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WORLD OF PHYSICS

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University of Cyprus, Cyprus
https://www.cs.ucy.ac.cy/seit/

University of Patras, Greece
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CTE, Romania
http://www.etcenter.eu/index.php/en/

Computer Technology Institute and Press "Diophantus", Greece
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http://www.newedu.sk/

Executive Summary

Key competences are essential in a knowledge society and guarantee more flexibility in the labour force, allowing it to adapt more quickly to constant changes in an increasingly interconnected world. They are also a major factor in innovation, productivity and competitiveness, and they contribute to the motivation and satisfaction of workers and the quality of work.

Basic competences in science and technology refer to the mastery, use and application of knowledge and methodologies that explain the natural world. These involve an understanding of the changes caused by human activity and the responsibility of each individual as a citizen.

Research on Physics education in secondary education schools around Europe is deemed very important for the work to be conducted in the scope of the World-of-Physics project. The aim of the report is to provide an overview of the state of Physics education in the World-of-Physics partners' countries.

List of abbreviations

Abbreviation	Definition
INVALSI	Italian National Evaluation System for Physics
ISCED	The International Standard Classification of Education
MoEC	Cyprus Ministry of Education and Culture
PLS	Scientific Degree Project
TIMSS	Trends in International Mathematics and Science Study
VET	Vocational Education and Training

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this class have been taught each topic. "Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets" 157

5.2.2.34 The following list includes the main topics addressed by the proposed test. Choose the response that best describes when the students in this class have been taught each topic. "Forces and motion (types of forces, basic description of motion, effects of density and pressure)" 158

5.2.2.35 How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose “Not applicable.” "Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)" 158

5.2.2.36 How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose “Not applicable.” "Energy forms, transformations, heat, and temperature" 159

5.2.2.37 How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose “Not applicable.” "Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)" 159

5.2.2.38 How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose “Not applicable.” "Electric

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Introduction

Key competences for lifelong learning are a combination of knowledge, skills and attitudes appropriate to the context. They are particularly necessary for personal fulfilment and development, social inclusion, active citizenship and employment (Gazzetta Ufficiale dell'Unione Europea del 30/12/2006).

Key competences are essential in a knowledge society and guarantee more flexibility in the labour force, allowing it to adapt more quickly to constant changes in an increasingly interconnected world. They are also a major factor in innovation, productivity and competitiveness, and they contribute to the motivation and satisfaction of workers and the quality of work.

Basic competences in science and technology refer to the mastery, use and application of knowledge and methodologies that explain the natural world. These involve an understanding of the changes caused by human activity and the responsibility of each individual as a citizen.

In all European countries, science education in primary education is taught as a general subject that integrated chemistry, physics and biology. In many countries the same approach continues for the years of lower secondary education. At the end of lower secondary education, science teaching, usually, it is divided into the following separate subjects: biology, chemistry and physics. In the secondary education (ISCED 3), the most part of European countries adopt an approach in which science is a separate subject, and the sciences are often a specialized curriculum. As consequence, the sciences are not teach with the same level of difficulty and/or not all students studying science subjects for all the years of ISCED level 3.

By comparison of Physics/Natural Sciences curricula, the analysis conducted in this report also identified the following as the most relevant topics for physics education in ISCED 3 level:

1. **Mechanics** - Linear motion (velocity, acceleration, vectors and scalars), Newton's laws of motion (force, momentum), Gravity, Conservation of momentum, Moment – conditions for equilibrium. Work, Energy (conversion, principle of conservation, power), Oscillations and waves, Gases (density and pressure).
2. **Electricity and magnetism** - Electrification by contact, Electrification by induction, Distribution of charge on conductors, Force between charges, Electric fields, Electric energy, Potential difference, Capacitors and capacitance, Electric sources, Electric current, Resistance, Effects of electric current, Magnetic fields, Current in a magnetic field, Electromagnetic induction, Light.
3. **Structure of matter** - The electron, Thermionic emission, Photoelectric emission, X-rays, Structure of the atom, Structure of the nucleus, Radioactivity, Nuclear energy, Ionising radiation and health hazards, The Standard Mode

The starting point of this analysis was the TIMSS survey (Trends in International Mathematics and Science Study), that is a regular international comparative assessments of student achievement in mathematics and science. In particular, the analysis focuses on the science education section of the TIMSS administered to students of the 8th grade. Starting from the TIMSS 2011 dataset, the most significant items were selected in order to create a specific survey to be administered to a sample of schools in Slovakia, Greece and Cyprus, countries which were not involved in the TIMSS 2011 survey.

In order to analyse the student responses of some European countries the following questions were selected:

1. How often students use the computer?
2. Is the teacher clear during the explanation?
3. How students employ to perform the science tasks?

4. How often teachers assign homework?
5. Are the sciences a more complex matter than other classmate?
6. How much do you agree with this statement about learning science?

To examine the teachers' approach the following questions were selected:

1. Do you use computers in the classroom?
2. How often do you usually ask them to do the following?
3. Do you think that is comfortable to use a computer during school lessons?
4. A computer available during the science lessons?
5. How often do you have the students do the following computer activities during science lesson?

For the analysis at the school level the following question was selected:

1. How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the following?

The analysis of the results leads us to conclude that there are not very large differences from the point of view of study time and workload for students. Partners' countries have similar results in terms of "study load "and "use of home PCs", but results highlight that there was "a smaller capacity of teachers in the explanation" and higher frequency of students being "invited to explain the topics learnt during the lessons".

The data on the "use of the computer during the lesson" analysed in most European countries reveals that there is a value of more than 80%, while in Italy it is just over 50%. This result points out a weakness of the Italian school system in which in many schools the use of computers is not possible or is not practiced by the teachers.

The analysis also presents main strategies, methods and technologies used in teaching, and some experiences of their use in the sector of Physics education are also presented. Regarding teaching methodologies, it is difficult to identify one that is

good for all students and all contexts. Teachers have access to a variety of strategies, methods and teaching techniques, which are to be intended as "tools of the trade", to choose from. Choices applied do not only depend on their teaching style preferences, but also on the economic and social student context, the topic that will be addressed and the typology of goal to be addressed.

1 National curricula about Physics

In all European countries, science education in primary education is teaching as a general subject that integrated chemistry, physics and biology. In many countries, like Italy, the same approach continues for the years of lower secondary education. At the end of lower secondary education, science teaching, usually, it is divided into the following separate subjects: biology, chemistry and physics.

In the secondary education (ISCED 3), the most part of European countries adopt an approach in which science is a separate subject, and the sciences are often a specialized curriculum. As consequence, the sciences are not teach with the same level of difficulty and/or not all students studying science subjects for all the years of ISCED level 3.

1.1 Italy

1.1.1 The structure of the Italian Education system

The Educational system in Italy is regulated by the Ministry of Education, University and Research, according to specific legal form (public schools, private schools, private schools authorized By Ministry). Instead, Vocational schools depend by the regions. The Italian school system is divided into three cycles of education:

- primary education, which includes primary school and has duration of five years;
- secondary education, which includes the secondary school of first level for three years, and the secondary school of second level of five-year duration;
- higher education, which includes University, Higher Artistic, Music and Dance and Vocational training.

In Italy, during 2007, it was created a ministerial working group focused on the development of science and technology, now reconstituted under the name Committee for the development of scientific and technological culture. The Committee has studied the methods and strategies to improve the teaching and learning process of science and make it more effective, it performs the following tasks:

- define actions and structures for the dissemination of scientific and technological culture in the country;
- propose the guidelines to develop a policy which defines the role of public and private bodies;
- propose and define projects and actions for schools, adult citizens and society as a whole;
- propose actions and services for training and support teachers;
- make proposals for the improvement of curriculum.

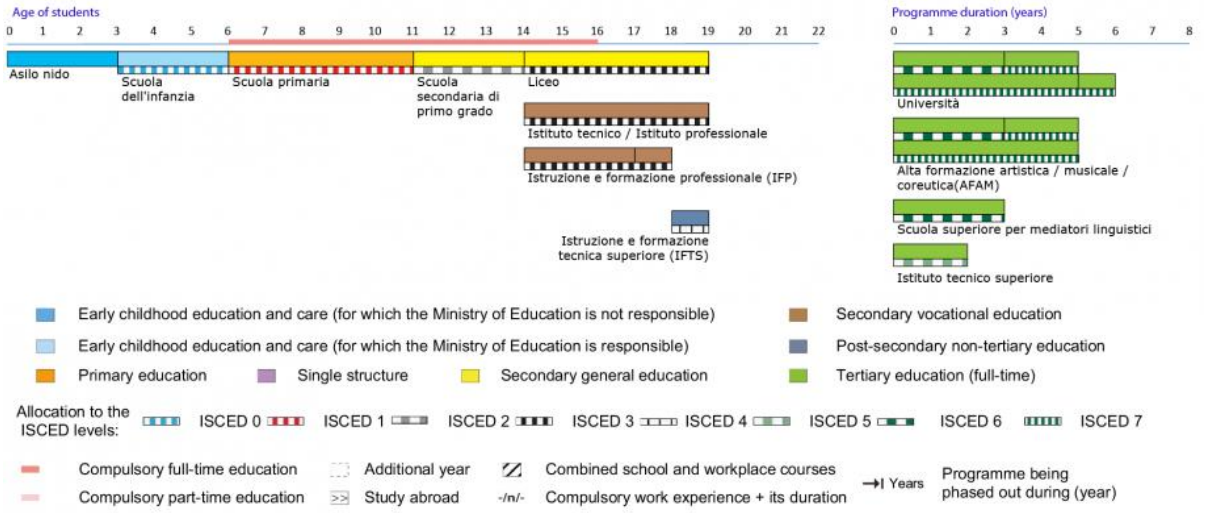

Figure 1: Structure of the national education system of Italy and the corresponding ISCED levels (1)

1.1.2 Physics education in primary school (ISCED 1)

In primary school physics is part of the discipline "Science". This report examines only the curriculum of the fourth and fifth class:

- fourth class : states of matter,
- fifth class: movement and levers, energy and force of gravity.

1.1.3 Physics education in secondary school of first level (ISCED 2)

- Initial 2 years (2 hours per week):
    - Bodies in motion: velocity and trajectory.
    - Acceleration: forces in static situations and causes of variations of motion.
    - Weight, mass, specific gravity.
    - Work and energy.
    - Flotation and Archimedes' principle.
    - Represent different types of movement through space diagrams/time; to interpret the diagrams.
    - Principles of forces, to observe the effects of weight; find situations of balance, measure the forces (dynamometer, balance).
    - Estimate the specific gravity of different everyday materials.
    - Examples taken from everyday experience that recognizes the difference between temperature and heat.
- Third year (2 hours per week):
    - Introduction to the principles of mechanics with simple experiments illustrative.
    - Flow of liquids: water velocity and flow rate of a channel or a pipe.
    - Difference between temperature and heat. The thermometer.
    - Electricity: Power and electricity concepts.
    - Magnetism: the magnet, the Earth's magnetic poles, the compass.

- Electromagnetic waves and transmission of radio signals.
- Sun and the solar system: from the observations of the ancients to the assumptions of contemporary science.
- Earth's movements: rotation, revolution; day and night, the seasons.
- Collect data from experimental tests (rates of measures, spaces, speed); graph and interpret data collected.
- Determine the melting temperature of ice and boiling water.
- Perform experiments that can distinguish temperature and heat.
- Experiments concerning electrical charges and the difference between conductors and insulators.
- Experiment with magnets and iron filings.
- Describe the main motions of the earth and their consequences.
- Show how the apparent motion of the sun for the detection seasons, latitude, time of day: the sundial.

1.1.4 Physics education in secondary school of second level (ISCED 3 & ISCED 4)

Between 2005 and 2011 more than half of European countries either reformed their primary and secondary education curricula or started planning reforms (2). Most of these reforms were triggered by the need to bring curricula (including science subjects) more closely in line with the EU key competences approach (Council Recommendations, 2006).

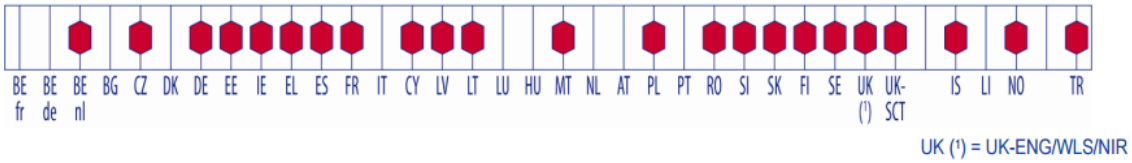

Figure 2: Countries engaged in curriculum reform, including science (ISCED 1-3), between 2005-2011 (2)

As show in the graph (Figure 2), Italy is not among the countries that initiated the reform of curricula. The upgrade of path was planned from 2010, but this process did not start on schedule time. In September 2014, the Government launched a new Lex named 'The Good School' in which curricula becomes flexible, and schools can activate optional subjects according to the needs of their students.

In Italy from 1St September 2010 is started the overall reform of the second cycle of education and training. Italian upper secondary school was reorganized as follows:

- 6 lyceum (classico, scientifico, linguistico, delle scienze umane, musicale e coreutico e percorsi artistici);
- technical schools subdivided in 2 branches (economics and technology) with 11 areas;
- vocational schools subdivided in 2 branches and 6 areas.

Table 1: School curricula by subjects in hours per year

	years				
	1	2	3	4	5
Art School			66	66	66
Languages High School			66	66	66
Music School			66	66	66
Liceo Classico			66	66	66
Scientific School	66	66	99	99	99
Human Sciences School			66	66	66
Technical Schools					
Mechanics, mechatronics and Energy	99	99			
Transports and logistics	99	99			
Electronic and Electrical	99	99			
Information and Communication Technology	99	99			
Graphic Communication	99	99			
Chemistry, materials and biotechnologies	99	99			

Fashion System	99	99			
Agriculture, Agrifood and industry	99	99			
Buildings, Environment and Territory	99	99			

1.1.5 Italian National Evaluation System for Physics

INVALSI is a self-assessment system of the schools takes into account three area:

1. context and resources,
2. outcomes,
3. processes, divided into educational and teaching practices, and management and organizational practices.

Schools will have to evaluate themselves about each of areas described above, in order to provide a representation of the school through an analysis of how it works. The results obtained from the self-assessment, will allow schools to identify development priorities towards which to direct its improvement plan.

INVALSI system provides, also, a test that has the aim to evaluate the learning levels of the students. The test is divided into two parts: Mathematics and Italian. The tests are administered to pupils in II and V of primary school and the third year of secondary lower school level.

1.1.6 National Strategies to foster physics skills and competencies

1.1.6.1 The Scientific Degree Project

The Scientific Degree Project (PLS) was born in 2004 with the motivation to increase the number of students enrolled in degree curriculum in Chemistry, Physics, Mathematics and Science. This plan is aimed to:

- improve the knowledge and perception of science subjects in secondary school, offering to students of the last three years the possibility to participate in curricular laboratory and stimulating extracurricular activities.

- Initiate a process of professional development of in service teachers of science in secondary school based on a joint work between schools and universities for the design, implementation, documentation and assessment of laboratories mentioned above.
- Promote optimization of training from the University to School and the from University to the world of work, strengthening and encouraging activities of stages and training at universities, public and private research institutes, Companies engaged in research and development.

1.2 Cyprus

1.2.1 The structure of the Cypriot Education system

The Educational system in Cyprus is centrally managed by the Cyprus Ministry of Education and Culture (MoEC). The MoEC is the responsible authority for all the government educational institutions in the country and also collaborates with the private ones too. In addition, it prepares and enforces new legislation relating to education, national curriculum and textbooks. The educational system consists of a number of stages, which are presented below (3):

- **Pre-Primary education**. It is compulsory education for children between the ages of $4^{8/12}$ and $5^{8/12}$. However, children that are over the age of 3 can also be accepted. In this level of education focus is directed towards satisfying the needs of the children so that they can develop their personalities. Contributing to this is the experiential environment offered, enabling them to recognize their capabilities and enhance their self-image.
- **Primary education**. It is compulsory education for children over the age of $5^{8/12}$. Children will spend 6 years in primary education. In this level of education focus is on creating and securing the required learning opportunities

for all children regardless of their differences (e.g. age, sex, family and social background, mental abilities etc.).

- **Secondary education**. It is divided into two three-year cycles of education. The first three-year cycle is *Gymnasio* (lower secondary education) and the second three-year cycle is *Lykeio* (upper secondary education). Pupils that are between the ages of 12 and 18 attend secondary education. Core lessons, interdisciplinary subjects and a variety of extracurricular activities comprise the curriculum at this level. For their second three-year cycle pupils have the choice to attend Secondary Technical and Vocational Education instead of *Lykeio*. In choosing this direction, pupils will be provided with knowledge and skills that enable them to enter the workforce or advance their studies in the area of interest. The structure of the Cyprus school system is presented in Figure 3.
- **Post-Secondary Vocational Education and Training (Post- Secondary Institutes of VET)**. All types of vocational education and training are provided to students. A combination of academic and technical knowledge and professional and practical skills ensure that students are of the required standard, further crediting their qualifications. The duration of such programmes is two years, on a 5-day basis.

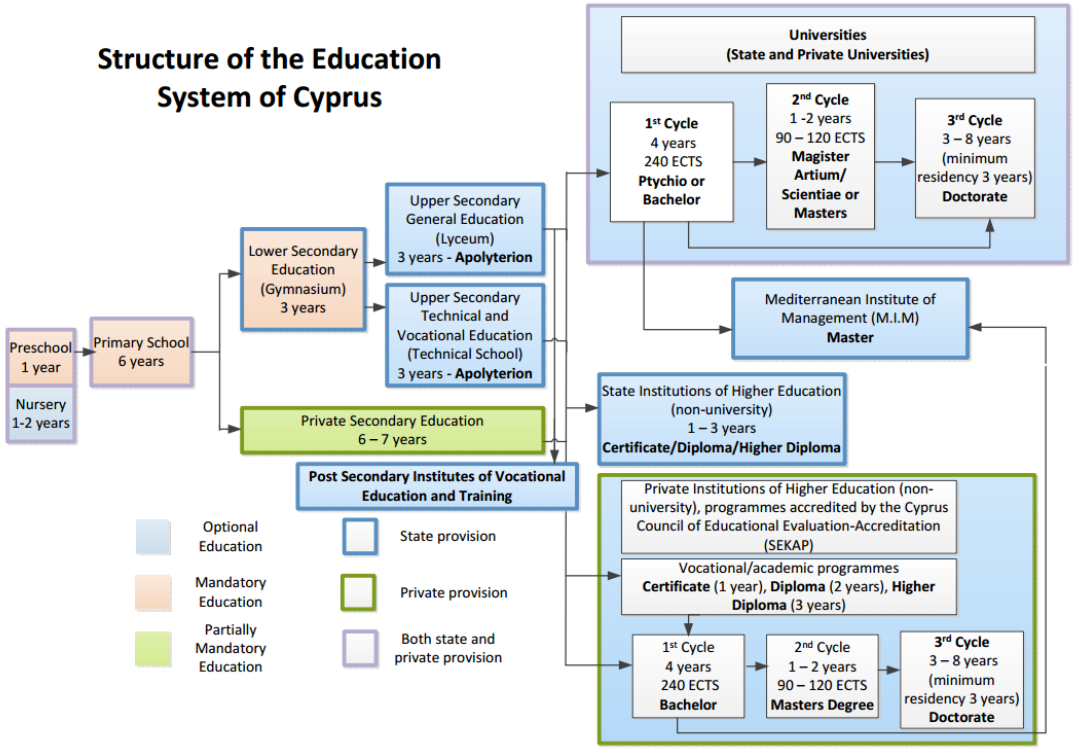

Figure 3: Structure of the education system in Cyprus (3)

- **Higher Education**. Three public universities and five private universities are currently operating in Cyprus. Higher education is also provided by State Higher Education Institutions and Private Institutions of Higher Education. Both these type of institutions however, do not have a university status. Vocational programmes offered at State Institutions of Higher Education range from one to three academic years, while second cycle programmes are not offered. A prerequisite for access to programmes in State Higher Education Institutions is the apolyterion or an equivalent qualification. Furthermore, candidates are ranked according to their performance in the Pancyprian Examinations for entrance to a particular programme. Forty Private Institutions of Higher Education are currently registered with the Ministry of Education and

Culture. Academic and vocational programmes of study are offered at the undergraduate and postgraduate levels.

The following schematic diagrams illustrate the structure of the Cyprus education system, focusing on main stream education from pre-primary to tertiary level.

