, top-level education authorities define the minimum total instruction time for all curriculum subjects; they also stipulate that mathematics ([51]) and science ([52]) are compulsory subjects in primary and lower secondary education ([53]). Before analysing instruction time allocated to mathematics and science in more detail, this section discusses some aspects of school autonomy and curriculum organisation that allow better interpretation of the data.

Top-level education authorities are in fact not the sole decision-makers in allocating instruction time to curriculum subjects. In a substantial number of countries, schools / local authorities enjoy some autonomy in deciding how instruction time should be allocated through the grades (vertical flexibility) and across curriculum subjects (horizontal flexibility), and which subjects should be part of the compulsory curriculum (subject flexibility).

Vertical flexibility refers to cases where top-level education authorities determine the total number of hours for a specific subject to be taught across more than one grade, without specifying how these hours should be distributed (European Commission / EACEA / Eurydice, 2021a). This concerns seven countries (Czechia, Estonia, Lithuania, Finland, Sweden, Iceland and Norway). In Estonia, for example, the Ministry of Education and Research determines instruction time for each subject in each of the three education stages structuring compulsory education, and schools are free to allocate this amount of instruction time to each grade.

Horizontal flexibility concerns cases where top-level education authorities set a total number of teaching hours for a range of compulsory subjects within the same grade. Schools / local authorities decide how much time to allocate to each subject (European Commission / EACEA / Eurydice, 2021a). This type of school autonomy exists to varying degrees in six countries (Belgium, Denmark, Italy, the Netherlands, Poland and Portugal). In Belgium (Flemish Community), for instance, it concerns the full range of compulsory subjects in primary and lower secondary education, whereas in Poland it applies to only the first three grades of primary education. The horizontal flexibility in Italy applies to almost all compulsory subjects in primary education. Therefore, in these education systems, instruction time for mathematics and science can vary across schools.

Besides vertical and horizontal flexibility, schools / local authorities in some countries also enjoy some subject flexibility (i.e. schools / local authorities choose some of the subjects that are part of students' compulsory curriculum). This concerns 14 education systems ([54]) in primary and lower secondary

([51]) The common Eurydice–OECD data collection on instruction time defines mathematics as a subject category covering all numeracy skills and subjects such as arithmetic, algebra, geometry and statistics (European Commission / EACEA / Eurydice, 2021a); this chapter uses this definition.

([52]) The common Eurydice–OECD data collection on instruction time defines science as a subject category including subjects such as science, physics, chemistry, biology, environmental sciences and ecology (European Commission / EACEA / Eurydice, 2021a); this chapter uses this definition. However, science as a broad subject category might include slightly different subjects according to national curricula, such as geography. Please see Annex I of this report.

([53]) Some grades in Ireland (lower secondary schools enjoy great autonomy in defining the school curriculum – see at the end of this section) and Hungary (science is not taught in grade 1) make exception to that rule.

([54]) Belgium (French and Flemish Communities), Czechia, Estonia, Ireland, Greece, Spain, Latvia, Hungary, Portugal, Slovakia, Finland, Albania and Montenegro.

education. In all of them, subject flexibility applies to less than 20% of total instruction time except in Ireland (62%) and Spain (24%) in lower secondary education. Typically, schools / local authorities use this flexible instruction time to offer subjects that are not part of the curriculum defined by top-level education authorities but respond to the particular needs and circumstances of the local school community. These subjects might be an additional foreign language or an advanced course in mathematics. The particularly high percentage in Ireland is due to the large degree of school autonomy granted to schools following the 2014 curriculum reform (European Commission / EACEA / Eurydice, 2021a).

3.2. Instruction time for mathematics and science in relation to other knowledge areas

The curriculum, especially at primary level, is not always (fully) built on common disciplines such as science, mathematics, social studies and ICT. Instead, it is organised around broader knowledge areas including several traditional disciplines. Specific instruction time arrangements suggest that such curriculum organisation exists in some countries.

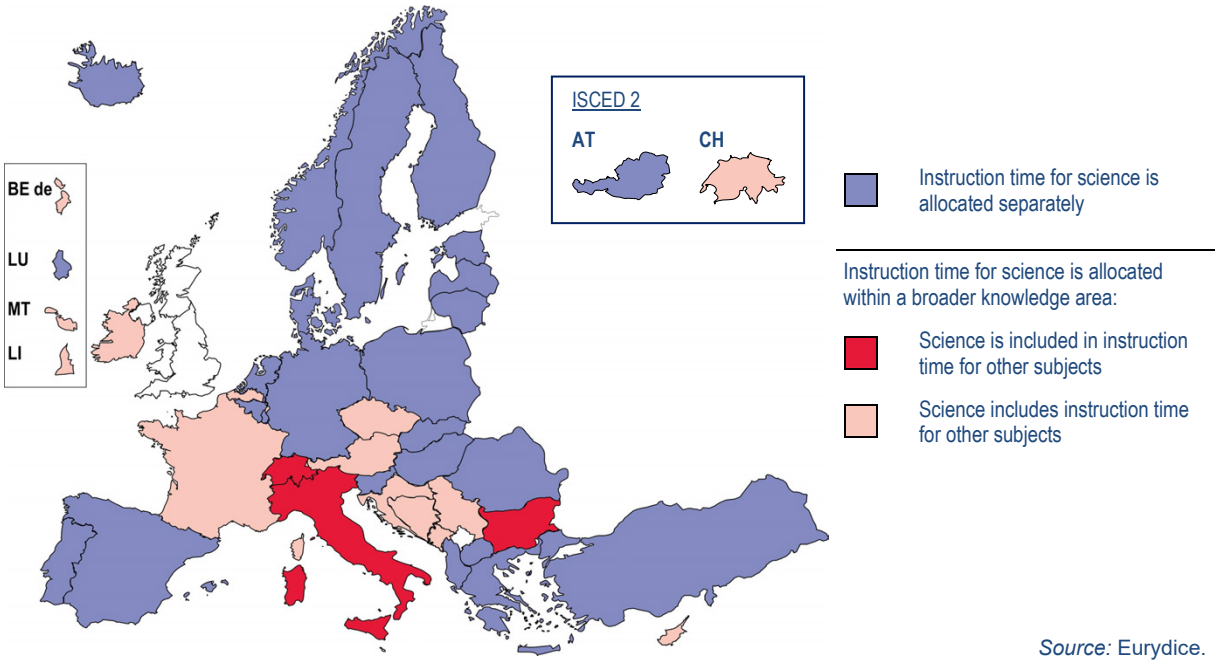
As Figure 3.1 indicates, in most education systems, top-level education authorities define instruction time for science separately. In other words, instruction time for science neither is included in nor includes instruction time for other subjects or knowledge areas.