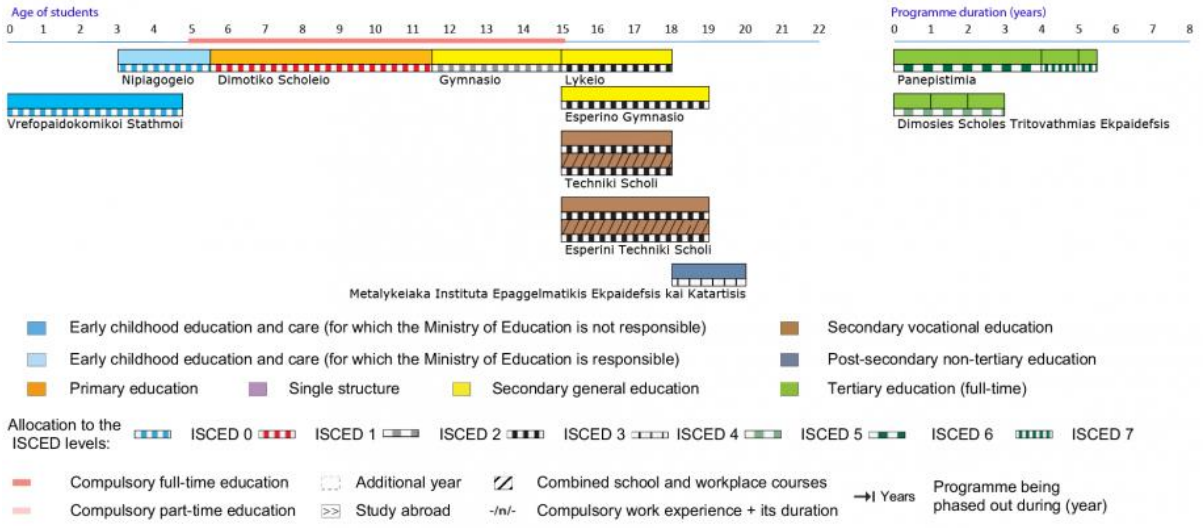

Figure 4: Structure of the national education system of Cyprus and the corresponding ISCED levels (1)

1.2.2 Physics education in primary school (ISCED 1)

In primary school, Physics forms part of the course "Natural Sciences (Φυσικές Επιστήμες)". In addition to Physics related content, the course also introduces leaners to content that relates to the main topics of living organisms, the natural environment, the human body and health, and the sky and earth. Table 1 presents the main topics and their subtopics for Physics related content that is covered in the different grades of primary education for the course "Natural Sciences".

Table 2: Topics and subtopics covered in Physics at primary education

Main topic	Subtopics					
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Electricity - Electrical circuits	-	Electricity at our home	-	Electric systems Conductors & insulators Electricity production	Electric systems - series & parallel connections	-
Heat - Temperature	-	-	Learning about thermometers The sun as a source of heating of the earth/ protection from the sun	State changes of water during heating or cooling The cycle of water State changes in other matters	Expansion and contraction of matters	Heat transfer Good and bad conductors of heat - heat insulation materials

Main topic	Subtopics					
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Light	-	Sources of light The sun as a source of light	-	Light travels in a straight line Shadows Mixing of colored lights	Reflections Idols at mirror level	-
Sound	-	-	-	-	-	Sources & characteristics of sound
Matter/Materials	Classification of materials Selecting materials depending on	Water in nature Drinking water & its logical use	Mass and volume Characteristics of solids, liquids and gases Properties of solids	Mixes of materials & solutions Factors affecting dissolution time	Factors affecting sinking & floating	-

Main topic	Subtopics					
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
	their use Protection from hazardous materials	Simple mixes of everyday materials & solutions	Sinking & floating	Water dissociation Atmosphere		
Forces - movements	-	-	Pushing & pulling Force & changes in movement Force in magnets Force in weight	-	Force that resists movement (the case of friction) Friction between surfaces	Forces from distance (the case of magnets)
Energy	-	-	-	-	-	Systems & changes that occur to these - properties of energy

1.2.3 Physics education in secondary school of first level (ISCED 2)

As previously noted in section 2.2.1, Secondary education is divided into two three-year cycles of education. The first three-year cycle is *Gymnasio* (lower secondary education), which corresponds to ISCED 2. There are 2 teaching periods per week devoted to Physics in the 2nd year of Gymnasio (4) and the curriculum is structured based on the following main topics (5):

- scientific methods – measurements,
- motion,
- force,
- pressure.

There are two teaching periods per week devoted to Physics in the 3rd year of *Gymnasio* and the curriculum is structured based on the following main topics (5):

- energy,
- electricity (static and current),
- atomic structure – heat – temperature,
- heating and thermal equilibrium (insulation and conductance),
- physical changes in matter.

1.2.4 Physics education in secondary school of second level (ISCED 3 & ISCED 4)

The second three-year cycle in Secondary education is Lykeio (upper secondary education), which corresponds to ISCED 3. There are 2 - 4 teaching periods per week devoted to Physics at this level, depending on whether students have chosen Physics as a specialiszation (κατεύθυνση) subject or common core stream (κοινός κορμός) subject (5). The curriculum for Physics in the 1st year of Lykeio is structured based on the following main topics (5):

- physical measurements - measurement units,

- motion in straight direction,
- acceleration caused by forces (Newton's first law),
- mechanical work,
- optics.

As a specialization stream subject, the curriculum for Physics in the 2nd year of *Lykeio* is structured based on the following main topics (5):

- motion in multiple dimensions – interpreting quantitatively graphs of distance, time, and speed,
- relative motion - reference systems,
- motion in two dimensions - circular motion,
- universal gravitation – satellites,
- mechanical systems - momentum,
- static electricity,
- current electricity.

As a common core stream subject, the curriculum is structured based on the following main topics (5):

- Newton's laws (applications),
- motion in two dimensions - circular motion and examples,
- universal gravitation - satellites – topics in Astronomy and Space Physics,
- momentum - momentum conservation principle – applications,
- static electricity (importance and applications in our lives),
- current electricity,
- the electricity in our home,
- the atmosphere of the earth and meteorological elements,
- internal structure of the earth – earthquakes.

As a specialization subject, the curriculum for Physics in the 3rd year of Lykeio is structured based on the following main topics (5):

- engineering solids,

- vibrations,
- waves,
- magnetism,
- electromagnetism.

As a common stream subject, the curriculum is structured based on the following main topics (5):

- engineering solids (examples and applications),
- oscillations (applications in daily life),
- waves (current applications),
- magnetic phenomena,
- electromagnetism (phenomena and applications).

1.2.5 Cypriot National Evaluation System for Physics

The following forms of assessment are considered for the purpose of evaluating the overall performance of learners' in the subject of Physics (6):

- Diagnostic assessment - aims to determine the level of conceptual understanding that the learners have gained and to also assess their skills development.
- Formative assessment – a form of assessment where information on the learning levels of the learners is collected, and which directs the adjustment of instruction in order to better address the needs of the learners.
- Self-assessment – used as a medium for learners to exercise their metacognitive skills for self-control and self-regulation with regards to the learning process.
- Final assessment – includes written tests that are conducted by learners during each semester and the final written examination.

All forms of assessment are utilized by the teachers in order to collect feedback on the learning process. This feedback helps identify areas where improvements and

restructuring may be necessary. The ultimate aim is to improve the learners' performance and results.

1.3 Greece

1.3.1 The structure of the Greek Education system

The Greek Education system is administered centrally by the Greek Ministry of Education, Research and Religious Affairs[1] and includes the following structures (1):

1. Primary education includes two levels:

a) **Pre-primary school** ("*Nipiagogeio*" - ISCED 0), where attendance is available from the age of four(4) and compulsory for all five(5) year-old children.[2]

b) **Primary school** ("*Dimotiko Scholeio*" - ISCED 1), which comprises of six-year compulsory attendance for children in the age range of 6-12 years-old.

2. Secondary education is divided into two levels:

a) **Lower Secondary School** ("*Gymnasio*" - ISCED 2), which provides a three-year cycle of general compulsory education for ages 12-15 years-old.

b) **Upper Secondary School** ("*Lykeio*" - ISCED 3) is a second non-compulsory three-year cycle, for the age of 15 and above, which is offered in two different types: a) general secondary education ("*Geniko Lykeio*"), which includes both common core subjects and optional subjects of specialisation and b) vocational secondary education ("*Epaggelmatiko*

[1] The Ministry controls the curricula, the recruiting of staff and the funding for all forms of primary and secondary education. It is also responsible for the funding and the student distribution to the tertiary institutions.

[2] There are also centers for early childhood education ("Vrefonipiakoi stathmoi" and "Paidikoi Stathmoi"), which operate under the remit of the Municipal Authorities.

Lykeio"), which also leads to an optional post-secondary cycle of studies.[3]

3. **Post-Secondary Vocational Education** (ISCED 4), the so-called "apprenticeship class", which is a one year educational scheme which includes school and workplace courses.
4. **Higher Education** (ISCED 6 & 7) is divided in the University sector and the Technological sector. The first includes Universities, Polytechnics and the School of Fine Arts. The second includes the Technological Education Institutions ("*Technologika Ekpaideftika Idrymata*" – T.E.I.) and the Higher School of Pedagogical and Technological Education ("A.S.PE.T.E.").
5. Finally, there are educational structures of Lifelong Learning: **Vocational Training Schools and Institutes** ("*Scholes Epaggelmatikis Katartisis*" and "*Institouta Epaggelmatikis Katartisis*" - ISCED 4), Lifelong learning Centers ("*Kentra Dia Viou Mathisis*") and Colleges.

The following figure presents the structure of the Greek education system:

[3] Parallel to day schools, there are also Evening ("Esperina") upper secondary schools operating, which involve a four-year attendance.

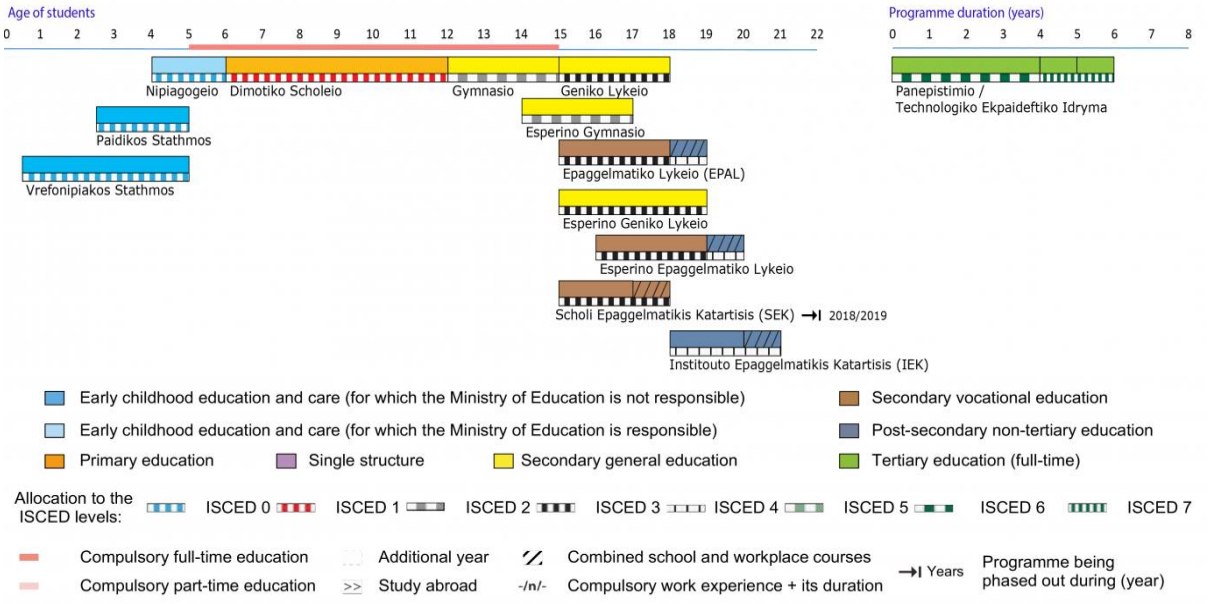

Figure 5: Structure of the national education system of Greece and the corresponding ISCED levels (1)

1.3.2 Physics education in primary school (ISCED 1)

In primary school, Physics as an independent course is found in the 5th and 6th grade's curriculum. In lower grades, particular issues from physics are approached in within the course "Study of Environment", which introduces learners to aspects of the natural, residential and social environment. The following table presents the main topics and subtopics of Physics related content in different grades of primary education (7).

Table 3: Topics and subtopics of Physics in primary education

Main topic	Subtopics					
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Time	Human and time	Measuring of time	-	-	-	-
Matter/Materials	Objects from my environment	Water everywhere. The cycle of water. Water in everyday life. Materials. Solid, liquids, gases	-	Creation of mixtures. Mixture separation the existence of air in physical environment Ice-water- vapor	Structure of matter. Properties of material bodies. Study of mixtures. Solutions	-
Sound	The journey of sound	-	-	-	Sound production Sound transmission.	-

Main topic	Subtopics					
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
					Reflection and absorption of sound. Human ear. Noise pollution and protection methods.	
Light	Sun and our life	-	-	Light and heat	Propagation of light. Light and material bodies. Reflection, diffusion and absorption.	Refraction. Colors, Human Eye.
Electricity - Electrical circuits	Electric energy in our	-	-	-	Electrons. The electric circuit	Magnets. Relation between

Main topic	Subtopics					
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
	life				Conductors and insulators. Electric sources. Electric devices. Dangers of electric currents.	electricity and magnetism.
Forces - movements	-	-	-	-	Speed Force Friction Pressure	Forces from distance (the case of magnets)

1.3.3 Physics education in secondary school of first level (ISCED 2)

The curriculum of the Lower Secondary School ("*Gymnasio*") comprises the following Physics courses (7):

1. The first year includes a one hour per week course of "Physics through Experiments" with the following main topics:
   - length measurements - average value,
   - time measurements – accuracy,
   - mass measurements – charts,
   - temperature measurements – calibration,
   - from heat to temperature - thermal equilibrium,
   - changes of state of water - the "Cycle" of water,
   - expansion and contraction of water - a natural "anomaly",
   - light Heats - "cold" and "hot" colors,
   - the greenhouse effect over-heats,
   - electric short-circuit - risks and "security",
   - from electricity to magnetism - the electric motor,
   - from magnetism to electricity - the electric generator.
2. The second year includes a two hours per week course of "Physics" with the following main topics:
   - scientific method,
   - motion,
   - forces,
   - pressure,
   - energy,
   - heat,
   - changes of state,
   - heat transmission.

3. The third year includes a two hours per week course of “Physics” with the following main topics:
   - electric force and electric charge,
   - electric current,
   - electric energy,
   - oscillations,
   - mechanical waves,
   - nature and transmission of light,
   - reflection of light,
   - refraction of light,
   - lenses and optical instruments,
   - atomic nucleus,
   - nuclear reactions.

1.3.4 Physics education in secondary school of second level (ISCED 3 & ISCED 4)

The curriculum of the general Upper Secondary School (“*Lykeio*”) comprises the following Physics courses (7):

1. The first year includes a two hours per week course of “Physics” with the following main topics:
   - physical quantities and measurement units,
   - motion in straight direction,
   - dynamics of one dimension,
   - dynamics of two dimensions,
   - conservation of mechanical energy,
   - conservation of total energy and degradation of energy.
2. The second year includes a two hours per week common course of “Physics” with the following main topics:

- forces between charges,
- direct electric current,
- light,
- atomic phenomena.

An optional three hours per week specialized course of “Physics” with the following main topics:

- curvilinear motion: horizontal shot, circular motion,
- conservation of momentum,
- kinetic theory of gases,
- thermodynamics,
- electric field.

3. In the third year, the specialisation in science studies includes a three hours per week course of “Physics” with the following main topics:
   - electrical and mechanical oscillations,
   - waves,
   - fluids in motion,
   - mechanics of solid body,
   - percussion and motion,
   - relativity theory,
   - elements of Quantum mechanics.

1.3.5 Greek National Evaluation System for Physics

The main objective of the national evaluation system is the collection of feedback on the educational process and the detection of learning deficiencies, in order to improve the educational system and the learners’ performance. The evaluation of the educational procedure is based on the following forms of assessment (7):

- Diagnostic valuation, which aims at determining the knowledge and experience acquired by the students and the difficulties that have arised.

- Formative valuation, which aims at monitoring the students' progress concerning specified educational objectives.
- Final valuation, which aims at an overall assessment of the educational outcomes.

1.4 Romania

1.4.1 The structure of the Romanian Education system

The Romanian Education system is administered centrally by the Ministry of National Education and Scientific Research and includes the following structures (Figure 6).

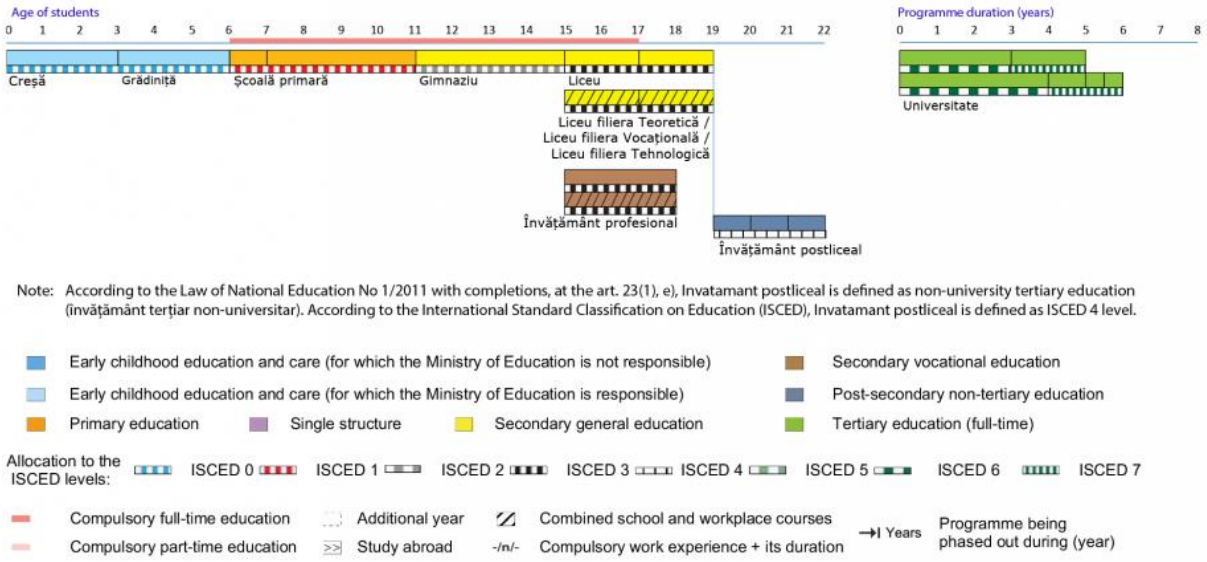

Figure 6: Structure of the national education system of Romania and the corresponding ISCED levels (1)

Primary education ISCED 1 made up of the kindergarten preparatory group and grades I to IV. Pupils can enroll to the first grade of primary school if they turn 6 or 7 during the respective calendar year.

Secondary education made up of:

- **Lower secondary (gymnasium)** ISCED 2 which includes grades V to VIII and ends up with the taking of a "national test examination". The

examination tests pupils' knowledge in the fields of Romanian language and literature and Mathematics.

- **Upper secondary (high-school)** ISCED 3 which includes grades X—XII and has the following branches: theoretical, technological and vocational (art, sport, theology). Enrolment is made on the basis of the results in the national test exam and the average degree of the gymnasium. High school studies end up with a "*baccalaureate examination*". After passing this examination, the graduates get the "*baccalaureate diploma*". Only students in the technological and vocational branches must take in addition a "*qualification examination*" and get a "*qualification certificate*".
- **Vocational education** (ISCED 4): is organized by technical and vocational high schools and form students in professions required by the job market. The studies end up with a "*qualification examination*". After passing this examination, the graduates get a "*qualification certificate*". Graduates can then continue their studies in the upper - secondary cycle, a technological or vocational high-school, in a low-frequency program.
- **Post high-school non-university education** lasts1 to 3 years and is organized in post-high schools forming the students in professions required by the job market. Admission is free (not granted on a competitive basis). High school graduates, whether they are baccalaurate diploma holders or not, can attend post high-school non-university education. For baccalaureate holders, credits obtained during the post high-school non university education can be recognized as units of transferable study credits for the university's first cycle: bachelor degree.

- **Higher education** (ISCED 6 & 7) - the general compulsory education is of 10 grades and includes primary education (grades I- IV), gymnasium or lower secondary education (grades V-VIII) and grades IX-X of high-school. The obligation to attend the 10 grades education (the frequency form), ceases at the age of 18.
  Education in technological and vocational high-schools, professional schools, non-university post-high schools is organized for specializations and qualifications established by The Ministry of Education, Youth and Sports, according to the National Registry of qualifications.

1.4.2 Physics education

Table 4: Topics and subtopics of Physics in primary education

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
Introduction	**Study of physics – Introductive aspects**			
Basic concepts of Physics	**Physical measurements** Physical phenomena. Physical measurements, units of measure, multiple and submultiple of units of measurement **Determining the value of a physical measurement** The direct measurement of length, area, volume and time interval Errors in measurement, sources of errors, recording data in a table, calculating			

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
	the average value and the absolute average, writing the result of a physical measurement size Determining indirectly the area and volume			
Mechanics phenomena	**Movement and Stationary state (of a body)** Body. Mobile. Reference. System of reference Movement and stationary state. Trajectory Distance traveled. Duration of movement Average speed. Units of measurement. Speed characteristics (direction, sense) Uniform rectilinear movement. Graphical			

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
	representation of movement The power of movement and stopping of a body. Average acceleration; units of measurement. *Extension: Rectilinear uniform movement (qualitative description)* **Inertia** Inertia, General properties of bodies Mass, Measurement of Inertia. Units of measurements Direct measurement of body mass, weighing Body density, unit of measurement. Determining the density **Interaction**			

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
	Interaction, effects of interaction Force, measurement of interaction Examples of forces (weight, friction force, elastic force) Units of measurement Force measurement, diameter The relation between mass and weight			
Thermic phenomena	**Thermic state. Temperature** Thermic state, thermic equilibrium, temperature. Thermic contact Temperature measurement. Temperature scales Modifying the thermic state. Heating, cooling (heat transfer) **The effects of changing the**		Thermic phenomena Brownian movement (experimental). Thermic agitation. Diffusion. Thermic equilibrium. Empirical temperature Heat, measurement of process Heat transfer (through conduction, convection,	

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
	thermal state Expansion/ contraction. Transformations of aggregation state Applications (thermal anomaly of water, water circuit in nature)		radiation) Expansion in technology: The thermic engine(qualitative) Caloric coefficient. Calorimetry State of aggregation, characteristics Extension: Status transformations Interdisciplinary extension: Study of heat exchange involved in ice melting (latent heat) Expansion in technology: the establishment of equilibrium in nonhomogeneous systems Extension: Fuels	
Mathematical concepts and models to study in		Studied physical measurements and phenomena		

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
physics		The stages of performing an experiment Extension: The experimental study of metric relations in a right triangle Scalar and vector physical measurement Scalar physical measurements. The identification of the scalar physical measurements (ex. time, mass, volume, density, temperature) Vector physical measurements. The identification vector physical measurements (for example: speed, acceleration, force)		

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
Mechanical phenomena Interactions		Interaction and the effects of interaction: Interaction. Effects of interaction (static, dynamic). Interaction through contact and influence Force – a measure of interaction. Forces of contact and action at distance Principles of inertia Principles action and reaction Example of forces: weight, normal pressing force, friction force, tension on a string, elastic force Measurements of forces. Dynamometer Movement of a body under the action of multiple forces The composition of forces. The parallelogram rule		

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
		Extension: Polygon rule for the composition of multiple vectors; Movement of a body on an inclined plane The decomposition of a force following two mutually perpendicular directions		
Mechanical phenomena **Mechanical work. Energy**		Mechanical work and energy Mechanical work done by constant forces. Unit of measurement Mechanical power. Units of measurement of power. Efficiency Kinetic Energy Potential gravitational energy. Extension: Potential elastic energy Mechanical energy The conservation of mechanical energy Extension: Methods of converting		

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
		mechanical energy		
Mechanical phenomena **Equilibrium of bodes**		The translation movement and the rotation movement of undistorted bodies Equilibrium of translation Moment of force. Unit of measurement. Rotation equilibrium Lever (interdisciplinary treatment – Levers in locomotor systems) Center of weight Body equilibrium and potential energy		
Mechanical phenomena **The statistics of fluids**		Pressure. Pressure. Hydrostatic Pressure Atmospheric pressure (interdisciplinary approach –		

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
		geography) Pascal's law. Applications Archimedes' law. Applications		
Mechanical phenomena Mechanical waves - Sound		Mechanical waves (interdisciplinary approach - Geography: seismic waves, waves) Production and perception (interdisciplinary approach Biology – auditory systems) Sound propagation. Echo Sound characteristics(qualitative interdisciplinary approach - Music)		
Electric and magnetic phenomena			**Electrostatic** Electrocution, electric load. Interactions between electrocuted bodies Coulomb's law	

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
			(experimental identification of measurements which influences the electric force) **Electro kinetics** Electric circuits. The components of a circuit. Electric generators Electric voltage. Intensity of the electric current Instruments of measurements – ampere meter, voltmeter, ohmmeter, wattmeter, multimeter Potential difference; Electric resistance Ohm's law for a part of the circuit Ohm's law for the whole circuit Equivalent resistors	

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
			Extension: Kirchhoff's theorems Electric energy and power. Joule's law Extension: chemical effect of electric current. Electrolysis Extension: power transfer in a simple electric circuit of direct current Magnetic effect of electric current Experimental study (qualitative) of the magnetic effect. Electromagnets ; Exerted force of an electromagnet depending on the intensity of the current (sense and measurement, Constructive parameters of a coil:	

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
			section, number of coils, core type) Application	
Optical phenomena			**Introduction** Sources of light Propagation of light in diverse mediums (abstraction, dispersion, body colors etc.) Ray of light/beam of light Propagation of light principles **Reflection** Reflection of light Reflection laws – experimental application – plane mirrors *Extension: Application of reflection laws in technology* **Refraction** Refraction index Refraction of light –	**Reflection and refraction** Thin lenses. Systems of lenses Optical instruments

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
			experimental highlight of the phenomena Total reflection *Extension: refraction laws, refraction index* Practical applications: optical fibers, prism with total reflection **Thin lens** Experimental identification of the type of lens (convergent, divergent) Experimental identification of the physical characteristics of thin, focal, image position lens Geometrical construction of image through thin lens *Extension: Determination of thin lens formulas – Conjugated points, linear*	

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
			transversal measurements using elements of plane geometry **Optical instruments** The eye, The magnifying glass, eyeglasses	
Energy and life			**Forms of energy. Sources of energy – integrated theme** Transformation and conservation of energy in different systems (for example, life support system on a space station, other systems identified and studied in biology, geography etc.)	
Principles and legislation in classical mechanics				Movement and rest Principle I Principle II Principle III Hooke's law. The tension in

Main topic	Grade 6	Grade 7	Grade 8	Grade 9
				a thread The laws of friction The Law of universal attraction
Variation theories and conservation laws in mechanics				Work. Power Kinetic energy variation of the material point theorem Gravitational potential energy and elastic potential energy Law of mechanical energy conservation Pulse variation theorem Law of impulse preservation
Elements of statics				Translation equilibrium Rotation equilibrium

Main topic	Grade 10	Grade 11	Grade 12
Thermodynamics	Basic thermodynamic notions Calorimetry Principle I of thermodynamics Application of the first principle of thermodynamics to transformations of the ideal gas Aggregate state transformations Heat engines Principle II of Thermodynamics		
Production and use of the continuous current	Electric current Ohm's Law Kirchhoff's Laws Grouping of resistors and generators Energy and power Effects of electric current		
Alternative current	Alternative current Description of resistor, coil, capacitor behavior in alternative current Circuit Elements; Energy and power in alternative		

	current Transformer Electric motors Appliances	
Mechanic oscillations and waves		The mechanical oscillator Periodic phenomena. Characteristic units used for the oscillatory motion Damped mechanical oscillations ”Harmonic oscillator" model Joining of parallel oscillations. Connected mechanical oscillators Resonance Mechanical waves Spreading a disturbance in an elastic medium. The "surface wave" model. Space and temporal periodicity Seismic waves Stationary waves Acoustic Mechanical Wave Diffraction - qualitative study Ultrasound and infrasound.

Oscillations and electromagnetic waves	RLC circuit in alternative current Free electromagnetic oscillations. The electromagnetic field. Electromagnetic wave and its classification Applications	
Modulatory optics	Light dispersion. Interference The Young device Localized interference. Applications Diffraction of light. Applications Polarization of light. Applications	
Chaos theory elements	Determinism and predictability. Determinism and unpredictability. Description of chaotic behavior. Space between phases. Classic and unusual attractors Fractal geometry elements	
The special relativity theory		The basis of special relativity theory Classical Relativity The Michelson Experiment The postulates of special relativity. Lorentz transformations.

	Consequences Elements of kinematics and dynamic relativity .Compression of different speeds The fundamental principle of dynamics Mass-energy connection
Atomic physics	Spectrum The Rutherford experiment. The planetary atom model The Franck-Hertz experiment The Bohr model The atom with several electrons X radiations LASER effect
Semiconductors. Use in electronics	Electric conduction in metals and metals Semiconductor diode. Field effect transistor. Applications Integrated circuits
Nuclear physics	Main properties of the core Core connection energy. Stability of the core Radioactivity. The laws of radioactive

	disintegration Interaction of nuclear radiation with substance. Detection of nuclear radiation Nuclear fission. Nuclear reactor Nuclear fusion Particle accelerators Elementary particles

1.5 Slovakia

1.5.1 The structure of the Slovakian Education system

The **Ministry of Education, Science, Research and Sport of the Slovak Republic**, the central public administration authority for education, is responsible for the development of the content, goals and methods of education. **Local self-governance** is within the competence of municipalities, which provide most of pre-primary, primary and lower secondary education in Slovakia. **Regional governance** is within the competence of higher territorial units, which provide most of upper secondary education.

Education system in Slovak republic consists of Figure 7:

- **primary education** - primary schools, primary schools with kindergarten,
- **secondary education** - apprenticeship training institutes, secondary vocational institutes, secondary grammar schools, secondary vocational schools and special schools,
- **tertiary education** - is provided at three levels - Bachelor, Master and PhD study programmes – fully within the competence of universities and higher education institutions.

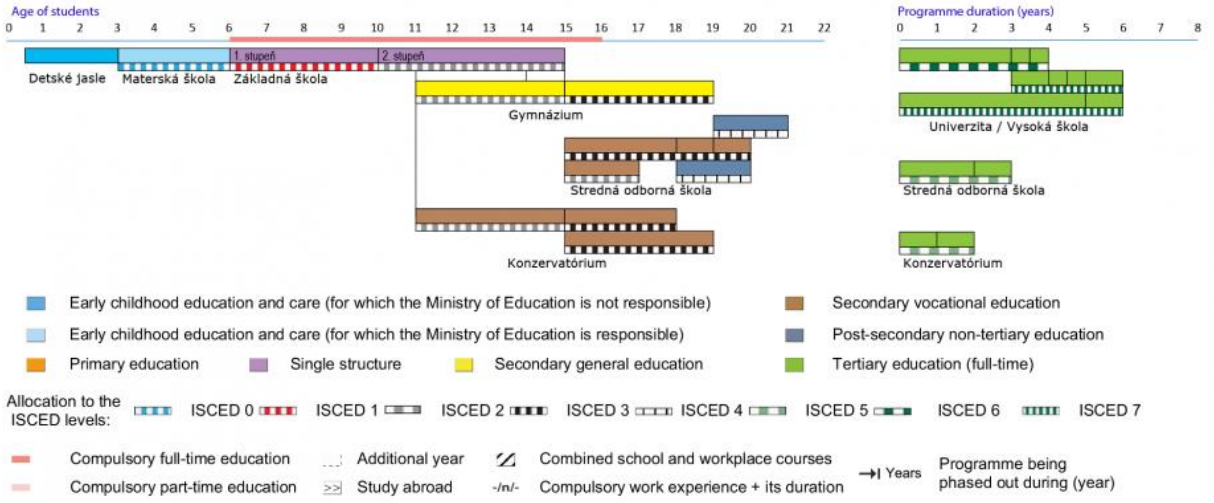

Figure 7: Structure of the national education system of Slovakia and the corresponding ISCED levels (1)

They may be state, private or church schools but they all provide education of equal standard. Since 1997, the primary school consists of 9 grades and two stages: The first stage (Grades 1 - 4, ISCED 1) and the second stage (Grades 5 - 9, ISCED 2) which is usually differentiated according to pupils' interests and skills. The pupils are admitted to Grade 1 upon attaining the age of 6 years. The compulsory school attendance lasts 10 years. After completing the primary school, the pupils are required to apply for a secondary school.

According to the law, public primary schools are established by municipalities (towns). Such schools may also be established by churches, natural persons, or legal entities, provided they comply with standard conditions. Their scope is defined in the special regulation of the Ministry of Education. The primary school may also include a school club, school library, boarding school, or other facility for education outside classes.

1.5.2 Physics education in primary school (ISCED 1)

In primary school physics is part of the discipline "Introduction to the Natural Science (Prírodoveda)".

Table 5: Curricula for Grade 1-4 of primary school (ISCED 1)

Subject	Number of lessons per week			
	Grade 1	Grade 2	Grade 3	Grade 4
Natural Sciences	-	-	2	2

- time,
- animals,
- water,
- mass,
- gaseous, liquid and solid matters,
- heat and temperature,
- human body,
- properties of matter,
  - density,
- simple machines,
- powers,
- universe.

1.5.2.1 Physics education in secondary school of first level (ISCED 2)

Table 6: Curricula for Grade 5-9 of primary school (ISCED 2)

Subject	Number of lessons per week				
	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9
Physics	-	2	2	2	1

- examination of the properties of liquids, gases and solid matters,
- behavior of matters in liquids and gases,
- temperature; examination of changes in the state of the matter,

- heat,
- light,
- force and motion, work, power,
- magnetism and electricity; electrical circuit.

1.5.3 Physics education in secondary school of second level (ISCED 3 & ISCED 4)

Table 7: Curricula of 4-years gymnasia - basic alternative (ISCED 3 & 4)

Subject	Number of lessons per week			
	Grade 1	Grade 2	Grade 3	Grade 4
Physics	3	3	2	2

- force and motion -1st , 2nd, 3rd Newton laws, free fall
- behavior of matters in liquids and gases,
- magnetism and electricity - electrical voltage, electric current, electric current in metals, electric current in semiconductors, liquids and gases.
- electromagnetic radiation and particles of the microworld,
- energy - kinetic, potential, internal, energy released by combustion (calorific value), radiation energy (heat), photon and its energy, nuclear energy.

2 The state of Physics Education in Europe

The aim of this section is to provide a picture of the state of Physics Education in Europe with a specific focus on the countries involved in the WoP project.

The starting point of this analysis was the TIMSS survey (Trends in International Mathematics and Science Study), that is a regular international comparative assessments of student achievement in mathematics and science. In particular, we focus on the science education section of the TIMSS administered for the students of the 8th grade.

Starting from the TIMSS 2011 dataset[4], the most significant items were selected in order to create a specific survey (Section 6.1) to be administered to a sample of schools in Slovakia, Greece and Cyprus, countries which were not involved in the TIMSS 2011 survey.

The following table shows the list of countries that have administered the TIMSS questionnaire for the school 8th grade[5]. The European countries participating in the survey are highlighted in bold.

Table 8: TIMSS 2011 8th grade participating countries

Armenia	Georgia	**Italy**	Macedonia, Republic of	Qatar	Syrian Arab Republic
Australia	Ghana	Japan	Malaysia	**Romania**	Thailand
Bahrain	*Hong Kong-CHN*	Jordan	Morocco	Russian Federation	Tunisia
Chile	**Hungary**	Kazakhstan	New Zealand	Saudi Arabia	**Turkey**
Chinese Taipei	Indonesia	Korea, Republic of	**Norway**	Singapore	Ukraine
England-GBR	Iran, Islamic Republic of	Lebanon	Oman	**Slovenia**	United Arab Emirates

[4] The TIMSS 2011 was used as a reference because the results of the TIMSS 2015 were not available at the beginning of our work.

[5] It should be highlighted that have been included in the list of European countries also Israel and Turkey because countries participating in EU projects.

Finland	**Israel**	**Lithuania**	*Palestinian Nat'l Auth.*	**Sweden**	United States

The analysis was conducted starting from the raw data available on the TIMSS 2011 site (8) (Section 6.2) and from the result of the administration of the survey to a sample of schools from Slovakia, Greece and Cyprus (Section 6.3). In Slovakia, ten teachers and 94 students participated. In Greece, 8 teachers and 23 students participated and in Cyprus, 1 teacher and 18 students participated. The data for Slovakia, Greece and Cyprus contribute to define the European picture of the science education, although they are not significant from a statistical point of view. Although not statistically significant, there are some concerning results from the data analysed. For example, a considerable number of students do not enjoy learning science, wish that they did not have to study science, do not read about science in their spare time and find science to be boring. These results show the significance of the current project and emphasise the importance of creating a 3D VW that will motivate students to use it in their free time and also provide them with an enjoyable learning experience, to show them that Physics can be fun. Section 6.3 presents a more extensive view of all the results that were collected from teachers and students in Slovakia, Greece and Cyprus.

For each item are reported all the “relative frequencies” of the different response mode for each European country. Starting from these data, a detailed analysis was carried out in order to provide an overall picture of the science education in Europe. The analysis carried out at European level has been conducted on TIMSS 2011 data. The open source software R (version 3.2) has been used to analyse the data. The TIMSS survey uses the Jacknife sampling schema in order to ensure the representativeness of the data at national level. Any statistical analysis of such data must take into account this sampling design. TIMSS data offers different weights, each used for a specific purpose.

In our analysis, the main aim is to compare the results from different countries; thus, we used the SENWGT weight in order to compare results from countries with different sample size. According to the sampling method used in the survey, the sampling design was reproduced using the “survey” package. In particular, the *svrepdesign* function has been used to define the sampling design starting the 'JKREP', 'JKZONE' and 'SENWGT' values. All the analyses were carried out by referring to the above sampling scheme.

2.1.1 Analysis for European countries

2.1.1.1 Analysis at the student level

In order to analyse the student responses of some European countries we have selected the following items:

7. How often students use the computer?
   - At home (BSBG10A)
   - At school (BSBG10B)
   - Some other place (BSBG10C)
8. Is the teacher clear during the explanation? (code BSBG18C)
9. How students employ to perform the science tasks? (code BSBS21B)
10. How often teachers assign homework? (code BSBS21A)
11. Are the sciences a more complex matter than other classmate? (code BSBS19B)
12. How much do you agree with this statement about learning science?
    - I enjoy learning science (BSBS17A)
    - I wish I did not have to study science (BSBS17B)
    - I read about science in my spare time (BSBS17C)
    - Science is boring (BSBS17D)
    - I learn many interesting things in science (BSBS17E)

- I like science (BSBS17F)
- It is important to do well in science (BSBS17G)

The Figure 8 shows the frequencies of the use of computers in different context: at home, at school and in some other place. We can note that all EU countries have a similar trend (the two Scandinavian countries and Greece have a higher proportion of students who use computers every day) with a very high percentage always greater to 70% of students that use the pc at home daily.

A special case seems to be the Turkey, where there is a very high percentage of students who never uses the computer at home and has a lower proportion of kids who use a computer every day, than other European countries (37% of respondents compared with 75% in Italy and 92% in Sweden. In Turkey, there is a large proportion of missing data approximately 13%. England, Hungary and Greece are the countries where you use more frequently the pc at school, while Italy is the country with the highest percentage of students who never use computers at school. Italy also has the highest percentage of students who are not using the PC somewhere else other than home or school. England and Hungary have a very similar trend for all three items and are the countries where you use your PC more often to school with a frequency of at least once a week.

Figure 8: Frequencies plot for the question "When you teach science to this class, how you use the following resources?" (BSBG10)

The Figure 9 shows the perception of the students about the teachers' explanation skill ("*agree*" indicate that the teacher is clear in his explanation, "*disagree"* that the teacher is not easy to understand during the explanation). Teachers from Turkey and Cyprus seem to be the easiest to understand (but it could depend by the teachers' clarity or by the difficulty of the topics). In England, Norway

and Israel there is the same trend in the response, with greater frequency of responses indicating that students *agree* that teachers are clear. In Italy and Greece, the most frequent response is "*little agree"*. In Slovakia, the most frequent response is "*disagree a little"*.

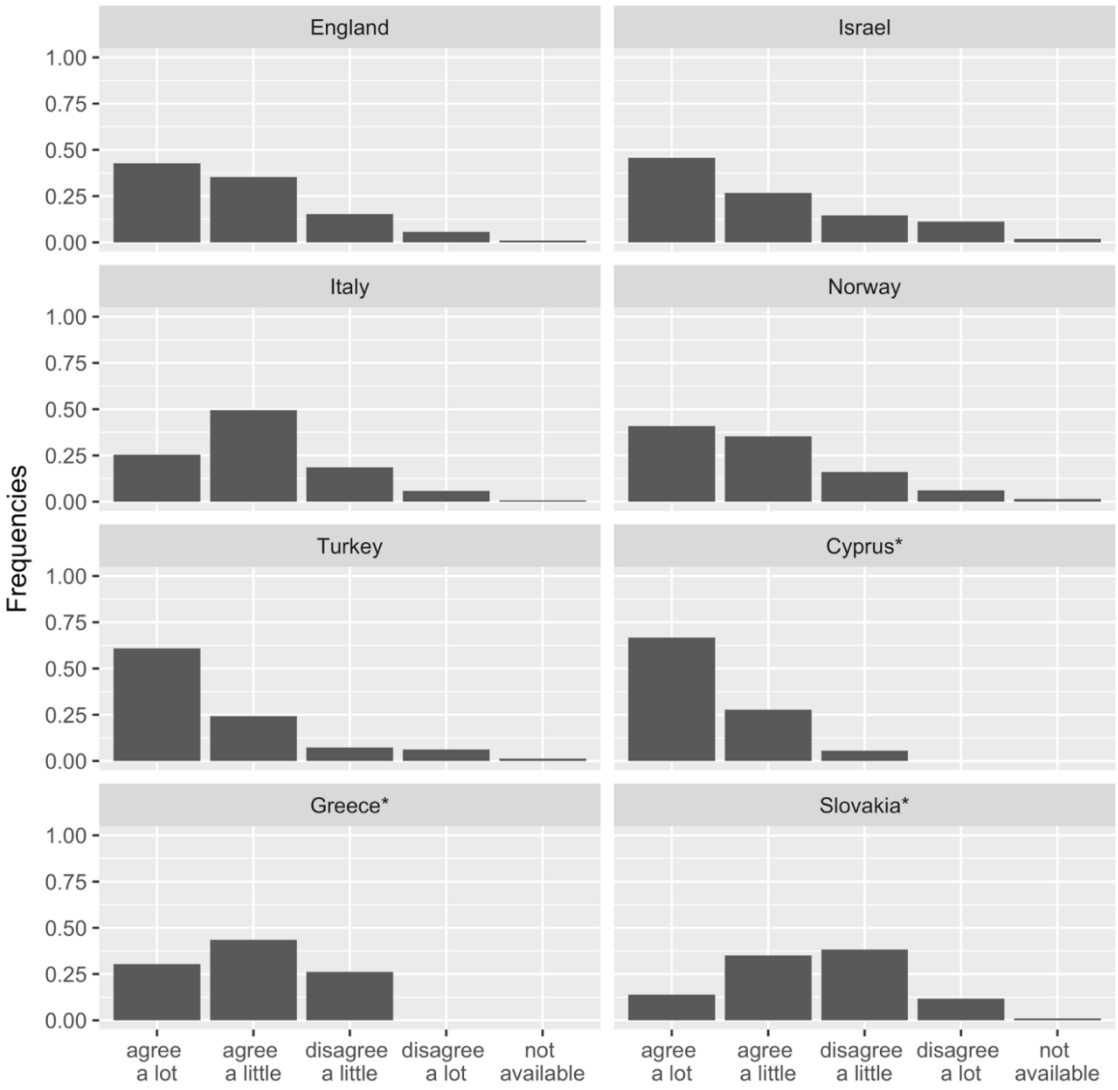

Figure 9: Frequencies plot for the question "How much do you agree with the statement 'My teacher is easy to understand' about your science lessons?" (BSBS18C)

The Figure 10 is referred to time for study, calculated in minutes, to complete the sciences homework. It shows a similar behaviour for the analysed European countries. The most common mode is 16-30 minutes, in fact most of students take a time ranging between 16 and 30 minutes to carry out the tasks of science, and very few students take longer than 90 minutes to do a task of science. Instead, in Greece the most common mode is 31-60 minutes.