However, in 16 education systems, top-level education authorities allocate instruction time for science together with other curriculum subjects in one or more grades in primary or lower secondary education. In nearly all of these systems, instruction time for science, as defined by top-level education authorities, includes instruction time for social studies (Czechia, France, Croatia, Austria, Bosnia and Herzegovina, Liechtenstein, Montenegro and Serbia) and/or technology (Belgium (German-speaking and Flemish Communities), Ireland, France, Cyprus, Malta, Austria and Montenegro). In France, in addition to the two previously cited subjects, instruction time for science comprises learning time for ICT. In all these cases, the focus of these broad knowledge areas is somewhat placed on science.

The reverse is found in Bulgaria and Italy, where broad knowledge areas including science focus on social studies (Bulgaria) and mathematics (Italy). Finally, Switzerland shows a mixed picture: in primary education, a broad knowledge area focusing on social studies includes instruction time for science and technology, while in lower secondary education instruction time for science includes taught time for technology.

In about half of the aforementioned cases, this particular instruction time arrangement for teaching science concerns all grades of primary education. In Bulgaria, Cyprus, Bosnia and Herzegovina, and Montenegro, it applies only to some grades at primary level, whereas in Belgium (German-speaking Community), Switzerland and Liechtenstein it concerns both primary and lower secondary education. In France, the number of grades in which it applies varies depending on the subject concerned (social studies, ICT and technology). Finally, top-level education authorities in Italy do not define instruction time for science as a separate subject, but define it for a broader knowledge area comprising mathematics and science.

Figure 3.1: Allocation of instruction time for science, ISCED 1-2, 2020/2021



Source: Eurydice.

Explanatory notes

The main purpose of the map is to show whether instruction time for science is allocated separately or it integrates (or is integrated in) instruction time for other subjects.

This map aims to provide an overall representation of primary and lower secondary education together. The picture provided for education systems where science integrates (or is integrated in) other subjects might concern only some grades in primary or lower secondary education.

Country-specific notes

Belgium (BE de, BE nl): Top-level education authorities do not determine instruction time for individual subjects (horizontal flexibility), but indicate that technology should be taught with sciences in primary education (Belgium (Flemish Community)) or in both primary and lower secondary education (Belgium (German-speaking Community)).
Poland: For ISCED 1, top-level education authorities do not determine instruction time for individual subjects (horizontal flexibility) in the first three grades, so this categorisation applies only to the last grade of primary education (grade 4).
Switzerland: The map shows the situation in the 21 German-speaking and bilingual cantons, which constitute most of Switzerland. In the French-speaking cantons, science is a standalone subject in most grades.

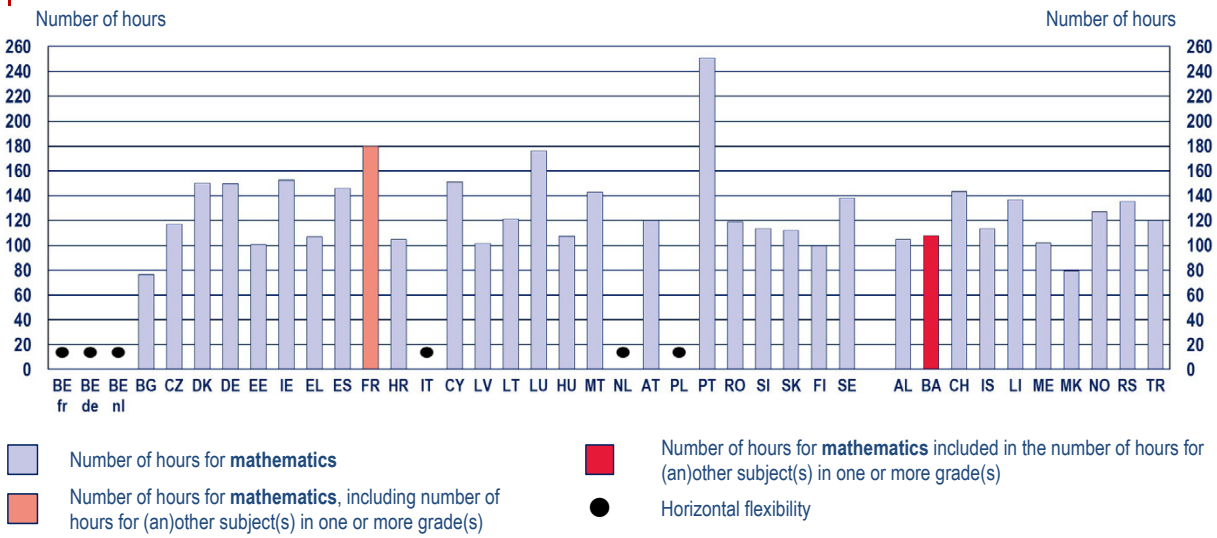
In contrast to taught time for science, instruction time for mathematics is allocated to the teaching of only mathematics in all countries except France, Italy, and Bosnia and Herzegovina. In France, it comprises the time allocated to teach ICT (a cross-curricular subject) in the last two grades of primary education; in Italy, it includes instruction time for science, as mentioned above. Finally, in Bosnia and Herzegovina, top-level education authorities define a certain amount of instruction time to teach both reading / writing / literature and mathematics in the first grade of primary education.