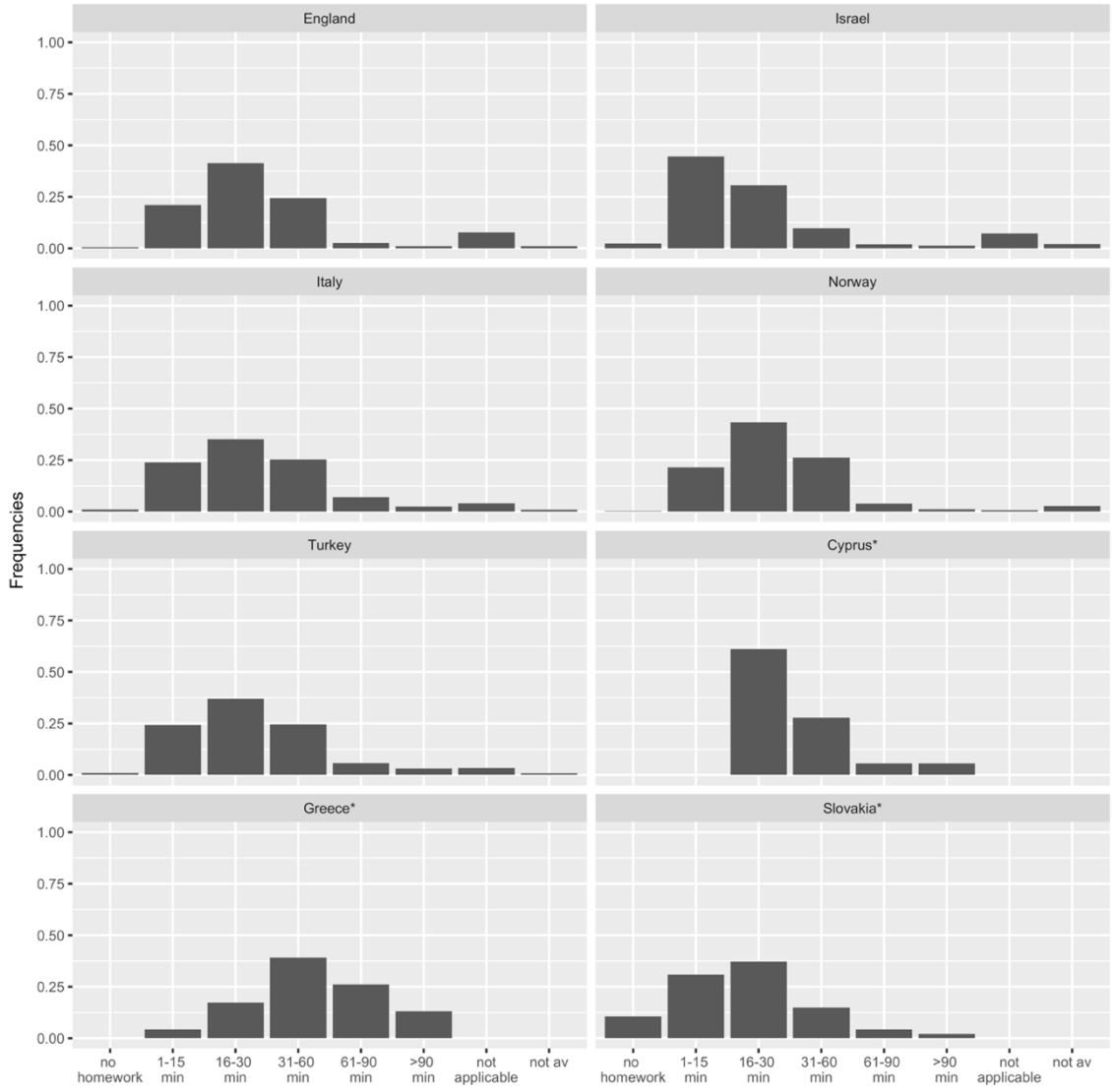

Figure 10: Frequencies plot for the question "When your teacher gives you science homework, about how many minutes do you usually spend on your homework?" (BSBS21B)

The workload and the time taken by students to complete their homework don't seem to differ much in the selected countries. Israel has a high frequency for the modality 1-15 minutes of study, compared to other European countries. Students from Israel study the sciences more quickly than other and they have a lower teaching load than other European countries.

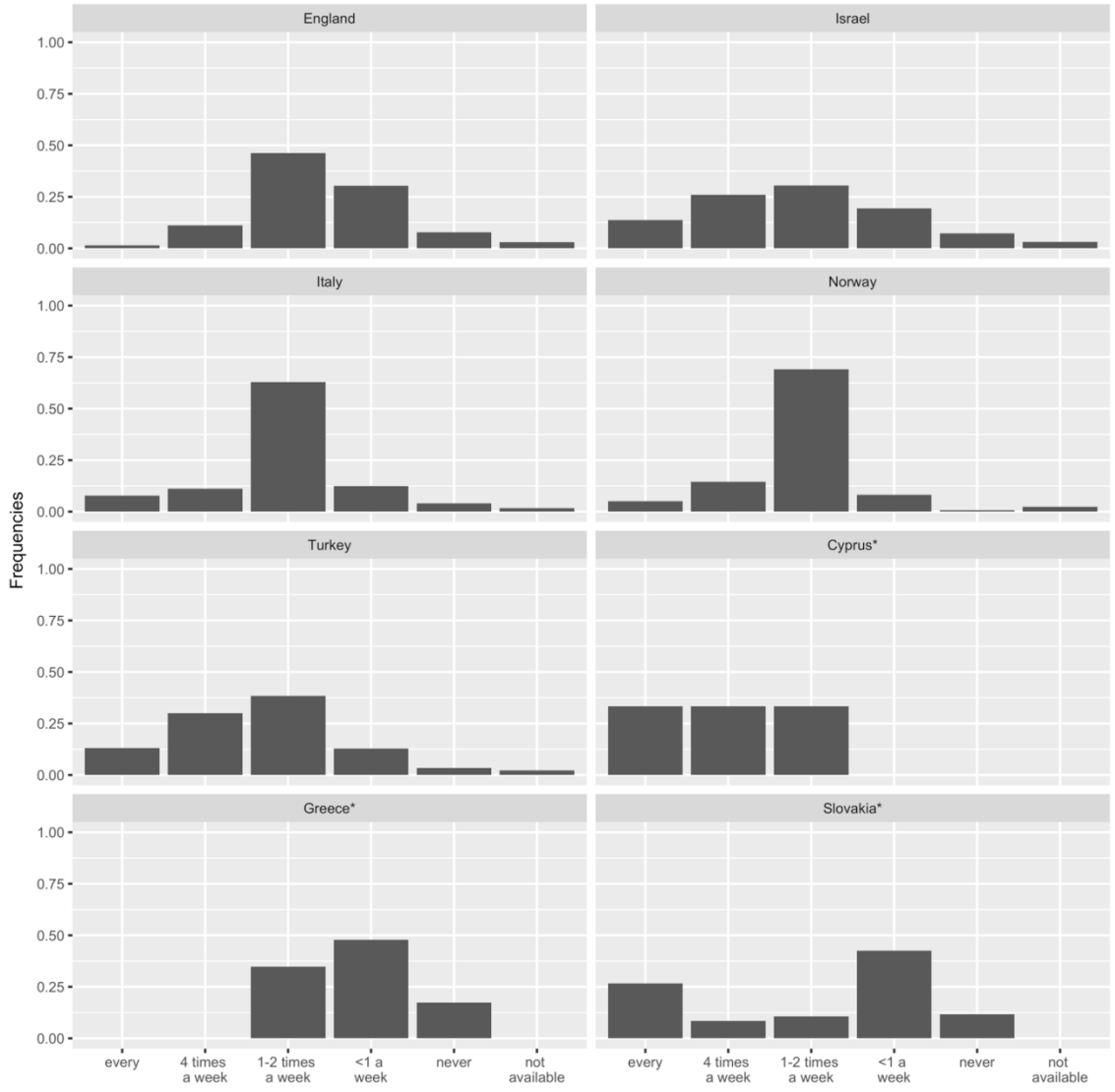

Figure 11 Frequencies plot for the question "How often does your teacher give you homework in science?" (BSBS21A)

The Figure 11 shows how many times the teachers give science homework to their students. It reveals that in most of the countries the proportion is higher for *1-2 times a week*, Italy and Norway have an identical trend with a significantly higher proportion for the response mode *1-2 times a week.* In England, teachers usually assign homework 1-2 times a week, while Turkey has a very different trend from other

European countries, the percentage of teachers who leave tasks four times a week is very high, and if compared with other European countries also the proportion of homework assigned every day is very high.

Turkey seems to be a country where the workload is very high compared to other countries with a large proportion of teachers who leave homework every day or 4 times a week (a proportion of about 40%).

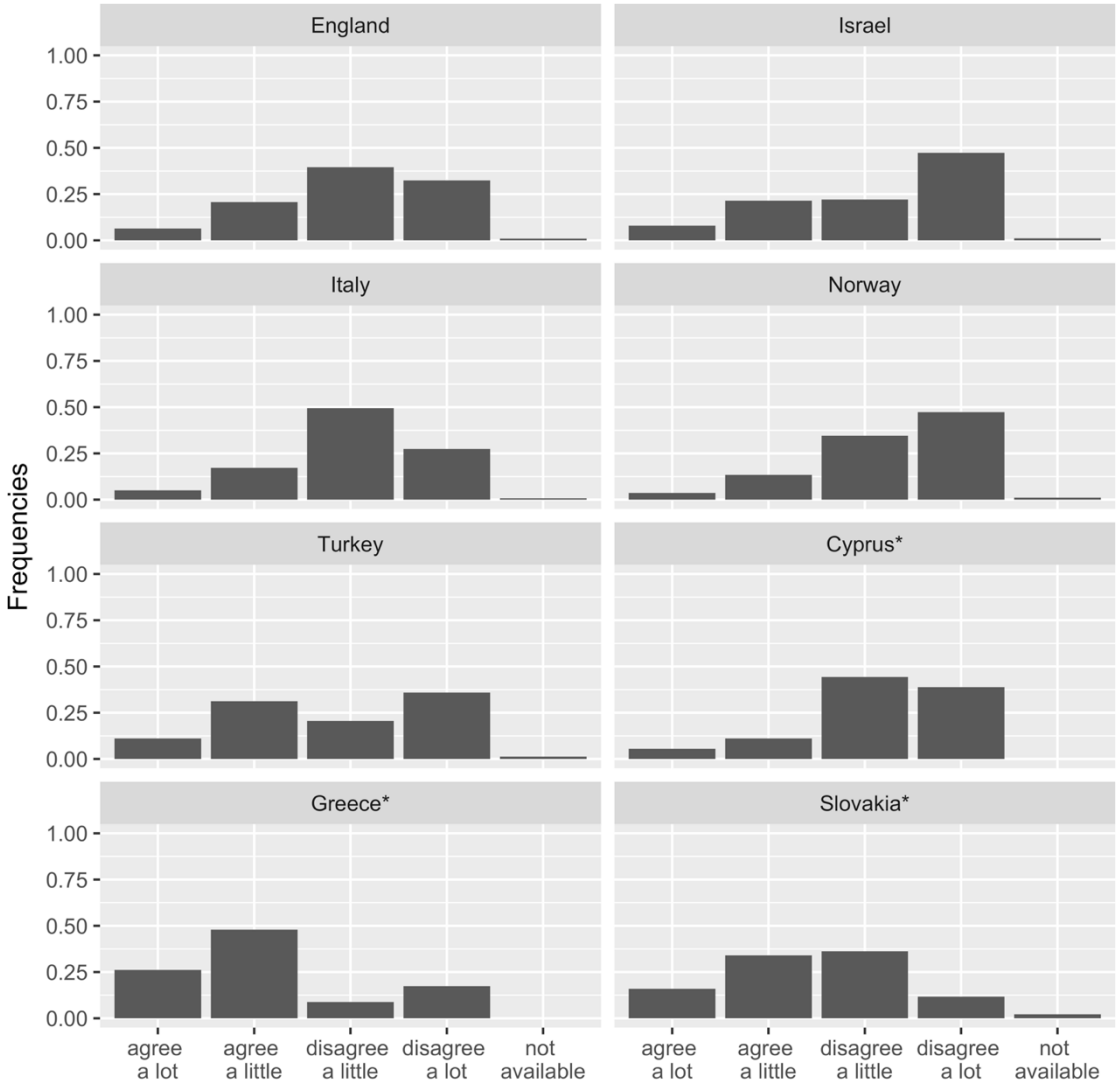

Figure 12 Frequencies plot for the question "How much do you agree with the statement 'Science is more difficult for me than for many of my classmates' about science?" (BSBS19B)

The Figure 12 shows the number of students who agree with the statement that the sciences are the material more difficult to study. None of the four countries have a high proportion of "*total agree"* answers, and the fact that sciences are the matter more complicated, in Norway there is a high percentage of responses in the mode "*a lot disagree"*, while in Italy and in England the mode "*little disagree"* has a big number of responses.

We can conclude that all European countries have the majority of students that do not believe that the sciences are the most difficult subject. Greece data reveals a specific trend; in fact there is a majority of students who feel less inclined to science than their peers.

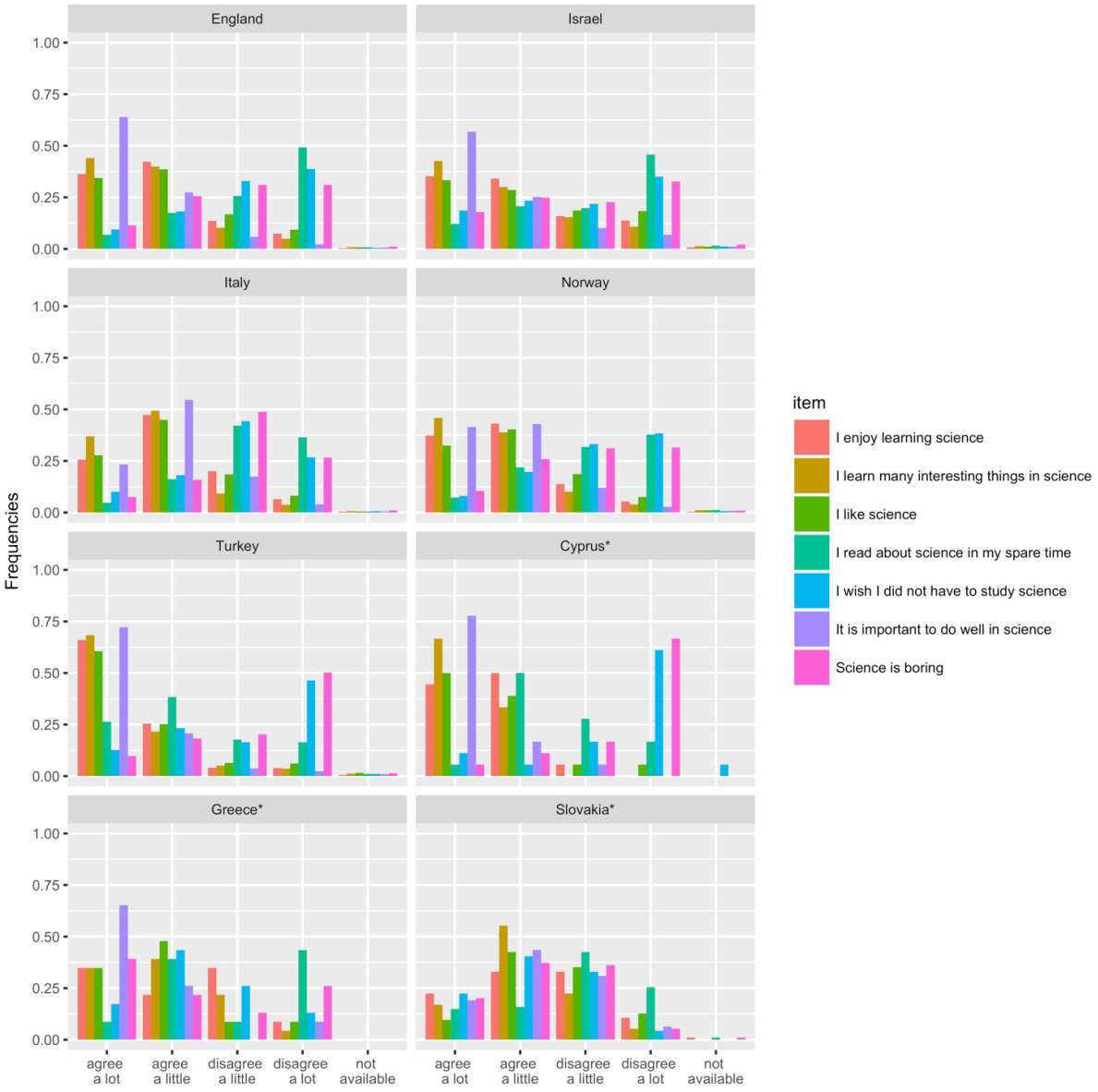

Figure 13 Frequencies plot for question "How much do you agree with these statements about learning science?" (BSBS17)

In the Figure 13, we can note that in most the countries, the science is likely and fun (especially in Turkey where there is the highest percentage of "agree a lot" for items that assess if the sciences are a subject fun and enjoyable). A small

proportion of students think that the sciences are boring and a matter a matter that they would not have wanted to study.

Italy is the country with the lowest percentage of strongly agree with the students' claim that the sciences are a funny matter, but has a higher proportion of answers “some agree” and a low proportion of students who is “not agree”, so also in Italy the sciences are a subject that like enough. In conclusion, Science is funny and amusing to study in all 5 European countries (even if students do not read a lot of science topics in free time).

2.1.1.2 Analysis at the teacher level

We have selected the following items:

1. Do you use computers in the classroom? (code BTBG09AC)
2. How often do you usually ask them to do the following?
    a. Observe natural phenomena (BTBS19A)
    b. Watch me demonstrate an experiment or investigation (BTBS19B)
    c. Read their textbook or other resources materials (BTBS19E)
    d. Conduct experiments or investigations (BTBS19D)
    e. Design or plan experiments or investigations (BTBS19C)
    f. Have students memorize facts and principles (BTBS19F)
    g. Use scientific formulas and laws to solve routine problems (BTBS19G)
    h. Give explanation about something they are studying (BTBS19H)
    i. Relate what they are learning in science to their daily lives (BTBS19I)
    j. Do filed work outside of class (BTBS19J)
    k. Take a written text or quiz (BTBS19K)
3. Do you think that is comfortable to use a computer during school lessons? (BTBG09BA)
4. A computer available during the science lessons? (code BTBS21A)

5. How often do you have the students do the following computer activities during science lesson?

    a. Practice skills and procedures (BTBS21CA)
    b. Look up ideas and information (BTBS21CB)
    c. Do scientific procedures or experiments (BTBS21CC)
    d. Study natural phenomena trough simulation (BTBS21CD)
    e. Process and analyse data (BTBS21CE)

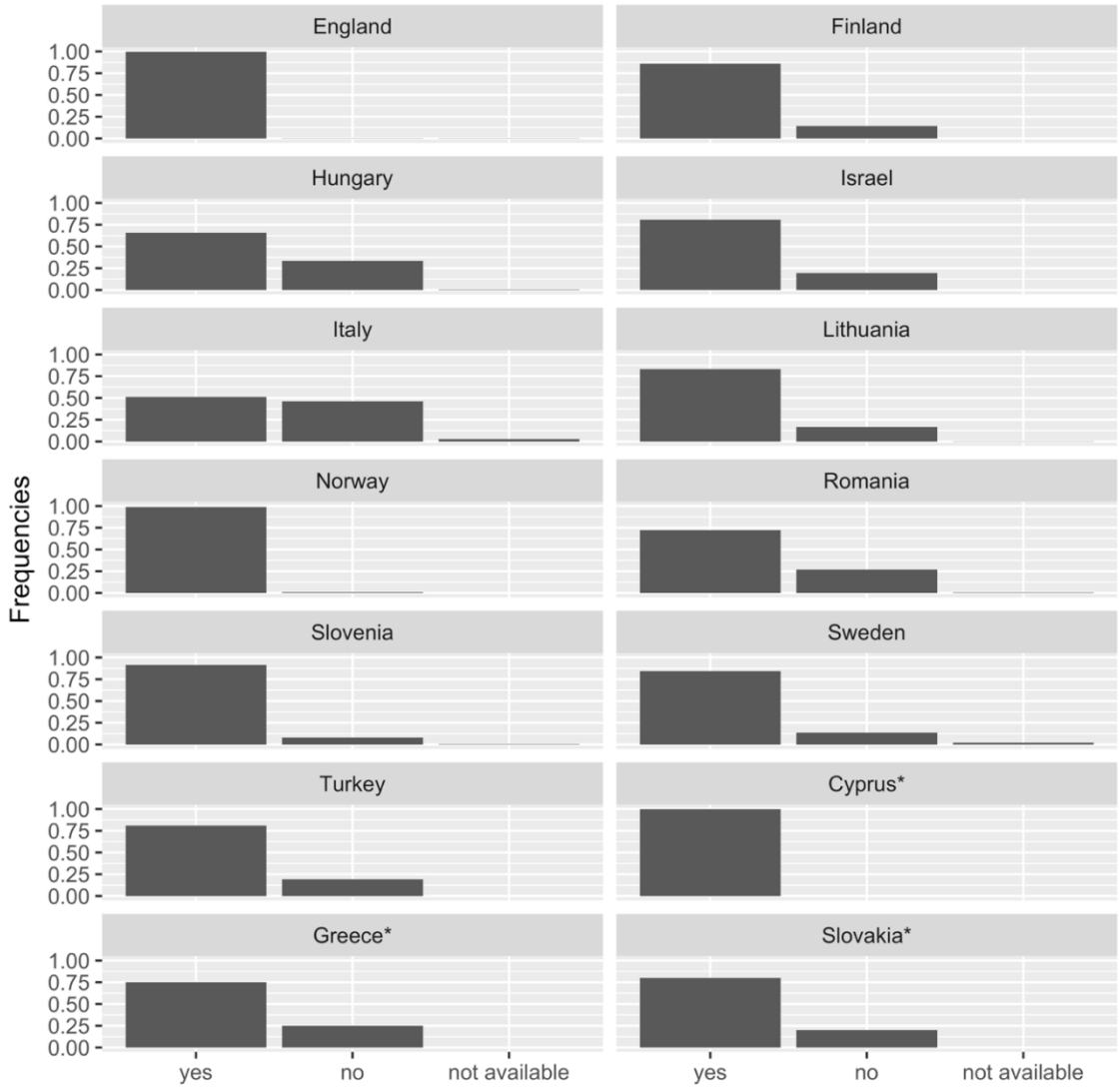

Figure 14: Frequencies plot for the question "Do you use computers in the classroom?" (BTBG09AC)

The Figure 14, that concerns the use of computers during lessons, shows some very interesting aspects. It is clear that Norway, England and Cyprus are the countries in which the use of computer during school lessons is nearly to 100%, followed by Slovenia, Finland and Lithuania with a very similar proportion. A special

mention goes to Italy, where the proportion of non-use of the computer is almost 50%, and it seems very high compared to all other European countries.

Figure 15: Frequencies plot for the question "In teaching science to the students in this class, how often do you usually ask them to do the following?" 1/2

The chart above shows that the most frequent activities in European countries during the hours of science is the reading the textbook with a portion of answers "every" higher than the other 4 items. The trend in European countries for the 4 items

is quite similar with greater frequency in “some” modes (only Turkey has a course that differs from other European countries with a very high proportion in “every” mode for the items “*to observe natural phenomena*” and “*watch the teacher doing an experiment*”. In Italy the activities that are carried out more frequently are: “*reading the textbook*” and “*observe natural phenomena*”.

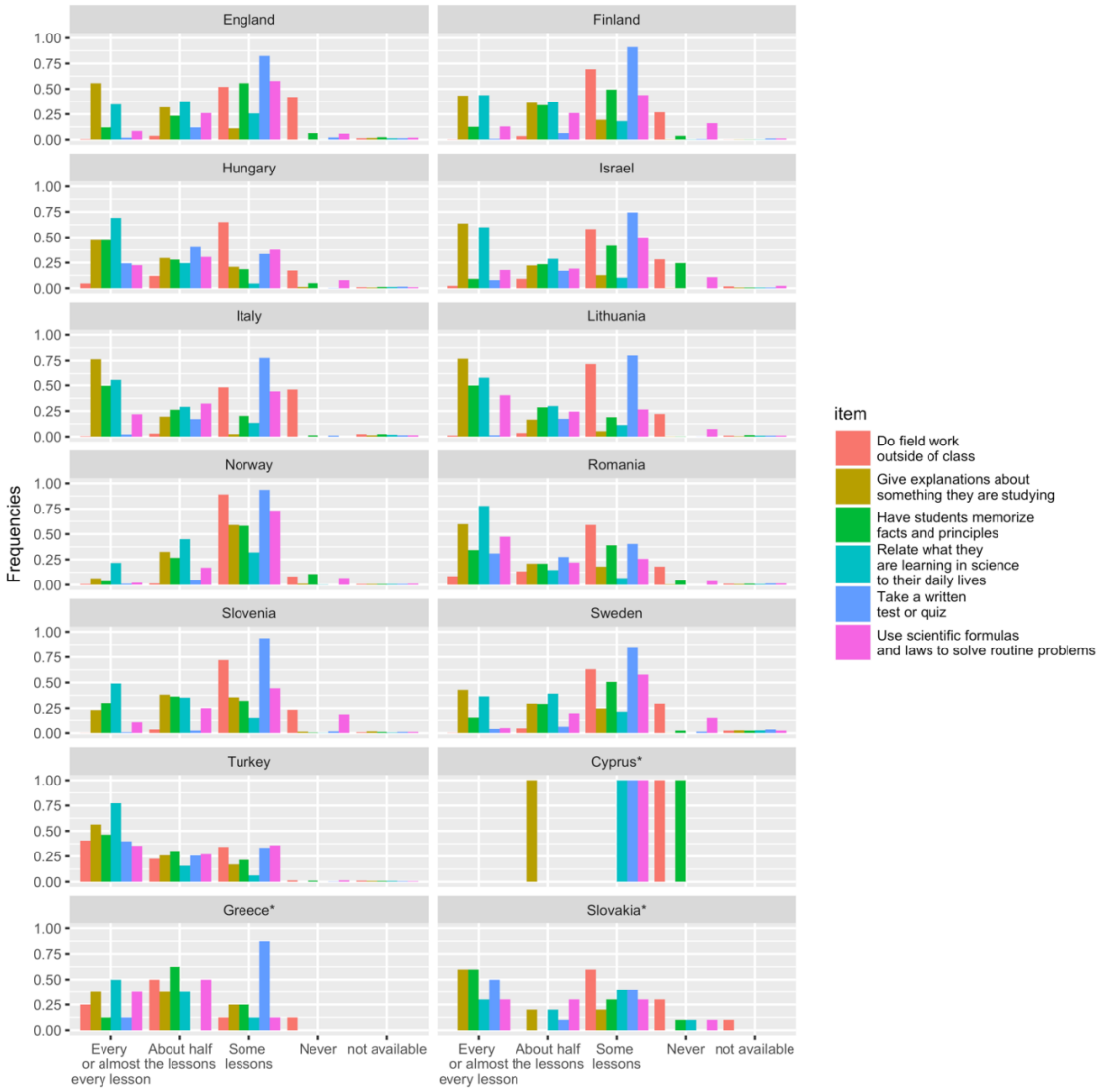

Figure 16: Frequencies plot for the question “In teaching science to the students in this class, how often do you usually ask them to do the following?” 2/2

In Figure 16, we can see how often the teachers ask to students to do these activities. Italy, Lithuania and Turkey are the countries where students are more involved, particularly in explaining the topics covered in class. The Scandinavian countries, by contrast, are those in which students not are called into question, it would be interesting to see if this happens because teachers are clear and they do not need to check if students have understood and do not need to verify their preparation daily.

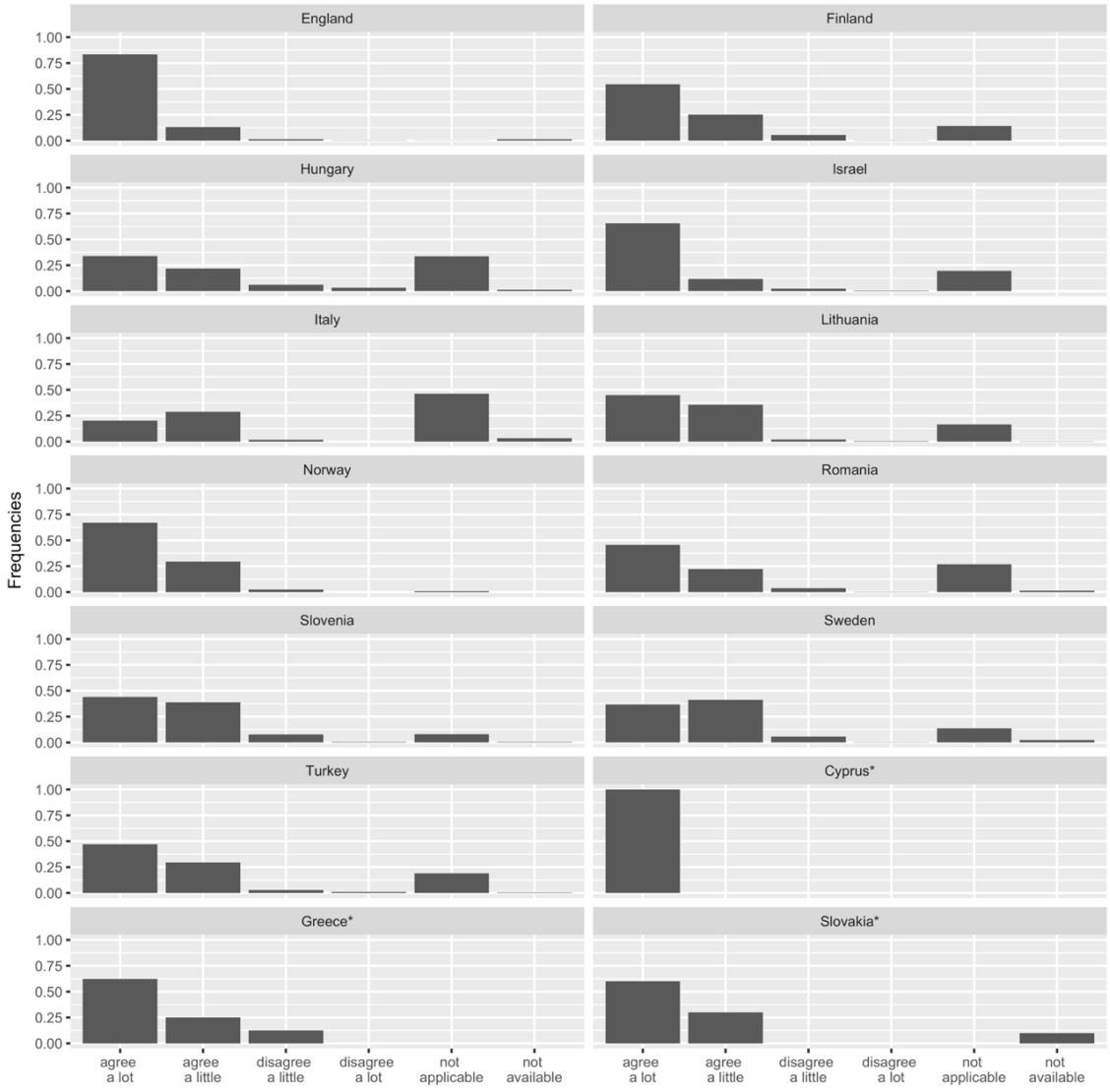

Figure 17: Frequencies plot for the question "How much do you agree with the statement 'I feel comfortable using computers in my teaching' about using computers in your classroom instruction?" (BTBG09BA)

From the plots in Figure 17 emerges a different trend for the European countries: England and Israel are those with a higher percentage of teachers who are fully agreed with the view that the computer is an appropriate tool to make lessons. Turkey and Norway have also a high proportion of teachers "*totally agree"*, and "*little agree"*, while Italy and Sweden have a higher proportion of teachers that are "*some*

agree" with this statement and are therefore the countries in which teachers do not seem to appreciate so much the use of computers in their lessons.

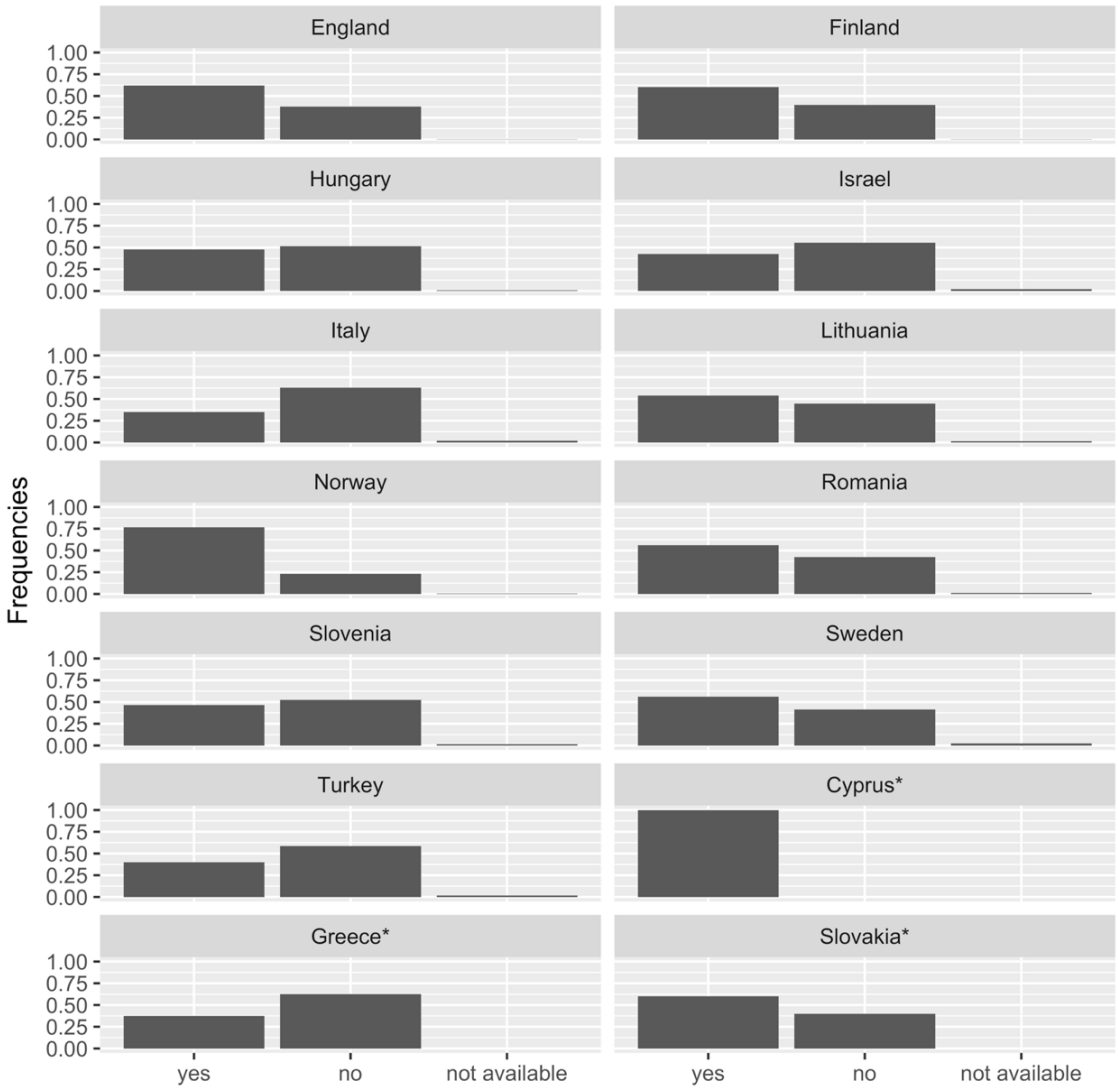

Figure 18: Frequencies plot for the item "Do the students in this class have computer(s) available to use during their science lessons?" (BTBS21A)

The Figure 18 shows the percentage of schools in the European countries where a computer is available during sciences lessons. In Italy, the numbers of schools where computers are not available is very high and well above the 60%, in

Turkey and Israel prevail the number of schools where computers are not available, but to a lesser extent than in Italy. Sweden, England and Finland have a very similar pattern with a higher proportion of schools with computers available (although the percentage of schools in which the computer is not available during science lessons is quite high). However, Norway has a very high proportion of schools with available computer and a few schools where PCs are not available during sciences lessons.

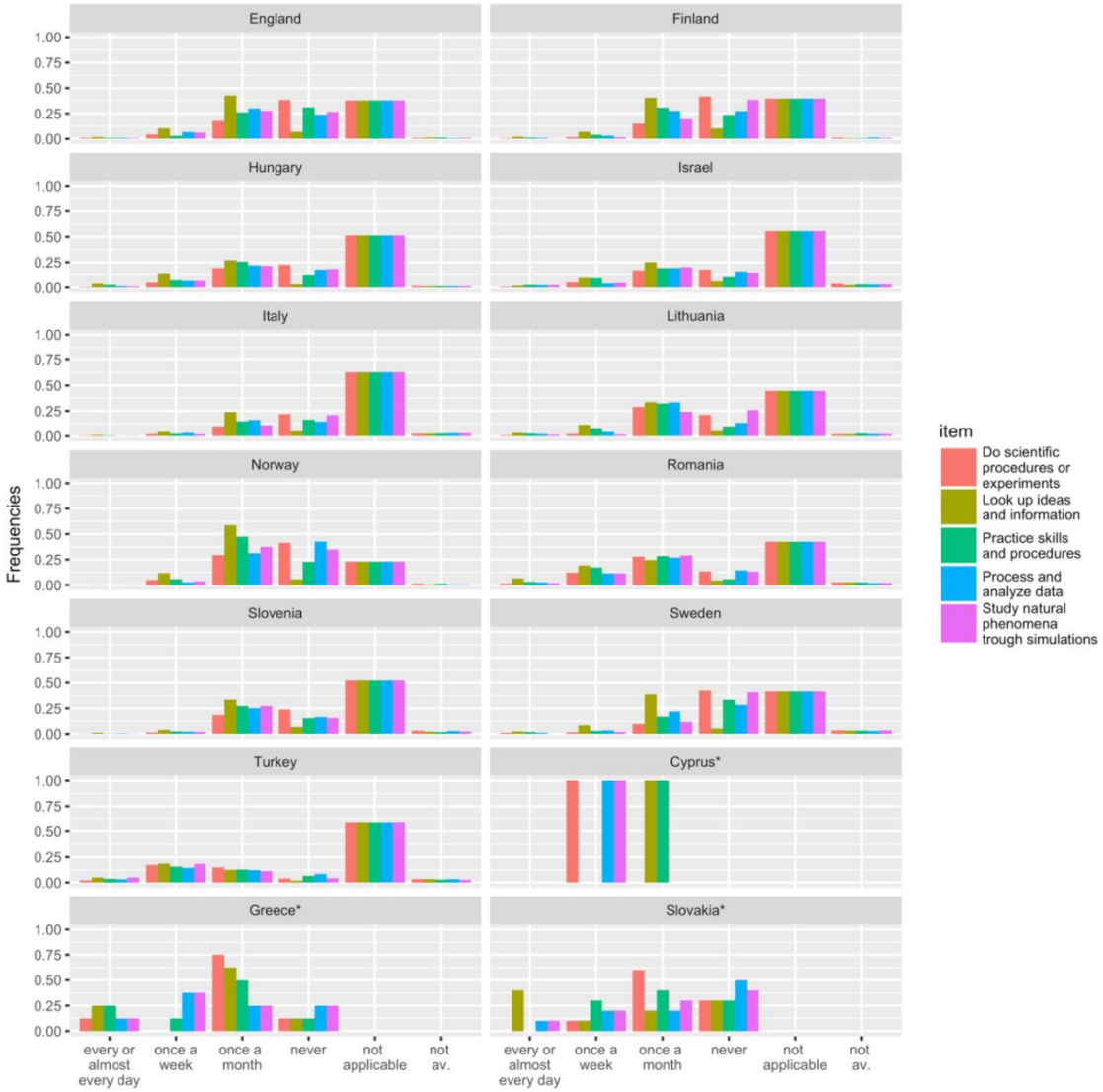

Figure 19: Frequencies plot for the question "How often do you have the students do the following computer activities during science lessons?"

In the Figure 19, we can see how many times the computer is used during science classes to perform different activities. In most European countries the computer, during the hours of science, do not assumes a fundamental role, in fact, the proportion of responses "*never or once a month*" has the highest percentage; also this time the European country with a different behavior is Turkey in which there is a greater proportion of responses "*once a week*".