3.3. Instruction time for mathematics

This section discusses the instruction time allocated to teach mathematics in primary and lower secondary education. It also examines the relationship between the number of hours allocated to mathematics on the one hand and instruction time for mathematics as a proportion of total instruction time on the other hand. All indicators present the minimum amount of instruction time per notional year (i.e. the total teaching load for mathematics for a given education level divided by the number of years of that education level). This calculation removes variations resulting from the differences in the number of grades in each education level across Europe.

At primary level, instruction time for mathematics per notional year ranges from 100 to 120 hours in around half of the education systems for which there are data (see Figure 3.2); in the other half, it is greater than 120 hours, with Portugal having the highest number of taught hours (251 hours) ([55]). Bulgaria and North Macedonia are the only countries where the amount of instruction time stands below 100 hours per notional year (76 and 80 hours respectively).

Figure 3.2: Instruction time for mathematics per notional year, ISCED 1, 2020/2021



BE fr	BE de	BE nl	BG	CZ	DK	DE	EE	IE	EL	ES	FR	HR	IT	CY	LV	LT	LU	HU	MT
●	●	●	76	117	150	150	101	153	107	146	180	105	●	151	102	122	176	107	143
NL	**AT**	**PL**	**PT**	**RO**	**SI**	**SK**	**FI**	**SE**		**AL**	**BA**	**CH**	**IS**	**LI**	**ME**	**MK**	**NO**	**RS**	**TR**
●	120	●	251	119	114	112	100	138		105	108	143	113	137	102	80	127	135	120

Source: Eurydice.

Explanatory notes

Instruction time per notional year in primary education: This corresponds to the total taught time in primary education divided by the number of years in primary education.

Horizontal flexibility: Top-level education authorities determine the total instruction time for a group of subjects within a specific grade. Schools / local authorities are then free to decide how much time to allocate to individual subjects.

When horizontal flexibility applies to some of the grades in primary level, those grades are excluded from the calculation of notional years.

Country-specific notes

Denmark: Data correspond to the taught time for the last six grades of primary education (accommodating 7-13-year olds), which comprises seven grades, so taught time is divided by 6. Horizontal flexibility applies in the first grade (accommodating 6-year olds).
France: Data include instruction time for ICT in the last two grades of primary education.
Poland: In the first three grades of primary education, which comprises four grades, horizontal flexibility applies. Instruction time is defined for mathematics only in the last grade of primary education.
Portugal: Data correspond to the taught time for the first four grades of primary education, which comprises six grades, so taught time is divided by 4. Horizontal flexibility applies in the last two grades.
Bosnia and Herzegovina: Data do not include instruction time for mathematics in the first grade.
Switzerland: Data show the situation of the 21 German-speaking and bilingual cantons, which constitute most of Switzerland.
North Macedonia: Owing to the COVID-19 pandemic, the number of instruction days was reduced from 180 to 159. Moreover, the length of lessons was shortened by 10 minutes (distance learning), further reducing the total instruction time. The 2020/2021 teaching programme was realised.

([55]) It should be noted that Portugal's data are calculated based on the first four grades of primary education, which comprises six grades.

In addition to Portugal, a few countries provide 150 hours or more for the teaching of mathematics per notional year: Denmark, Germany, Ireland, France, Cyprus and Luxembourg. In France, instruction time for mathematics includes instruction time for ICT (a cross-curricular subject) in the last two grades of primary education. Conversely, in Bosnia and Herzegovina, instruction time for mathematics in grade 1 is part of the teaching load for reading, writing and literature.

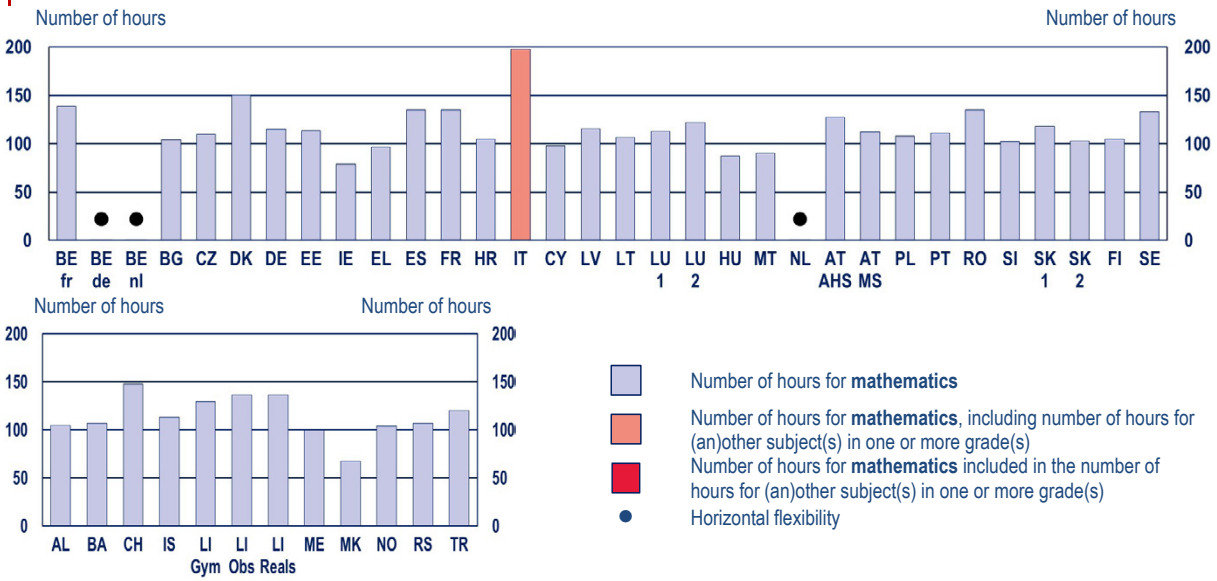
As explained above, in Belgium, Italy, the Netherlands and Poland, schools decide how to allocate the total instruction time across curriculum subjects for all or most grades of primary education (horizontal flexibility). In Poland, this horizontal flexibility concerns 3 out of 4 years in primary education. In Denmark and Portugal, schools have this autonomy in some years at primary level (the first grade (out of seven) accommodating 6-year olds in Denmark and the last two (out of six) in Portugal).

In lower secondary education, the minimum instruction time per notional year for mathematics ranges from 100 to 120 hours in around 21 education systems/tracks (see Figure 3.3). It stands below 100 hours in six countries: Ireland, Greece, Cyprus, Hungary, Malta, and North Macedonia. At the other end of the range, 12 education systems/tracks provide more than 120 hours per notional year for teaching mathematics, with Denmark offering the largest number of hours (i.e. 150 hours). Italy stands out, as instruction time for mathematics also includes taught hours for science.

Most education systems provide less instruction time to mathematics at lower secondary level than in primary education. This decrease is particularly significant (i.e. more than 50%) in Ireland and Portugal. In Germany, France, Cyprus, Luxembourg, Malta and Serbia, the decrease is around 20%. It has to be noted that these countries have a comparatively large number of taught hours in primary education. France needs to be singled out: despite an important drop (25%), it is still among the countries with a comparatively high amount of instruction time for mathematics in lower secondary education.

Some countries at the lower end of the range of taught hours in lower secondary education also have a relatively low amount of instruction time for mathematics in primary education. This is particularly the case in North Macedonia, and also to some extent in Bulgaria, Croatia, Finland, Albania and Montenegro, where around 100 hours per notional year are dedicated to the teaching of mathematics in both primary education and lower secondary education.

Figure 3.3: Instruction time for mathematics per notional year, ISCED 2, 2020/2021



BE fr	BE de	BE nl	BG	CZ	DK	DE	EE	IE	EL	ES	FR	HR	IT	CY	LV	LT	LU 1	LU 2	HU	MT	NL
139	●	●	104	110	150	115	114	79	97	135	135	105	198	98	116	106	113	122	87	90	●

AT AHS	AT MS	PL	PT	RO	SI	SK 1	SK 2	FI	SE	AL	BA	CH	IS	LI Gym	LI Obs	LI Reals	ME	MK	NO	RS	TR
128	113	108	111	135	102	118	103	105	133	105	107	148	113	130	137	137	100	68	104	107	120

Source: Eurydice.

Explanatory notes

Instruction time per notional year in lower secondary education: This corresponds to the total taught time in lower secondary education divided by the number of years in lower secondary education.

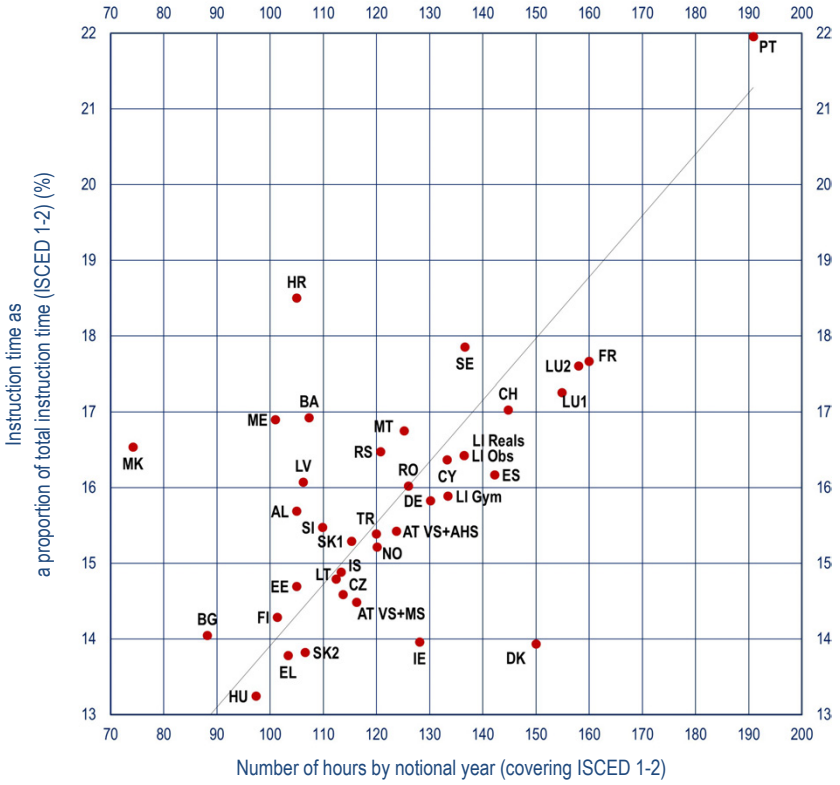
Horizontal flexibility: Top-level education authorities determine the total instruction time for a group of subjects within a specific grade. Schools / local authorities are then free to decide how much time to allocate to individual subjects.