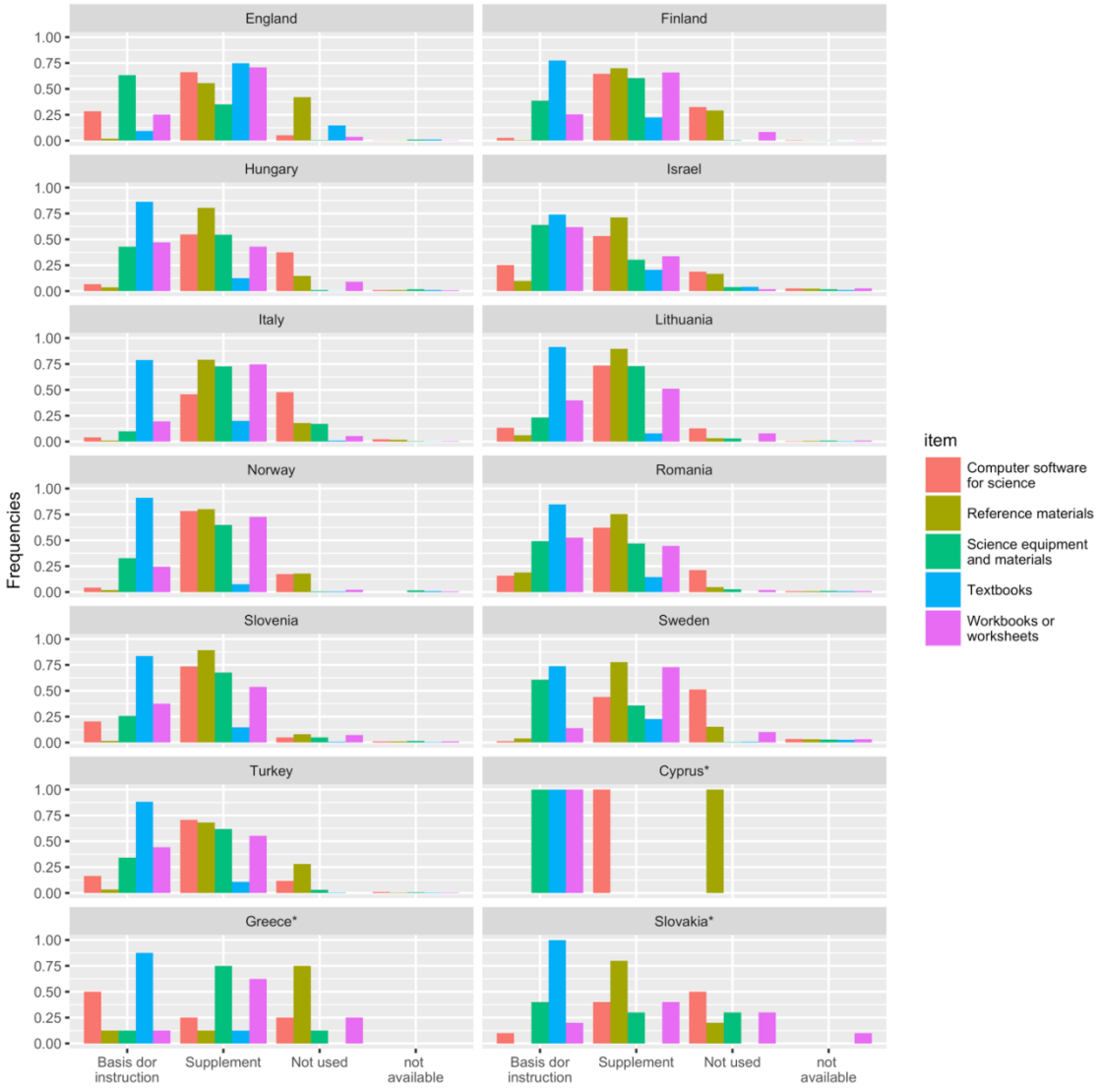

Figure 20: Frequencies plot for the question "When you teach science to this class, how you use the following resources?"

In the Figure 20 we can see how many times are used these tools in 5 different hours of science; the textbook is the basic instrument in all countries except England, the computer is considered to be a support tool for all European countries; Italy however (like Sweden) is the country with the highest percentage of responses "*not used*" to confirm that many science teachers do not use the computer to carry

out their didactic activities. In England, Israel, Sweden and Romania materials and scientific equipment are very used. In general, it can be said that the textbook is still the most used tool by teachers of European countries to carry out their teaching activities.

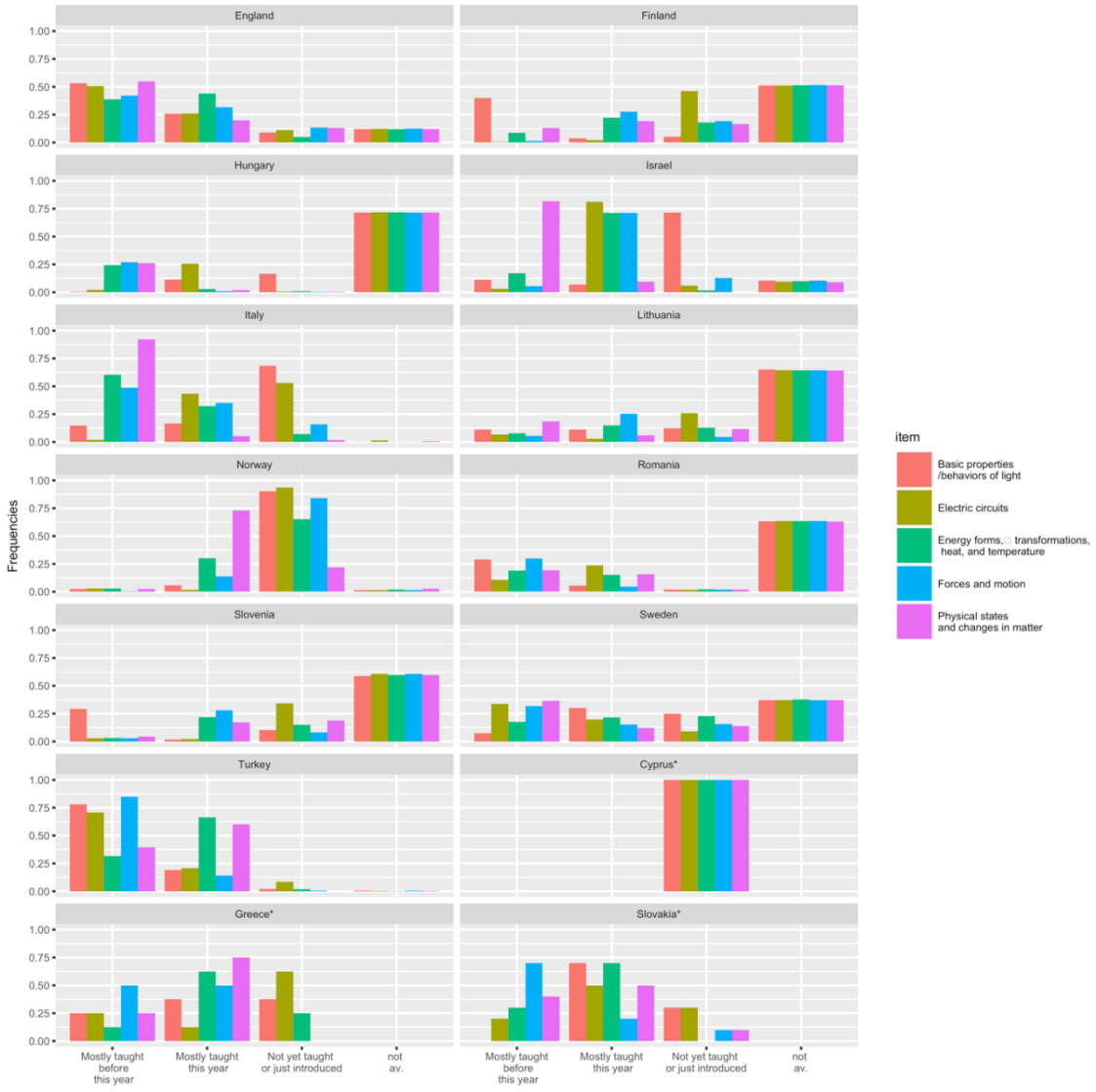

Figure 21: Frequencies plot for the question "Choose the response that best describes when the students in this class have been taught each topic"

The analysis of the question BTBS22C offers a picture of when, in respect of the grade 8, specific physic subjects are treated in the different European school systems. The subjects analysed are "*Physical states and changes in the matter*", "*Energy forms, transformations, heat, and temperatures*", "*Basic properties/behaviours of light*", "*Electric circuits" and "Forces and Motion*". The graph shows a strong variability between the European countries. Some countries, such as Lithuania, Romania, Hungary, Slovenia and partly also the Finland does not provide a precise information, in fact, in these countries, there is a prevalence of data not available. For Cyprus and Norway, these topics are addressed in subsequent years. Generally, England, Italy, Greece and Slovakia cover these topics before or in the eighth grade; in particular, only topics like light and electrical circuits are covered in the successive years in Italy, Greece and Slovakia.

2.1.1.3 Analysis at the school level

For the analysis at the school level the following question was selected:

1. “How much is your school’s capacity to provide instruction affected by a shortage or inadequacy of the following?”
    a. Audio visual resources for science instruction (BCBG09CE)
    b. Calculators for science instruction (BCBG09CF)
    c. Science equipment and materials (BCBG09CG)
    d. Library materials relevant to science instruction (BCBG09CD)
    e. Technologically competent staff (BCBG09AF)
    f. Teachers with a specialization in science (BCBG09AC)
    g. Computers software for science instruction (BCBG09CC)
    h. Computers for science instruction (BCBG09CB)

Figure 22 and Figure 23 allows evaluating how the teaching is influenced by different resources like audio-visual resources, calculators for science instruction, library materials relevant to science instruction and science equipment and materials.

In Figure 22 we can see to how education is affected by the inadequacy of pc, specialized teachers and technologically competent staff during school hours. It shows such as UK and Slovenia are the countries with fewer problems (have a higher proportion of answers "*not at all"*). Turkey is the country with a very high proportion of answers "*some"* and "*a lot"*, while Italy ranks in a middle position with a similar trend to that Finnish (except the item "teacher with specialization").

Figure 22: Frequencies plot for the question "How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the following?" 1/2

In many European countries such as England, Finland, Lithuania, Hungary, Romania and Slovenia it is interesting to note the very high response rate for the answer "*not at all*" in the item "*teacher with a specialization*". The countries, with a high percentage of responses "*a lot*" are Israel and especially Turkey, where it emerges that the teaching is strongly negatively affected by the inadequacy of teachers with specialization.

Figure 23: Frequencies plot for the question "How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the following?" 2/2

Figure 23 shows the calculators are the tools that not adversely affect the teaching of science education in all European countries (except Romania), since they have a very high proportion of "not at all" responses (especially in Norway and Sweden, the proportion of not at all is greater than 79%). There are European countries where education is being negatively affected by comparison to these four items; the only

countries that have a high proportion on "*a lot*" of modes are Israel and Turkey. In Italy, the items with a higher proportion of responses on "*a lot*" mode are the equipment and school supplies.

2.1.2 Conclusions

The analysis of the results leads us to conclude that there are not very large differences from the point of view of the study time and the workload for students (except for the Turkey).

The Scandinavian countries and the UK have similar trends and have the best performance with regard: the skills of teachers in the explanation, the skills of the technical staff and the increased use of PCs at home and in class.

Turkey is the European country that has a trend leading away more other European countries for many items, especially about "*the use of PCs at home*", where it has a lower percentage of students who use the PC at home at least once a week.

Italy has similar results in terms of "*study load* "and "*use of home PCs*", but it seems to be highlighted "*a smaller capacity of teachers in the explanation*" and a higher frequency times in which students are invited to explain the topics learn during the lessons (probably teachers are not very clear and they want to verify if students have really understood the topics covered in previous lessons).

The data on the "*use of the computer during the lesson*" analysed in almost European countries reveals that there is a value more than 80%, while Italy is just over 50%. This result points out a weakness of the Italian school system in which in many schools is not possible or is not practiced by the teachers the use of computers at school.

3 An analysis of teaching methods in Physics Education

When we talk about teaching methodologies there is no way to identify one that is good for all student and all contexts. Teachers have access to a variety of strategies, methods and teaching techniques which are to be intended as "tools of the trade" to choose from depending of not only their teaching style preferences, but also the economic and social student context, the topic that will be addressed and the typology of goal to be addressed.

In the following paragraphs, we will present main strategies, methods and technologies used in teaching, then we show some experiences of their use in the sector of physics education.

3.1 Teaching Strategies

The strategy represents the general orientation, of an educational intervention, defined by the teacher in quality of facilitator of the Learning Process.
There are two mainly strategies:

- **Exposition strategy**: Teachers focus on the content's aspect of teaching. Exposition strategy is indicated for content's transmission infact it guarantees a systematic teaching.
- **Heuristic strategy**: is focused on the learning style of pupils and encourages student's participation. The pupils's involvement leads a more significant effort from the cognitive point of view and allows on time tuning of teaching content by monitoring student attention and motivation.

3.2 Teaching Methods

The teaching methods are specific actions of the educational process with the aim of achieving specific educational goals. Teachers, starting from the educational goals, organize a series of activities to promote the acquisition and consolidation of knowledge of the facts, the phenomena, formulas, ideas and laws, guiding students in a general process of acquisition of skills.

Following an overview of the main teaching methods:

- **Non-Directive method**: This method developed by the psychologist Carl Rogers, is based on the human relations instead of concepts of subject matter. Rogers state that people need to have positive human relationships in order to grow and learn. The teacher's goal is to help students develop a personal learning style, empathy, confidence, a strong personality and help them solve their learning problem.
- **Groupwork**: The learning processes are centered on the group: discussion groups, workshops, peer learning. Group works motivate students, encourage active learning, and develop key critical-thinking, communication, and decision-making skills.
- **Team teaching or teacher group**: teachers interact and integrate their skills to provide benefit to students. Research results show that team teaching improve student learning outcomes, retentions rate, interpersonal skills, communication skills, analysis and judgment and student-teacher relationships.
- **Mastery learning**: it aims achieving selected goals and complete knowledge and mastery of the matters treated to the highest number of pupils. If necessary, teachers can appeal to individualized study plans commensurate to the aptitudes and capacities of each student. The individualized learning path take in account the diversity of cognitive styles, learning styles and

learning times through the continuous monitoring of the ongoing difficulties and strengths and weaknesses.

- **Socratic method**: It was developed by the philosopher Socrates. The questions follow an exact order develops in a series of stages that drive the student in a specific Reasoning.
- **Active method**: is a student centered method based on the state that student learns better through its activities, discovering in autonomous way and placed in front of the problem seen in its entirety and complexity. The teacher is a facilitator and provides advice during the learning process.

3.3 Teaching techniques

The teaching techniques concern specific aspects, aimed at the realization of educational intervention, required by the educational project and placed inside the method that you are using. The teaching techniques represent the tactical action of the teaching and are not exclusive of a specific method or of a specific strategy.
Following an overview of the main teaching techniques:

- **Role-Play**: the role-play is a teaching technique that is part of the active methods. Students are asked to perform the role of "Actors", to represent a specific situation “Interacting Between Them”. Other participants act as "observers" of the content. A common way to proceed is to put in place an "accident" giving to participants the opportunity to examine their own behavior, to practice and experiment with new attitudes, to emphasize different points of view and receive a feedback on their behavior.
- **Peer-Tutoring**: is a teaching technique that is based on two circumstances which often occur in the classroom: students' intellectual level differences and their ability to collaborate. The teacher form group of two people and assign the tutor role to one and the learner role to the other one; finally, a common educational goal that is recognized and accepted by both is provided.
- **Cooperative Learning**: is a teaching technique through which students learn in small groups, helping each other and feeling co-responsible of the learning path. The teacher assumes the role of facilitator and organizer of activities. The teacher creates a "learning environments" in which the students, encouraged by a positive climate, turn every learning activity in a process of "group problem solving", achieving the objectives whose realization requires the contribution of all group.

- **Virtual community** is born among a group of people who share a set of practices, activities, interests, and using the Internet as a place to meet, share experiences and knowledge.
- **Communities of practices** (Etienne Wenger) are based on the idea that involvement in social practice is the fundamental process by which you learn.
- **Learning Communities** (A. Brown, J. Champion) are developed taking as a reference model to the scientific research community. Underlying them is the sharing of knowledge by the participants, and on the enhancement of metacognitive aspects: learning to learn. In learning communities, they are also favourite forms of peer tutoring and reciprocal teaching.
- **Learning Circles** (M. Riel) The learning circles foster collaboration and cooperation between schools, classes and workshops. These are global virtual community where you can develop and implement joint projects, collect information and describe on specific issues.

- **Learning-By-Doing** (9): means learning from experiences resulting directly from one's own actions, as contrasted with learning from watching others perform, reading others' instructions or descriptions. In the present context, "direct experience" means sensory contact with the results of doing. It enables students to spontaneously increase their maturity, their individual skills and deepen, with spontaneity and naturalness thanks to "first person" participation, their knowledge.
- **Experimental Learning**: this technique is based on principle that a person should learn through discovery and experience. The theory is called "Experiential Learning" to emphasize the central role that experience plays in the learning process (10). A classic example of teaching in the field of physics, is one in which a primary class needs to study the liquid measuring unit. The

first thing a teacher does is ask the kids what they drink milk at breakfast. All responses will be accepted and then we start with the experience. They bring the kids in the laboratory, with graduated containers where the measurements and then cups and glasses used for breakfast are marked. They fill up the containers and you begin to transfer water. "If I fill four glasses to the brim I get a liter, then a glass is a quarter of a liter."

Outdoor training is an example of experiential learning, it is a training outside the classroom where the group dynamics are more favourable environment in which to manifest itself.

- **Webquest**: A webquest is a teaching technique based on search activity, based on search activity in which students work with information from whole or in part by the Internet. An important element of this technique is to find a task that creates a deep reflection of the students on the content.

  A Webquest includes the following elements:

  - Introduction and/or presentation of the topic.
  - Assign the task. There are several ways to assign the task, in order to prevent the student is confined solely to gather information, for example asking students to: solving a problem, analyse the information, judge a behaviour or situation.
  - Process: give suggestions to students to complete the task in the most appropriate way. An important element of the process is to promote cooperation and interdependence processes among students.
  - Resources: sources of information, internet and more.
  - Assessment: the teacher has to explain the criteria and the evaluation procedure
- **Serious Game and simulation:** increase the learner's motivation, enabling him to embark on engaging and challenging paths through an enjoyable game.

The possibility to repeat the game, permits to acquire the mastery of the game dynamics and so the educational contents that the teacher want to transfer. These aspects have an impact on classroom education as well as on training programs, making the learning experiences informal and more effective.

3.4 Science Education

The teachers highlight the importance of researching teaching method to increase student motivation to learn physics. Mostly students thought that physics is complicated, so they felt less motivated to engage the subject. For the teachers, an important aspect of motivating student in the class to learn the subject is to encourage the student to have a positive attitude toward the subject.

3.5 Laboratory Teaching

The Laboratory (operating educational method), it should be understood in a broad sense: as any space, physical, operational and conceptual, suitably equipped and adapted for carrying out specific educational activities.

The physics laboratory is the moment in which the student approaches the real phenomena. In fact, in the physics laboratory the student is committed to investigate and discover properties, laws and relationships, to build models or validate them.

The activities carried out in the laboratory can be: strictly guided through a detailed work sheet, totally free or guided in part by a generic worksheet. It is important that the student learns “the art of experimentation”, so, it’s necessary that there are significant moments in which the student has the opportunity to act independently, make choices, by trial and error, to develop strategies, etc.

The experiments can be classified as follows:

1. Experiments to study/verify a physical law. They have educational values prevalent the following topics: measurement, data analysis, formalizing a posteriori and instructional aspects.
2. Demonstration experiments are particularly useful for the development of knowledge and understanding and analytical skills.
3. Discovery experiments have the characteristic to stimulate the interest and curiosity of students by stimulating them to find explanations, thus clearing up the physical concepts involved and enhancing the "divergent/lateral thinking".
4. Experiments with objects or phenomena of everyday life help to develop "critical thinking" and the transition from everyday language to science.
5. Use of the computer in the physics laboratory, both for the analysis of the data is for the collection on-line data of an experiment, by means of suitable sensors and link interfaces to the computer.

The study “Impact of Laboratory-Based Instructional Intervention on the Learning Outcomes of Low Performing Senior Secondary Students in Physics” (11) investigated the impact of laboratory-based instructional intervention on the learning outcomes of low performing senior secondary students in Physics. Based on the findings of this study, the following recommendations were made that:

- Physics teachers should be encouraged to adopt laboratory based instructional intervention method as an effective learning strategy to enhance the performance of low performing students in and influence their attitude towards Physics.
- Physics students at senior secondary school level should be given the opportunity to handle and manipulate materials, tools and equipment in the laboratories.
- Effective use of this method to teach physics can provide students with low performance in Physics the opportunity to participate in the activities and maximize individual potentials in learning the subject.

- Emphasis in Physics practical should focus on the core processes of learning incorporated in the laboratory based strategies used in this study.

3.6 Inquiry-Based Science Education

Inquiry-Based Science Education (IBSE) is a pedagogical method based on the investigation in which to teaching and learning sciences can be implemented in various ways that derive from the analysis of modes of learning of the students, by the nature of scientific research and a careful reflection on the core content to be learned.

"The inquiry is a multiform activity that involves making observations; ask questions; examine manuals and other information sources to acquire what is already known; planning investigations; review what is already known in light of experimental evidence; using tools to gather, analyze and interpret data; proposing answers, explanations, and predictions and communicate results. The inquiry requires the identification of assumptions, use of logical and critical thinking and to consider alternative explanations (12).

According to the American National Research Council the main characteristics are:

1. involvement actively by significant questions from a scientific point of view;
2. collection of evidences to develop and evaluate explanations for the scientific questions;
3. development and formulation of explanations starting from direct and indirect evidences;
4. assessment of explanations in light of alternative explanations (peer comparison and comparison with scientific knowledge);
5. communication and justification to explain proposals.

The IBSE promotes in students' ability to use scientific knowledge, to identify questions and to draw conclusions based on tests, to understand and to help make decisions about the natural world and the changes made to it by human activity "(Pisa-scientific literacy).