Country-specific notes

Italy: Data include instruction time for science in the three grades of lower secondary education.
Luxembourg: LU1 corresponds to *enseignement secondaire classique* (classical secondary education); LU2 corresponds to *enseignement secondaire général* (general secondary education).
Austria: AHS corresponds to *Allgemeinbildende höhere Schule* (academic secondary school – grades 5–8) and MS corresponds to *Mittelschule* (compulsory secondary school – grades 5–8).
Slovakia: SK1 corresponds to the grades of lower secondary education (grades 5–9) in *Základná škola* (basic school); SK2 corresponds to grade 5 in *Základná škola* and the first four grades of *8-ročné gymnázium* (8-year grammar school). Calculations of instruction time for *8-ročné gymnázium* include data for the first year of ISCED 3.
Switzerland: Data show the situation of the 21 German-speaking and bilingual cantons, which constitute most of Switzerland.
Liechtenstein: LI Gym corresponds to *Gymnasium* (school type with advanced requirements); LI Obs corresponds to *Oberschule* (school type with basic requirements); LI Reals corresponds to *Realschule* (school type with intermediate requirements).
North Macedonia: Owing to the COVID-19 pandemic, the number of instruction days was reduced from 180 to 159. Moreover, the length of lessons was shortened by 10 minutes (distance learning), further reducing the total instruction time. The 2020/2021 teaching programme was realised.

A large number of taught hours dedicated to mathematics does not necessarily imply that the curriculum places a lot of emphasis on mathematics. Figure 3.4 intends to show whether a significant amount of instruction time corresponds to a comparatively significant weight of mathematics within the curriculum. More specifically, this figure presents the relationship between the aggregated number of hours in primary and secondary education for mathematics by notional year (x-axis) and instruction time for mathematics as a proportion of total instruction time in primary and lower secondary education (y-axis).

Figure 3.4: Instruction time for mathematics per notional year and as a proportion of total instruction time, ISCED 1-2, 2020/2021



Explanatory notes

Instruction time per notional year in primary and lower secondary education: This corresponds to the total taught time in hours in primary and lower secondary education divided by the number of years in primary and lower secondary education.

Horizontal flexibility: Top-level education authorities determine the total instruction time for a group of subjects within a specific grade. Schools / local authorities are then free to decide how much time to allocate to individual subjects.

The figure does not show education systems/tracks with horizontal flexibility in all or most grades of primary level and/or lower secondary level (i.e. Belgium, Italy, the Netherlands and Poland).

Source: Eurydice.

Country-specific notes

See Figures 3.2 and 3.3.

Austria: VS + AHS stands for *Volkschule* (primary school – grades 1–4) + *Allgemeinbildende höhere Schule* (AHS; academic secondary school – grades 5-8); VS + MS stands for *Volkschule* (primary school – grades 1–4) + *Mittelschule* (compulsory secondary school – grades 5–8).

As expected, the scatter plot shows a strong and positive relationship between the two sets of data. Most education systems are situated along the trend line going from Hungary (few notional hours and low percentage) to Portugal (large number of hours and high percentage) ([56]).

Considering this trend and the number of hours allocated to mathematics, education systems furthest from the trend line, namely those of Croatia, Bosnia and Herzegovina ([57]), Montenegro and North Macedonia, have a high percentage of instruction time dedicated to mathematics relative to the number of notional hours. In other words, despite a relatively lower number of taught hours (in comparison with other countries), their curriculums put relatively more emphasis on mathematics (in comparison with countries with a similar number of taught hours). The same observation can also be made about Latvia, Malta, Sweden, Albania and Serbia, although to a lesser extent.

The opposite seems much less frequent. In other words, only a couple of countries – Denmark and Ireland ([58]) – show a relatively low percentage of instruction time dedicated to mathematics in relation to the number of notional hours, compared with other countries.

([56]) The data for Portugal are calculated based on some of the grades in primary education (see Figure 3.2 and country-specific notes).

([57]) In Bosnia and Herzegovina, data do not include instruction time for mathematics in the first grade, which may partly explain the low amount of taught time.

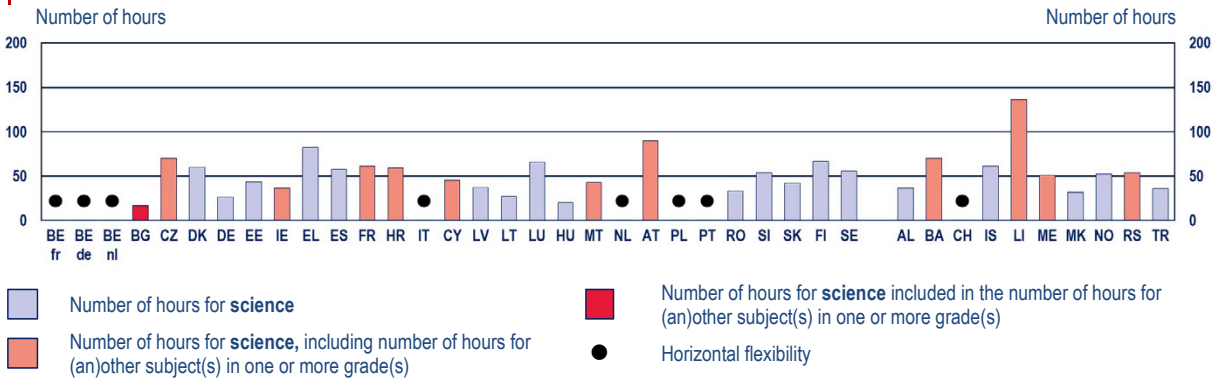
([58]) The data for Denmark are calculated based on some of the grades in primary education (see Figure 3.2 and country-specific notes).

3.4. Instruction time for science

This section focuses on science. It examines instruction time dedicated to it in primary and lower secondary education. In addition, as the previous section did for mathematics, it looks into the relationship between the number of hours dedicated to science and instruction time for science as a proportion of total instruction time in primary and lower secondary education. This analysis is helpful in apprehending how significant the teaching of science is in relation to the rest of the curriculum subjects.

Figure 3.5 presents the number of hours allocated to science per notional year in primary education. Focusing on the education systems that provide instruction time for science only, the number of taught hours per notional year ranges from 20 in Hungary to 82 in Greece. Comparatively, Greece has a particularly large number of hours, as the next country down on the scale (Finland) provides 67 hours to teach science at primary level. In most countries, the teaching load for science is situated between 30 and 60 hours per notional year. Countries falling below the lower end of this range are Germany, Lithuania and Hungary, while above the upper end of this range stand Luxembourg and Iceland, in addition to Greece and Finland.