3.7 Experiences of teaching methods applied to Physics

3.7.1 Cooperative Learning

ÖNDER e Silay (13), propose a cooperative learning model for the study of physics based on the organization of groups formed by students who have different learning style. In fact, the research paper “The Importance of Learning Styles to Form More Successful Cooperative Groups in Physics Course” (14) shows better performances in students in the physics course and the cooperative groups formed according to their learning styles are more effective than the cooperative groups formed according to their academic success. In the study groups the students have different roles according their specific learning styles:

- Visual students:
  - transferring the group’s work into a paper,
  - drawing the experiment plan and showing the data on a table.
- Auditory students:
  - explaining the answers to the questions in the worksheets to the class,
  - presenting the experiment results to the class.
- Kinesthetic students:
  - solving the problems on the board,
  - preparing the experiment equipment and establishing the experiment mechanism.

3.7.2 Flipped classroom

This methodology foresees a certain degree of autonomy and preparation by the student. In fact, the time at house is dedicated to acquire information, while the time at school is used for laboratorial activities. The teacher asks to students to obtain information (indicating resources or preparing video lessons) so they have a baggage of knowledge and skills to activate and apply during the lesson at school.

The web site http://www.flippingphysics.com/ is a portal with the mission to:

- teach physics to as many people as possible,
- make physics education fun and real,
- provide free lecture videos for teachers to help flip their students' learning.

The portal contains many open learning resources (video, text, blog, software etc.) addressed to the teachers in order to adopted flipped methodologies in the classroom.

3.7.3 Game Based Education

The paper “The Application of Traditional Game Rorodaan as Learning Tool in Physics Subject: Force and Movement to Improve Learning Results” (15) describes the Rorodaan game and an experimentation setting with student in physics. This game explain the physics topics force and movement in a concretely way and offer the opportunity to test the dynamic theory through the game. This teaching method permit to learners to improve the scholastic performance in physics subject.

3.7.4 Virtual Reality

The virtual reality can amplify student’s learning thanks to immersive inquiry environments for learners' knowledge construction (16). By themselves becoming part of phenomenon, learners gain direct experiential intuitions about how the natural world operates.

REAL TIME RELATIVITY is a virtual reality environment enables to understand phenomena that are outside human experience. The paper “Student experiences of virtual reality - a case study in learning special relativity” explores how students used this environment to study physics topic. This report highlights that virtual reality may make difficult abstract topics more accessible. According to this paper “Students found the simulation to be a positive learning experience and described the subject area as being less abstract after its use. Students were more capable of correctly answering concept questions relating to

special relativity, and a small but measurable improvement was observed in the final exam".

AVARES virtual reality campus (17) hosts various learning facilities such as 3D auditoriums (environments for virtual training sessions), media room, virtual 3D Libraries etc. Objectives of the activity will be to introduce students to the Renewable Energy Sources, support their collaborative working skills and some ICT skills such as Virtual Reality.

4 Bibliography

1. Eurydice. Description of National Education Systems – Greece. [Online] https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Countries.
2. EC. Education, Audiovisual and Culture Executive Agency. Science Education in Europe: National Policies, Practices and Research. [Online] 2011. http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/133EN.pdf.
3. Cyprus Ministry of Education and Culture. The Education System of Cyprus. . [Online] http://www.highereducation.ac.cy/en/educational-system.html .
4. A guide to education in Cyprus. [Online] http://moec.gov.cy/odigos-ekpaidefsis/documents/english.pdf.
5. Αξιολόγηση του μαθήματος της Φυσικής. [Online] http://archeia.moec.gov.cy/sm/213/ap_periechomeno.pdf .
6. Περιεχόμενο Φυσικής (περίγραμμα ύλης ανά τάξη, θεματικές ενότητες). [Online] http://archeia.moec.gov.cy/sm/213/ap_axiologisi.pdf .
7. The cross thematic curriculum framework for compulsory education of Greece. [Online] http://ebooks.edu.gr/new/ps.php.
8. TIMSS. TIMSS. [Online] http://timss.bc.edu/timss2011/international-database.html.
9. The learning-by-doing principle. Reese, Hayne W. s.l. : Behavioral Development Bulletin, 2011.
10. Kolb, David. Experiential education: Experience as the source of learning and development. s.l. : FT Press, 2014.
11. Ojediran, I. , Oludipe, D. and Ehindero, O. Impact of Laboratory-Based Instructional Intervention on the Learning Outcomes of Low Performing Senior Secondary Students in Physics. Creative Education. 2014, s. 197-206.

12. Wang, Jingying, Guo, Donghui and Jou, Min . A study on the effects of model-based inquiry pedagogy on students' inquiry skills in a virtual physics lab. Computers in Human Behavior. August 2015, pp. 658-669.
13. ÖNDER, Fatih , SILAY, İlhan a EYLÜL, Dokuz. The Importance of Learning Styles to Form More Successful Cooperative Groups in Physics Course. European J of Physics Education . 2016, Zv. 6, 4.
14. ONDER, Fatih a SILAY, İlhan. The Importance of Learning Styles to Form More Successful Cooperative Groups in Physics Course [S.l.]. European Journal of Physics Education. 2017, Zv. 6, 4, s. 1-11.
15. Okky, Fajar Trimaryana a Ratih , Rizki Retinofa. The Application of Traditional Game Rorodaan as Learning Tool in Physics Subject: Force and Movement to Improve Learning Results. Journal of Physics: Conference Series. 2016, Zv. 739, 1.
16. Jacobson, Michael a Reimann , Peter . Designs for Learning Environments of the Future: International Perspectives from the Learning Sciences. s.l. : Springer Science & Business Media, 2010.
17. Avares. [Online] 2017. http://avares.org/home.
18. Guida alla nuova scuola secondaria superiore MIUR,
19. Science education in Europe: national policies, practices and research. Euridice; Education, Audiovisual and Culture Executive Agency, 2011
20. New trends: promotion of didactic methods that favour the increase of OF students' interest and motivation for studying physics; L. DINESCU, C. MIRON, E.S. BARNA, Romanian Reports in Physics, Vol. 63, No. 2, P. 557–566, 2011
21. "The Structure of the European Education systems 2014/15: schematic Diagrams (2014) Euridice, Education and Training
22. The Importance of Learning Styles to Form More Successful Cooperative Groups in Physics Course, Fatih ÖNDER, İlhan SILAY, Dokuz Eylül University

Buca Faculty of Education Izmir, TURKEY, European J of Physics Education Volume 6 Issue 4 Onder & Silay (2016)

23. Giuseppina Rinaudo - Didattica della Fisica, Corso SIS – Indirizzo fisico-matematico - a.a. 2006/07, sito web: http://www.iapht.unito.it/fsis
24. TESSARO - Processi e metodologie dell'insegnamento - SSIS Veneto
25. Isaac Ayodele Ojediran, Daniel Idowu Oludipe, Olusola Joseph Ehindero - Impact of Laboratory-Based Instructional Intervention on the Learning Outcomes of Low Performing Senior Secondary Students in Physics. Creative Education, 2014, 5, 197-206 Published Online March 2014 in SciRes. http://www.scirp.org/journal/ce, http://dx.doi.org/10.4236/ce.2014.54029
26. David A. Kolb, Experiential Learning: experience as the source of learning and development (Englewood Cliffs, Prentice Hall, 1984)
27. Hayne W. Reese, The Learning-by-Doing Principle, West Virginia University, BEHAVIORAL DEVELOPMENT BULLETIN VOL. 11, 2011 ISSN: 1942-0722
28. Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. Educational Technology Research & Development, 44(2), 43-58.
29. Cannon, H. M. & Friesen, D. P., (2010). The simplicity paradox: Another look at complexity in Design of simulations and experiential learning. Developments in Simulation and Experiential Learning , Vol. 37, Reprinted in the Bernie Keys Library [Available from http://ABSEL.org].
30. De Freitas, S. (2006). Using games and simulations for supporting learning. Learning, Media and Technology Special Issue on Gaming, 31, 343-358.
31. Mansour S., El-Said M, (2008). The Impact of Multi-Players Serious Games on the Social Interaction among Online Students versus Face-to-Face Students. 7th WSEAS international Conference on Applied Computer and Applied Computational Science, Hangzhou,China, April 6-8, 2008.

32. Lillian C. McDermott. (1989) A perspective on teacher preparation in physics and other sciences: The need for special science courses for teachers. American Journal of Physics DOI: http://dx.doi.org/10.1119/1.16395Volume 58, Issue
33. Michael P. Freedman, Relationship among Laboratory Instruction, Attitude toward Science, and Achievement in Science Knowledge, Article in Journal of Research in Science Teaching - April 1997
34. Maria Kettle, Flipped physics, 2013 IOP Publishing Ltd, Physics Education, Volume 48, Number 5
35. Okky Fajar Trimaryana, Ratih Rizki Retinofa, The Application of Traditional Game Rorodaan as Learning tool in Physics Subject: Force and Movement to Improve Learning Results,Journal of Physics: Conference Series 739 (2016)
36. Student experiences of virtual reality - a case study in learning special relativity,
    D. McGrath, M. Wegener, T. McIntyre, C. Savage, M. Williamson, American Journal of Physics 78, 862 (2010)| American Journal of Physics
37. Michael Jacobson, Peter Reimann (2010) Designs for Learning Environments of the Future: International Perspectives from the Learning Sciences Springer Science & Business Media.

5 Annexes

5.1 The tool

5.1.1 Section for the students

5.1.1.1 How often do you use a computer in each of these places?

	Every day or almost every day	*Once or twice a week*	*Once or twice a month*	*Never or almost never*
At home				
At school				
Some other place				

5.1.1.2 How much do you agree with these statements about learning science?

	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I enjoy learning science				
b) I wish I did not have to study science				
c) I read about science in my spare time				
d) Science is boring				
e) I learn many interesting things in science				
f) I like science				
g) It is important to do well in science				

5.1.1.3 How much do you agree with these statements about your science lessons?

	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I know what my teacher expects me to do				
b) I think of things not related to the lesson				
c) My teacher is easy to understand				
d) I am interested in what my teacher says				
e) My teacher gives me interesting things to do				

5.1.1.4 How much do you agree with these statements about science?

	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I usually do well in science				
b) Science is more difficult for me than for many of my classmates				
c) Science is not one of my strengths				
d) I learn things quickly in science				
e) Science makes me confused and nervous				
f) I am good at working out difficult science problems				
g) My teacher thinks I can do well in science <programs/classes/lessons> with difficult				

materials				
h) My teacher tells me I am good at science				
i) Science is harder for me than any other subject				
j) I think learning science will help me in my daily life				
k) I need science to learn other school subjects				
l) I need to do well in science to get into the <university> of my choice				
m) I need to do well in science to get the job I want				
n) I would like a job that involves using science				

5.1.1.5 How often does your teacher give you homework in science?

- Every day
- or 4 times a week
- 1 or 2 times a week
- Less than once a week
- Never

5.1.1.6 When your teacher gives you science homework, about how many minutes do you usually spend on your homework?

- My teacher never gives me homework in science
- 1–15 minutes
- 16–30 minutes

- 31–60 minutes
- 61–90 minutes
- More than 90 minutes

5.1.2 Section for the Teachers

5.1.2.1 Do you use computers in your teaching in any of the following ways?

	yes	*no*
a) For preparation		
b) For administration		
c) In your classroom instruction		

5.1.2.2 If "Yes" to "classroom instruction"

5.1.2.3 How much do you agree with the following statements about using computers in your classroom instruction?

	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I feel comfortable using computers in my teaching				
b) When I have technical problems, I have ready access to computer support staff in my school				
c) I receive adequate support for integrating computers in my teaching activities				

5.1.2.4 In a typical week, how much time do you spend teaching science to the students in this class?

_____hours and _____minutes per week

5.1.2.5 In teaching science to the students in this class, how often do you usually ask them to do the following?

	Every or almost every lesson	*About half the lessons*	*Some lessons*	*Never*
a) Observe natural phenomena and describe what they see				
b) Watch me demonstrate an experiment or Investigation				
c) Design or plan experiments or investigations				
d) Conduct experiments or investigations				
e) Read their textbooks or other resource materials				
f) Have students memorize facts and principles				
g) Use scientific formulas and laws to solve routine problems				
h) Give explanations about something they are studying				
i) Relate what they are learning in science				

to their daily lives				
j) Do field work outside of class				
k) Take a written test or quiz				

5.1.2.6 When you teach science to this class, how do you use the following resources?

	Basis for instruction	*Supplement*	*Not used*
a) Textbooks			
b) Workbooks or worksheets			
c) Science equipment and materials			
d) Computer software for science instruction			
e) Reference materials (e.g., encyclopedia, dictionary)			

5.1.2.7 Do the students in this class have computer(s) available to use during their science lessons?

- Yes
- No

If “Yes”

5.1.2.8 A. Do any of the computer(s) have access to the Internet?

- Yes
- No

5.1.2.9 How often do you have the students do the following computer activities during science lessons?

	Every or almost every day	*Once or twice a week*	*Once or twice a month*	*Never or almost never*
a) Practice skills and procedures				
b) Look up ideas and information				
c) Do scientific procedures or experiments				
d) Study natural phenomena through simulations				
e) Process and analyse data				

5.1.2.10 The following list includes the main topics addressed by the proposed test. Choose the response that best describes when the students in this class have been taught each topic.

If a topic was in the curriculum before the <eighth grade>, please choose "Mostly taught before this year." If a topic was taught half this year but not yet completed, please choose "Mostly taught this year." If a topic is not in the curriculum, please choose "Not yet taught or just introduced."

	Mostly taught before this year	*Mostly taught this year*	*Not yet taught or just introduced*
a) Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes			

in volume and/or pressure)			
b) Energy forms, transformations, heat, and temperature			
c) Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)			
d) Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets			
e) Forces and motion (types of forces, basic description of motion, effects of density and pressure)			

5.1.2.11 How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose "Not applicable."

	Not applicable	*Very well prepared*	*Somewhat prepared*	*Not well prepared*
a) Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)				
b) Energy forms, transformations, heat, and temperature				
c) Basic properties/behaviors of light (reflection, refraction, light and				

color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)				
d) Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets				
e) Forces and motion (types of forces, basic description of motion, effects of density and pressure)				

5.1.3 Section for School (principal of the School)

1. ***What is the total number of computers that can be used for instructional purposes by <eighth-grade> students?***

   _____computers

2. ***Does your school have a science laboratory that can be used by <eighth-grade> students?***
   - Yes
   - No
3. ***Do teachers usually have assistance available when students are conducting science experiments?***
   - Yes
   - No
4. ***How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the following?***

	Not at all	*A little*	*Some*	*A lot*
Technologically competent staff				
Teachers with a specialization in science				
Computers for science instruction				
Computer software for science instruction				
Library materials relevant to science instruction				
Audio-visual resources for science instruction				
Calculators for science instruction				
Science equipment and materials				

5.2 The results

5.2.1 Section for the students

5.2.1.1 How often do you use a computer at home

Country	Every day or almost every day	Once or twice a week	Once or twice a month	Never or almost never	Omitted or invalid
Finland	0.878	0.101	0.013	0.005	0.004
Hungary	0.795	0.125	0.020	0.046	0.015
Israel	0.869	0.081	0.014	0.024	0.013
Italy	0.750	0.183	0.031	0.028	0.007
Lithuania	0.830	0.101	0.014	0.034	0.020
Norway	0.897	0.085	0.005	0.005	0.007
Romania	0.685	0.131	0.020	0.110	0.053
Slovenia	0.821	0.141	0.019	0.011	0.008
Sweden	0.902	0.073	0.008	0.005	0.013
Turkey	0.317	0.236	0.044	0.267	0.137
England	0.801	0.161	0.016	0.016	0.006

5.2.1.2 How often do you use a computer at school

Country	Every day or almost every day	Once or twice a week	Once or twice a month	Never or almost never	Omitted or invalid
Finland	0.022	0.380	0.478	0.107	0.012
Hungary	0.016	0.835	0.085	0.038	0.027
Israel	0.038	0.333	0.254	0.349	0.026
Italy	0.012	0.218	0.216	0.516	0.038
Lithuania	0.025	0.398	0.249	0.295	0.033
Norway	0.094	0.528	0.297	0.062	0.020
Romania	0.036	0.351	0.159	0.361	0.094
Slovenia	0.019	0.290	0.349	0.316	0.026
Sweden	0.154	0.354	0.350	0.118	0.024
Turkey	0.037	0.488	0.098	0.264	0.113
England	0.124	0.730	0.097	0.032	0.017

5.2.1.3 How often do you use a computer some other place

Country	Every day or almost every day	Once or twice a week	Once or twice a month	Never or almost never	Omitted or invalid
Finland	0.040	0.280	0.400	0.266	0.014
Hungary	0.038	0.161	0.344	0.420	0.038
Israel	0.086	0.341	0.292	0.251	0.030
Italy	0.047	0.200	0.223	0.496	0.034
Lithuania	0.032	0.144	0.357	0.430	0.037
Norway	0.057	0.334	0.366	0.220	0.023
Romania	0.062	0.218	0.314	0.322	0.084
Slovenia	0.035	0.171	0.322	0.445	0.027
Sweden	0.071	0.268	0.360	0.273	0.029
Turkey	0.089	0.231	0.224	0.294	0.163
England	0.034	0.190	0.383	0.363	0.030

5.2.1.4 How much do you agree with these statements about learning science "I enjoy learning science"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.352	0.342	0.160	0.138	0.008
Italy	0.257	0.472	0.201	0.065	0.005
Norway	0.374	0.431	0.137	0.054	0.004
Turkey	0.660	0.254	0.040	0.040	0.005

England	0.364	0.422	0.136	0.073	0.005

5.2.1.5 How much do you agree with these statements about learning science "I wish I did not have to study science"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.186	0.233	0.219	0.351	0.011
Italy	0.101	0.181	0.443	0.268	0.007
Norway	0.081	0.196	0.332	0.384	0.007
Turkey	0.128	0.233	0.165	0.464	0.011
England	0.095	0.183	0.329	0.388	0.005

5.2.1.6 How much do you agree with these statements about learning science "I read about science in my spare time"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.122	0.207	0.197	0.457	0.016
Italy	0.047	0.162	0.422	0.364	0.006
Norway	0.072	0.219	0.318	0.378	0.012
Turkey	0.264	0.384	0.177	0.164	0.011
England	0.069	0.174	0.257	0.493	0.008

5.2.1.7 How much do you agree with these statements about learning science "Science is boring"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.178	0.248	0.226	0.327	0.021
Italy	0.075	0.159	0.488	0.267	0.011
Norway	0.105	0.258	0.312	0.315	0.010
Turkey	0.097	0.183	0.202	0.503	0.015
England	0.114	0.256	0.310	0.310	0.011

5.2.1.8 How much do you agree with these statements about learning science "I learn many interesting things in science"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.426	0.300	0.154	0.108	0.013
Italy	0.370	0.493	0.092	0.038	0.007
Norway	0.458	0.389	0.101	0.040	0.011

Turkey	0.683	0.217	0.051	0.037	0.012
England	0.441	0.399	0.102	0.049	0.009

5.2.1.9 How much do you agree with these statements about learning science "I like science"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.334	0.285	0.187	0.184	0.010
Italy	0.277	0.450	0.185	0.081	0.006
Norway	0.324	0.403	0.186	0.076	0.011
Turkey	0.606	0.253	0.064	0.061	0.016
England	0.343	0.386	0.169	0.094	0.008

5.2.1.10 How much do you agree with these statements about learning science "It is important to do well in science"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.568	0.252	0.102	0.068	0.011
Italy	0.233	0.547	0.175	0.041	0.005
Norway	0.415	0.429	0.120	0.027	0.009
Turkey	0.722	0.207	0.038	0.023	0.009
England	0.639	0.274	0.058	0.022	0.007

5.2.1.11 How much do you agree with these statements about your science lessons "I know what my teacher expects me to do"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.559	0.274	0.086	0.073	0.009
Italy	0.219	0.601	0.145	0.032	0.004
Norway	0.364	0.466	0.132	0.026	0.012
Turkey	0.538	0.311	0.074	0.070	0.007
England	0.446	0.422	0.096	0.030	0.006

5.2.1.12 How much do you agree with these statements about your science lessons "I think of things not related to the lesson"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.188	0.326	0.229	0.244	0.013

Italy	0.062	0.233	0.496	0.204	0.005
Norway	0.118	0.374	0.311	0.185	0.012
Turkey	0.093	0.256	0.198	0.445	0.009
England	0.176	0.406	0.279	0.131	0.008

5.2.1.13 How much do you agree with these statements about your science lessons "My teacher is easy to understand"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.456	0.268	0.145	0.112	0.019
Italy	0.253	0.495	0.185	0.059	0.007
Norway	0.409	0.353	0.161	0.062	0.015
Turkey	0.608	0.242	0.074	0.063	0.014
England	0.428	0.353	0.152	0.057	0.010

5.2.1.14 How much do you agree with these statements about your science lessons "I am interested in what my teacher says"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.437	0.283	0.164	0.104	0.012
Italy	0.308	0.509	0.136	0.043	0.004
Norway	0.346	0.416	0.170	0.057	0.011
Turkey	0.646	0.248	0.059	0.037	0.011
England	0.350	0.401	0.172	0.068	0.009

5.2.1.15 How much do you agree with these statements about your science lessons "My teacher gives me interesting things to do"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.326	0.288	0.202	0.172	0.011
Italy	0.213	0.451	0.256	0.075	0.004
Norway	0.278	0.389	0.229	0.093	0.012
Turkey	0.290	0.326	0.179	0.194	0.011
England	0.336	0.395	0.182	0.077	0.010