Figure 3.5: Instruction time for science per notional year, ISCED 1, 2020/2021



BE fr	BE de	BE nl	BG	CZ	DK	DE	EE	IE	EL	ES	FR	HR	IT	CY	LV	LT	LU	HU	MT
●	●	●	17	70	60	26	44	37	82	58	61	59	●	45	38	27	66	20	43
NL	**AT**	**PL**	**PT**	**RO**	**SI**	**SK**	**FI**	**SE**		**AL**	**BA**	**CH**	**IS**	**LI**	**ME**	**MK**	**NO**	**RS**	**TR**
●	90	●	●	33	54	42	67	56		37	70	●	62	137	51	32	52	54	36

Source: Eurydice.

Explanatory notes

Instruction time per notional year in primary education: This corresponds to the total taught time in primary education divided by the number of years in primary education.

Horizontal flexibility: Top-level education authorities determine the total instruction time for a group of subjects within a specific grade. Schools / local authorities are then free to decide how much time to allocate to individual subjects.

Country-specific notes

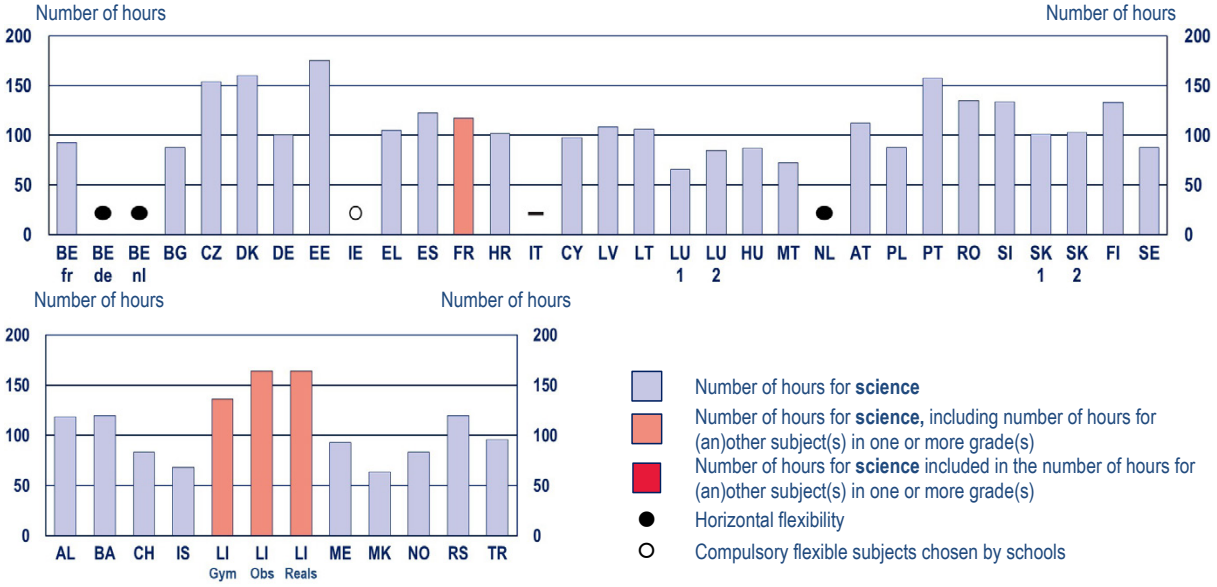
Bulgaria: Data do not include instruction time for science for the first two grades of primary education, which comprises four grades.
Czechia, Croatia, Liechtenstein and **Serbia**: Data include instruction time for social studies allocated in all grades of primary education.
Denmark: Data correspond to the taught time for the last six grades of primary education (accommodating 7-13-year olds), which comprises seven grades, so taught time is divided by 6. Horizontal flexibility applies in the first grade (accommodating 6-year olds).
Ireland and **Malta**: Data include instruction time for technology allocated in all grades of primary education.
France: Data include instruction time for social studies and ICT allocated in the first three grades of primary education, and instruction time for technology allocated in all grades of primary education.
Cyprus: In four out of the six grades of primary education, data include instruction time for technology.
Austria: Data include instruction time for social studies and technology allocated in all grades of primary education.
Poland: In the first three grades of primary education, which comprises four grades, horizontal flexibility applies. Instruction time is defined for science only in the last grade of primary education.
Bosnia and Herzegovina: In four of the five grades in primary education, data include instruction time for social studies.

Switzerland: In the 21 German-speaking and bilingual cantons, which constitute most of Switzerland, instruction time for science is integrated in instruction time for social studies. In the French-speaking cantons, science is a separate subject in most grades.
Montenegro: Data include instruction time for social studies in three of the five grades at primary level, and for technology in the first four grades at primary level.
North Macedonia: Owing to the COVID-19 pandemic, the number of instruction days was reduced from 180 to 159. Moreover, the length of lessons was shortened by 10 minutes (distance learning), further reducing the total instruction time. The 2020/2021 teaching programme was realised.

As discussed above (see Figure 3.1), instruction time for science, especially at primary level, can include instruction time for other subjects, particularly social studies and/or technology. This is the case for Czechia, Austria, Bosnia and Herzegovina, and Liechtenstein, which have the highest numbers of taught hours. At the other end of the scale, the very low amount of instruction time allocated to science in Bulgaria can also be explained by specific instruction time arrangements. Indeed, there are no teaching hours specifically for science as a separate subject during the first two years of primary education. Instruction time for science is included in a broader curriculum subject comprising science and social studies, with a slightly greater focus on social studies. Finally, amounts of instruction time for science in Ireland, Cyprus and Malta are relatively low (below 50 hours per notional year), considering that this time includes instruction time for technology (see country-specific notes below Figure 3.5).

Figure 3.6 illustrates the time devoted to science instruction in lower secondary education.

Figure 3.6: Instruction time for science per notional year, ISCED 2, 2020/2021



BE fr	BE de	BE nl	BG	CZ	DK	DE	EE	IE	EL	ES	FR	HR	IT	CY	LV	LT	LU 1	LU 2	HU	MT	NL
93	●	●	88	154	160	101	175	○	105	123	117	102	(-)	98	108	106	66	85	87	72	●

AT	PL	PT	RO	SI	SK 1	SK 2	FI	SE		AL	BA	CH	IS	LI Gym	LI Obs	LI Reals	ME	MK	NO	RS	TR
113	88	158	135	134	101	103	133	88		118	119	●	68	137	164	164	93	64	83	119	96

Source: Eurydice.

Explanatory notes

Instruction time per notional year in primary education: This corresponds to the total taught time in lower secondary education divided by the number of years in lower secondary education.

Horizontal flexibility: Top-level education authorities indicate the total instruction time for a group of subjects within a specific grade. Schools / local authorities are then free to decide how much time to allocate to individual subjects.

Compulsory flexible subjects chosen by schools: This corresponds to the total amount of compulsory instruction time indicated by the top-level authorities, which regional authorities, local authorities, schools or teachers allocate to subjects of their choice (or subjects they choose from a list defined by top-level education authorities).

Country-specific notes

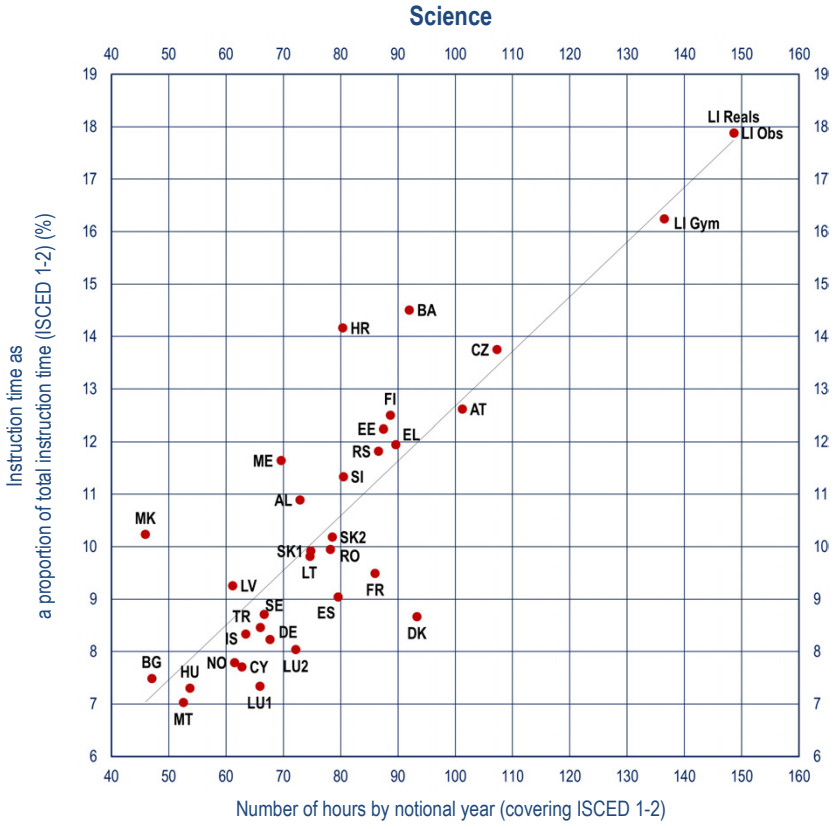
Ireland: Since the curriculum reform that started in 2014, schools have had considerable autonomy in designing their curricula. Concretely, it means that schools select their compulsory subjects (for instance science) from a large number of subjects. Schools also define the amount of instruction time to allocate to them. As for top-level education authorities, they determine the total compulsory instruction time and taught time for a few centrally selected subjects (i.e. mathematics, English, Irish, social studies, physical education and social, personal and health education).
France: Data include instruction time for technology in the first grade of lower secondary education.
Italy: Top-level education authorities do not define instruction time for science as a separate subject, but for a broader knowledge area comprising science and mathematics.
Luxembourg: LU1 corresponds to *enseignement secondaire classique* (classical secondary education); LU2 corresponds to *enseignement secondaire général* (general secondary education).
Slovakia: SK1 corresponds to the grades of lower secondary education (grades 5–9) in *Základná škola* (basic school); SK2 corresponds to grade 5 in *Základná škola* and the first four grades of *8-ročné gymnázium* (8-year grammar school). Calculations of instruction time for *8-ročné gymnázium* include data for the first year of ISCED 3.
Switzerland: Data show the situation of the 21 German-speaking and bilingual cantons, which constitute most of Switzerland.
Liechtenstein: LI Gym corresponds to *Gymnasium* (school type with advanced requirements); LI Obs corresponds to *Oberschule* (school type with basic requirements); LI Reals corresponds to *Realschule* (school type with intermediate requirements). Data include instruction time for social studies in all grades of *Oberschule* and *Realschule*. In *Gymnasium*, this is the case for the first three grades (out of four) of lower secondary education; top-level education authorities define instruction time separately for the two subjects in the last grade. This explains why *Gymnasium* has a lower amount of instruction time than the two other tracks: in the last grade of lower secondary education, in contrast to *Oberschule* and *Realschule*, data only include instruction time for science.
North Macedonia: Owing to the COVID-19 pandemic, the number of instruction days was reduced from 180 to 159. Moreover, the length of lessons was shortened by 10 minutes (distance learning), further reducing the total instruction time. The 2020/2021 teaching programme was realised.

As Figure 3.6 shows, the time devoted to science instruction increases substantially in lower secondary education. The amount of instruction time ranges from 64 hours in North Macedonia to 175 hours in Estonia. In most countries, the time spent on teaching science is greater than 100 hours per notional year. Besides North Macedonia, Luxembourg (*enseignement secondaire classique*), Malta and Iceland have particularly low amounts of instruction time for science (i.e. 66 hours, 72 hours and 68 hours respectively). Conversely, alongside Estonia, Denmark, Czechia, and Portugal provide the highest number of hours for teaching science (160 hours, 154 hours, and 158 hours respectively).

In comparison with primary education, the number of hours in lower secondary education is higher in all education systems, except in Luxembourg (*enseignement secondaire classique*) and Liechtenstein (*Gymnasium*), where the curriculum provides the same amount of instruction time for both levels. In around half of the education systems/tracks, the number of hours for teaching science at least doubles in lower secondary education. In Estonia, Hungary and Romania, this number quadruples, and in Bulgaria it is more than five times as high as in primary education. However, Bulgaria (in particular), Hungary and Romania have a particularly small amount of instruction time in primary education (see Figure 3.5).

Figure 3.7 presents the relationship between the aggregated number of hours dedicated to science in primary and secondary education by notional year (x-axis) and instruction time for science as a proportion of total instruction time in primary and lower secondary education (y-axis). Like in mathematics, the relationship between the two sets of data is strong and positive: the more hours are dedicated to science, the higher the proportion of science in the curriculum. A clear trend emerges, from Hungary (small number of hours and low percentage) to Czechia (large number of hours and high percentage). Liechtenstein (*Gymnasium*, *Realschule* and *Oberschule*) stands out, as instruction time for science includes instruction time for social studies (see Figures 3.5 and 3.6 and their country-specific notes).

Figure 3.7: Instruction time for science per notional year and as a proportion of total instruction time, ISCED 1-2, 2020/2021



Explanatory notes

Instruction time per notional year in primary and lower secondary education: This corresponds to the total taught time in hours in primary and lower secondary education divided by the number of years in primary and lower secondary education.

Horizontal flexibility: Top-level education authorities indicate the total instruction time for a group of subjects within a specific grade. Schools / local authorities are then free to decide how much time to allocate to individual subjects.

The figure does not show education systems/tracks with horizontal flexibility in all or most grades at primary level and/or lower secondary level (i.e. Belgium, Italy, the Netherlands, Poland and Portugal). In addition, it does not show Ireland, where science is not compulsory at seconddary level, or Switzerland, where instruction time for science is integrated into instruction time for social studies at primary level.

Source: Eurydice.

Country-specific notes

See Figures 3.5 and 3.6.

Similarly to what has been observed for mathematics, the percentage of taught time dedicated to science within the total teaching time is high in North Macedonia in comparison with countries with a similar number of taught hours. For Croatia, Bosnia and Herzegovina, and Montenegro, which show a similar pattern, instruction time for science includes taught time for social studies at primary level, which might introduce some bias into the comparison. Conversely, the percentage of instruction time dedicated to science is lower in Denmark than in other countries with a similar amount of instruction time. In Denmark, however, the approach used to calculate the amount of instruction time per notional year differs slightly from that used in other countries (please see country-specific note below Figure 3.5).

Summary

Time is an obvious dimension of any learning process. However, there is no research evidence pointing to an ideal amount of instruction time for learning mathematics or science. Instead, some studies show that additional time for the teaching of mathematics or science improves students' academic achievement. However, the significance of such an outcome must be carefully weighed against the limited number of research studies, which have very diverse research designs. Beyond instruction time, effective teaching is of paramount importance for successful learning to take place.

Defining total instruction time (i.e. for all curriculum subjects) is a responsibility of top-level education authorities in all countries. Allocating this total number of hours across all curriculum subjects is also

the prerogative of top-level education authorities. In some countries, however, it is shared with schools / local authorities.

Instruction time for mathematics is greater at primary level than at secondary level in most education systems. In primary education, the number of notional hours dedicated to the teaching of mathematics ranges between 100 and 120 per year ([59]) in about half of the education systems/tracks; in the other half, it is greater than 120. In lower secondary education, this number of notional hours also varies between 100 and 120 in about half of the education systems; it is greater than 120 in a dozen education systems/tracks and lower than 100 in the remaining six.

For science, the overall picture provided by the data shows instruction time increasing when students attend lower secondary level in nearly all education systems/tracks (i.e. the opposite of the trend observed for mathematics). In more than half of the education systems/tracks, the number of notional hours per year at least doubles compared with primary education. The place of science in the curriculum makes comparison across countries more difficult, especially at primary level. At that level, in a dozen countries, science is part of a broader knowledge area, comprising more than one traditional discipline, such as science and social studies. In these cases, instruction time for science includes (or is included in) instruction time for other curriculum subjects, in particular social studies, technology and ICT.

When feasible, the comparison between instruction time dedicated to mathematics on the one hand and to science on the other hand produces a different picture depending on the education level considered. In primary education, the number of hours dedicated to mathematics exceeds the amount allocated to science in all education systems. In lower secondary education, mathematics still has more weight in the curriculum than science in slightly more than half of the education systems. However, in almost one third of education systems, the opposite holds true. Finally, in the remaining cases, mathematics and science have similar numbers of taught hours ([60]).

Finally, the analysis shows that, in most countries, a significant amount of instruction time corresponds to a comparatively significant weight of mathematics/science within the curriculum, the opposite being equally true (a low amount of instruction time corresponds to comparatively little weight of mathematics/science within the curriculum).

([59]) Instruction time per notional year at a given education level corresponds to the total taught time in hours at that education level divided by the number of years of that education level.

([60]) The biennial Eurydice report on instruction time provides a more comprehensive analysis of the allocation of instruction time to all curriculum subjects in full-time compulsory education (European Commission / EACEA / Eurydice, 2021a).