5.2.1.16 How much do you agree with these statements about science "I usually do well in science"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid

Israel	0.468	0.343	0.113	0.066	0.011
Italy	0.191	0.598	0.173	0.034	0.004
Norway	0.345	0.484	0.135	0.025	0.010
Turkey	0.431	0.423	0.090	0.049	0.007
England	0.343	0.488	0.128	0.035	0.006

5.2.1.17 How much do you agree with these statements about science "Science is more difficult for me than for many of my classmates"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.081	0.214	0.221	0.473	0.012
Italy	0.051	0.172	0.494	0.275	0.008
Norway	0.036	0.135	0.345	0.472	0.011
Turkey	0.110	0.313	0.206	0.359	0.012
England	0.064	0.207	0.396	0.324	0.010

5.2.1.18 How much do you agree with these statements about science "Science is not one of my strengths"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.173	0.237	0.218	0.352	0.020
Italy	0.087	0.284	0.435	0.185	0.008
Norway	0.104	0.296	0.315	0.269	0.015
Turkey	0.109	0.246	0.210	0.420	0.016
England	0.132	0.256	0.312	0.290	0.011

5.2.1.19 How much do you agree with these statements about science "I learn things quickly in science"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.412	0.316	0.171	0.083	0.019
Italy	0.198	0.503	0.243	0.049	0.007
Norway	0.254	0.435	0.245	0.045	0.022
Turkey	0.386	0.406	0.129	0.064	0.015
England	0.258	0.416	0.259	0.057	0.011

5.2.1.20 How much do you agree with these statements about science "Science makes me confused and nervous"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.117	0.173	0.231	0.458	0.022
Italy	0.046	0.120	0.484	0.343	0.007
Norway	0.035	0.130	0.311	0.512	0.013
Turkey	0.114	0.202	0.221	0.449	0.014
England	0.050	0.160	0.331	0.446	0.013

5.2.1.21 How much do you agree with these statements about science "I am good at working out difficult science problems"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.306	0.317	0.214	0.143	0.021
Italy	0.087	0.387	0.396	0.118	0.012
Norway	0.150	0.406	0.335	0.094	0.015
Turkey	0.212	0.393	0.221	0.158	0.017
England	0.172	0.396	0.320	0.099	0.013

5.2.1.22 How much do you agree with these statements about science "My teacher thinks I can do well in science <programs/classes/lessons> with difficult materials"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.499	0.270	0.127	0.086	0.018
Italy	0.142	0.495	0.293	0.056	0.015
Norway	0.194	0.419	0.290	0.066	0.031
Turkey	0.310	0.364	0.191	0.122	0.013
England	0.234	0.454	0.232	0.059	0.022

5.2.1.23 How much do you agree with these statements about science "My teacher tells me I am good at science"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.406	0.275	0.162	0.140	0.017
Italy	0.121	0.482	0.323	0.060	0.013
Norway	0.221	0.441	0.231	0.076	0.032
Turkey	0.306	0.367	0.176	0.134	0.016

England	0.238	0.398	0.256	0.092	0.016

5.2.1.24 How much do you agree with these statements about science "Science is harder for me than any other subject"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.114	0.177	0.204	0.489	0.015
Italy	0.062	0.162	0.436	0.335	0.005
Norway	0.044	0.133	0.280	0.528	0.014
Turkey	0.130	0.251	0.211	0.397	0.010
England	0.075	0.162	0.329	0.424	0.010

5.2.1.25 How much do you agree with these statements about science "I think learning science will help me in my daily life"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.414	0.316	0.150	0.106	0.014
Italy	0.206	0.529	0.213	0.048	0.004
Norway	0.304	0.462	0.176	0.048	0.011
Turkey	0.519	0.291	0.089	0.093	0.008
England	0.435	0.387	0.134	0.033	0.012

5.2.1.26 How much do you agree with these statements about science "I need science to learn other school subjects"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.389	0.296	0.172	0.128	0.014
Italy	0.105	0.384	0.424	0.082	0.005
Norway	0.191	0.396	0.316	0.088	0.010
Turkey	0.386	0.349	0.153	0.104	0.008
England	0.324	0.391	0.218	0.053	0.014

5.2.1.27 How much do you agree with these statements about science "I need to do well in science to get into the university of my choice"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.470	0.249	0.144	0.121	0.017
Italy	0.219	0.319	0.359	0.098	0.006
Norway	0.274	0.342	0.276	0.091	0.018

Turkey	0.464	0.278	0.132	0.115	0.011
England	0.543	0.298	0.112	0.031	0.016

5.2.1.28 How much do you agree with these statements about science "I need to do well in science to get the job I want"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.381	0.237	0.195	0.172	0.015
Italy	0.167	0.242	0.448	0.138	0.006
Norway	0.254	0.302	0.311	0.115	0.018
Turkey	0.403	0.296	0.154	0.136	0.010
England	0.431	0.259	0.214	0.078	0.018

5.2.1.29 How much do you agree with these statements about science "I would like a job that involves using science"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Omitted or invalid
Israel	0.245	0.215	0.200	0.325	0.015
Italy	0.152	0.233	0.421	0.190	0.005
Norway	0.168	0.263	0.335	0.217	0.018
Turkey	0.299	0.279	0.171	0.241	0.010
England	0.257	0.250	0.272	0.206	0.015

5.2.1.30 How often does your teacher give you homework in science

Country	Every day	or 4 times a week	1 or 2 times a week	Less than once a week	Never	Omitted or invalid
Israel	0.137	0.260	0.305	0.194	0.072	0.032
Italy	0.078	0.111	0.628	0.125	0.041	0.017
Norway	0.051	0.145	0.691	0.082	0.007	0.024
Turkey	0.131	0.300	0.384	0.128	0.034	0.023
England	0.014	0.112	0.462	0.304	0.078	0.030

5.2.1.31 When your teacher gives you science homework, about how many minutes do you usually spend on your homework

Country	Never gives me homework in science	1–15 minutes	16–30 minutes	31–60 minutes	61–90 minutes	More than 90 minutes	Omitted or invalid

Israel	0.024	0.446	0.306	0.098	0.020	0.013	0.072
Italy	0.010	0.240	0.352	0.253	0.070	0.025	0.041
Norway	0.003	0.214	0.435	0.262	0.039	0.012	0.007
Turkey	0.009	0.243	0.370	0.246	0.057	0.032	0.034
England	0.006	0.211	0.414	0.244	0.027	0.010	0.078

5.2.2 Section for the teachers

5.2.2.1 Do you use computers in your teaching for preparation

Country	Yes	No	Omitted or invalid
Finland	0.949	0.049	0.002
Hungary	0.881	0.117	0.002
Israel	0.907	0.072	0.020
Italy	0.829	0.144	0.026
Lithuania	0.977	0.022	0.001
Norway	0.980	0.020	0.000
Romania	0.893	0.102	0.005
Slovenia	0.944	0.050	0.006
Sweden	0.951	0.029	0.021
Turkey	0.841	0.151	0.008
England	0.994	0.004	0.001

5.2.2.2 Do you use computers in your teaching for administration

Country	Yes	No	Omitted or invalid
Finland	0.859	0.141	0.000
Hungary	0.640	0.354	0.006
Israel	0.869	0.110	0.020
Italy	0.589	0.379	0.032
Lithuania	0.796	0.203	0.001
Norway	0.950	0.050	0.000
Romania	0.879	0.115	0.006
Slovenia	0.962	0.030	0.007
Sweden	0.965	0.014	0.021
Turkey	0.295	0.705	0.000

England	0.996	0.002	0.002

5.2.2.3 Do you use computers in your teaching in our classroom instruction

Country	Yes	No	Omitted or invalid
Finland	0.858	0.142	0.000
Hungary	0.659	0.336	0.005
Israel	0.806	0.194	0.000
Italy	0.513	0.461	0.026
Lithuania	0.832	0.167	0.002
Norway	0.990	0.010	0.000
Romania	0.724	0.270	0.006
Slovenia	0.914	0.081	0.006
Sweden	0.843	0.137	0.021
Turkey	0.810	0.190	0.000
England	0.997	0.002	0.001

5.2.2.4 How much do you agree with the following statements about using computers in your classroom instruction?" I feel comfortable using computers in my teaching"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Not Applicable	Omitted or invalid
Finland	0.546	0.254	0.055	0.003	0.142	0.000
Hungary	0.339	0.219	0.061	0.033	0.336	0.013
Israel	0.656	0.119	0.024	0.006	0.194	0.000
Italy	0.202	0.288	0.017	0.000	0.461	0.032
Lithuania	0.448	0.358	0.020	0.004	0.167	0.003
Norway	0.671	0.295	0.024	0.000	0.010	0.000
Romania	0.455	0.222	0.037	0.002	0.270	0.013
Slovenia	0.440	0.389	0.079	0.005	0.081	0.007
Sweden	0.368	0.411	0.057	0.004	0.137	0.023
Turkey	0.472	0.297	0.028	0.009	0.190	0.004
England	0.834	0.132	0.014	0.003	0.002	0.014

5.2.2.5 How much do you agree with the following statements about using computers in your classroom instruction?" When I have technical problems, I have ready access to computer support staff in my school"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Not Applicable	Omitted or invalid
Finland	0.221	0.355	0.215	0.063	0.142	0.003
Hungary	0.347	0.173	0.077	0.053	0.336	0.014
Israel	0.352	0.235	0.127	0.092	0.194	0.000
Italy	0.080	0.259	0.147	0.022	0.461	0.032
Lithuania	0.398	0.292	0.109	0.031	0.167	0.004
Norway	0.443	0.404	0.076	0.062	0.010	0.006
Romania	0.398	0.174	0.083	0.054	0.270	0.021
Slovenia	0.376	0.447	0.075	0.011	0.081	0.010
Sweden	0.106	0.295	0.307	0.131	0.137	0.025
Turkey	0.519	0.138	0.073	0.073	0.190	0.006
England	0.521	0.299	0.109	0.052	0.002	0.017

5.2.2.6 How much do you agree with the following statements about using computers in your classroom instruction?" I receive adequate support for integrating computers in my teaching activities"

Country	Agree a little	Agree a lot	Disagree a little	Disagree a lot	Not Applicable	Omitted or invalid
Finland	0.242	0.336	0.244	0.035	0.142	0.002
Hungary	0.343	0.226	0.053	0.028	0.336	0.013
Israel	0.407	0.232	0.097	0.062	0.194	0.007
Italy	0.056	0.258	0.146	0.045	0.461	0.033
Lithuania	0.387	0.321	0.094	0.027	0.167	0.004
Norway	0.347	0.435	0.141	0.061	0.010	0.006
Romania	0.430	0.181	0.059	0.039	0.270	0.020
Slovenia	0.460	0.388	0.057	0.001	0.081	0.014
Sweden	0.095	0.367	0.284	0.093	0.137	0.025
Turkey	0.403	0.285	0.071	0.045	0.190	0.006
England	0.405	0.366	0.174	0.039	0.002	0.015

5.2.2.7 In teaching science to the students in this class, how often do you usually ask them to do the following?" Observe natural phenomena and describe what they see"

Country	Every or almost every lesson	About half the lessons	Some lessons	Never	Omitted or invalid
Finland	0.226	0.415	0.344	0.010	0.005
Hungary	0.165	0.231	0.568	0.027	0.009
Israel	0.166	0.236	0.574	0.015	0.009
Italy	0.336	0.278	0.371	0.000	0.016
Lithuania	0.055	0.188	0.716	0.032	0.009
Norway	0.065	0.138	0.756	0.015	0.025
Romania	0.566	0.268	0.162	0.000	0.004
Slovenia	0.161	0.462	0.364	0.004	0.009
Sweden	0.092	0.201	0.635	0.046	0.026
Turkey	0.509	0.186	0.285	0.007	0.014
England	0.154	0.401	0.411	0.020	0.015

5.2.2.8 In teaching science to the students in this class, how often do you usually ask them to do the following?" Watch me demonstrate an experiment or Investigation"

Country	Every or almost every lesson	About half the lessons	Some lessons	Never	Omitted or invalid
Finland	0.168	0.290	0.500	0.038	0.004
Hungary	0.210	0.283	0.461	0.037	0.009
Israel	0.267	0.332	0.389	0.002	0.009
Italy	0.059	0.128	0.692	0.101	0.020
Lithuania	0.066	0.233	0.619	0.072	0.010
Norway	0.024	0.130	0.820	0.008	0.018
Romania	0.384	0.297	0.308	0.003	0.008
Slovenia	0.098	0.327	0.508	0.051	0.016
Sweden	0.094	0.235	0.622	0.023	0.027
Turkey	0.399	0.234	0.359	0.003	0.005
England	0.106	0.412	0.457	0.012	0.014

5.2.2.9 In teaching science to the students in this class, how often do you usually ask them to do the following?" Design or plan experiments or investigations"

Country	Every or almost every lesson	About half the lessons	Some lessons	Never	Omitted or invalid
Finland	0.041	0.103	0.613	0.237	0.007
Hungary	0.013	0.104	0.667	0.204	0.011
Israel	0.071	0.201	0.617	0.102	0.009
Italy	0.025	0.121	0.728	0.099	0.026
Lithuania	0.013	0.112	0.743	0.118	0.015
Norway	0.007	0.204	0.727	0.050	0.011
Romania	0.168	0.264	0.515	0.045	0.008
Slovenia	0.006	0.148	0.709	0.119	0.018
Sweden	0.040	0.206	0.650	0.070	0.034
Turkey	0.152	0.210	0.606	0.024	0.007
England	0.034	0.329	0.581	0.039	0.017

5.2.2.10 In teaching science to the students in this class, how often do you usually ask them to do the following?" Conduct experiments or investigations"

Country	Every or almost every lesson	About half the lessons	Some lessons	Never	Omitted or invalid
Finland	0.208	0.272	0.443	0.070	0.007
Hungary	0.024	0.083	0.773	0.107	0.013
Israel	0.080	0.262	0.587	0.054	0.017
Italy	0.022	0.135	0.763	0.053	0.027
Lithuania	0.010	0.134	0.766	0.078	0.011
Norway	0.007	0.291	0.681	0.020	0.000
Romania	0.158	0.281	0.529	0.023	0.008
Slovenia	0.015	0.152	0.751	0.075	0.008
Sweden	0.131	0.438	0.407	0.000	0.024
Turkey	0.161	0.220	0.582	0.030	0.007
England	0.185	0.518	0.279	0.007	0.012

5.2.2.11 In teaching science to the students in this class, how often do you usually ask them to do the following?"Read their textbooks or other resource materials"

Country	Every or almost every lesson	About half the lessons	Some lessons	Never	Omitted or invalid
Finland	0.579	0.224	0.181	0.013	0.004
Hungary	0.716	0.181	0.089	0.001	0.012
Israel	0.356	0.357	0.270	0.000	0.017
Italy	0.423	0.273	0.244	0.041	0.019
Lithuania	0.600	0.217	0.169	0.006	0.009
Norway	0.205	0.372	0.402	0.009	0.012
Romania	0.601	0.193	0.195	0.004	0.006
Slovenia	0.148	0.235	0.532	0.072	0.013
Sweden	0.112	0.309	0.530	0.019	0.030
Turkey	0.584	0.203	0.199	0.005	0.009
England	0.141	0.242	0.532	0.063	0.022

5.2.2.12 In teaching science to the students in this class, how often do you usually ask them to do the following?" Have students memorize facts and principles"

Country	Every or almost every lesson	About half the lessons	Some lessons	Never	Omitted or invalid
Finland	0.127	0.339	0.494	0.039	0.002
Hungary	0.473	0.279	0.186	0.049	0.013
Israel	0.092	0.237	0.415	0.246	0.009
Italy	0.496	0.263	0.204	0.013	0.024
Lithuania	0.500	0.287	0.190	0.005	0.018
Norway	0.036	0.267	0.583	0.106	0.007
Romania	0.344	0.209	0.391	0.045	0.010
Slovenia	0.299	0.362	0.321	0.007	0.011
Sweden	0.151	0.293	0.508	0.024	0.024
Turkey	0.463	0.303	0.215	0.012	0.007
England	0.121	0.235	0.556	0.064	0.024

5.2.2.13 In teaching science to the students in this class, how often do you usually ask them to do the following?" Use scientific formulas and laws to solve routine problems"

Country	Every or almost every lesson	About half the lessons	Some lessons	Never	Omitted or invalid
Finland	0.130	0.262	0.439	0.160	0.010
Hungary	0.225	0.308	0.377	0.079	0.011
Israel	0.179	0.191	0.501	0.106	0.023
Italy	0.218	0.325	0.442	0.000	0.016
Lithuania	0.406	0.244	0.265	0.074	0.012
Norway	0.020	0.171	0.730	0.069	0.010
Romania	0.473	0.219	0.257	0.038	0.013
Slovenia	0.105	0.250	0.445	0.189	0.011
Sweden	0.047	0.202	0.579	0.148	0.024
Turkey	0.354	0.270	0.359	0.012	0.005
England	0.085	0.261	0.577	0.059	0.019

5.2.2.14 In teaching science to the students in this class, how often do you usually ask them to do the following?" Give explanations about something they are studying"

Country	Every or almost every lesson	About half the lessons	Some lessons	Never	Omitted or invalid
Finland	0.433	0.364	0.196	0.005	0.002
Hungary	0.472	0.297	0.211	0.013	0.007
Israel	0.636	0.222	0.130	0.004	0.009
Italy	0.763	0.196	0.026	0.000	0.016
Lithuania	0.768	0.166	0.054	0.005	0.008
Norway	0.066	0.325	0.589	0.011	0.008
Romania	0.596	0.209	0.181	0.005	0.008
Slovenia	0.232	0.380	0.356	0.014	0.017
Sweden	0.428	0.296	0.248	0.002	0.026
Turkey	0.564	0.258	0.169	0.000	0.008
England	0.555	0.317	0.111	0.000	0.016

5.2.2.15 In teaching science to the students in this class, how often do you usually ask them to do the following?" Relate what they are learning in science to their daily lives"

Country	Every or almost every lesson	About half the lessons	Some lessons	Never	Omitted or invalid
Finland	0.439	0.373	0.182	0.002	0.003
Hungary	0.692	0.247	0.047	0.000	0.014
Israel	0.599	0.289	0.103	0.000	0.009
Italy	0.554	0.293	0.134	0.000	0.020
Lithuania	0.574	0.300	0.114	0.000	0.012
Norway	0.218	0.450	0.320	0.004	0.008
Romania	0.778	0.145	0.068	0.000	0.008
Slovenia	0.490	0.352	0.148	0.002	0.007
Sweden	0.366	0.391	0.217	0.000	0.026
Turkey	0.773	0.157	0.062	0.000	0.007
England	0.347	0.378	0.259	0.001	0.015

5.2.2.16 In teaching science to the students in this class, how often do you usually ask them to do the following?" Do field work outside of class"

Country	Every or almost every lesson	About half the lessons	Some lessons	Never	Omitted or invalid
Finland	0.004	0.036	0.692	0.267	0.001
Hungary	0.046	0.120	0.651	0.173	0.010
Israel	0.023	0.092	0.582	0.283	0.019
Italy	0.005	0.029	0.481	0.460	0.024
Lithuania	0.011	0.037	0.717	0.222	0.013
Norway	0.007	0.012	0.890	0.083	0.008
Romania	0.087	0.133	0.590	0.180	0.009
Slovenia	0.001	0.037	0.719	0.235	0.008
Sweden	0.005	0.046	0.631	0.294	0.024
Turkey	0.406	0.227	0.344	0.012	0.011
England	0.007	0.039	0.519	0.421	0.014

5.2.2.17 In teaching science to the students in this class, how often do you usually ask them to do the following?" Take a written test or quiz"

Country	Every or almost	About half the	Some	Never	Omitted or

	every lesson	lessons	lessons		invalid
Finland	0.008	0.065	0.911	0.007	0.010
Hungary	0.243	0.405	0.335	0.002	0.016
Israel	0.079	0.169	0.743	0.000	0.009
Italy	0.023	0.171	0.778	0.012	0.016
Lithuania	0.013	0.175	0.800	0.001	0.011
Norway	0.010	0.046	0.936	0.000	0.008
Romania	0.309	0.275	0.403	0.000	0.013
Slovenia	0.010	0.024	0.938	0.016	0.012
Sweden	0.040	0.061	0.849	0.013	0.036
Turkey	0.399	0.257	0.335	0.004	0.005
England	0.019	0.122	0.825	0.021	0.014

5.2.2.18 When you teach science to this class, how do you use the following resources? "Textbooks"

Country	Basic for instruction	Supplement	Not used	Omitted or invalid
Finland	0.775	0.225	0.000	0.001
Hungary	0.863	0.125	0.002	0.009
Israel	0.742	0.206	0.042	0.010
Italy	0.788	0.200	0.011	0.002
Lithuania	0.915	0.080	0.000	0.005
Norway	0.910	0.075	0.007	0.008
Romania	0.847	0.144	0.000	0.008
Slovenia	0.837	0.148	0.009	0.007
Sweden	0.739	0.226	0.007	0.027
Turkey	0.883	0.107	0.005	0.005
England	0.093	0.748	0.147	0.011

5.2.2.19 When you teach science to this class, how do you use the following resources? "Workbooks or worksheets"

Country	Basic for instruction	Supplement	Not used	Omitted or invalid
Finland	0.255	0.660	0.082	0.003
Hungary	0.470	0.430	0.091	0.009
Israel	0.620	0.336	0.017	0.027
Italy	0.195	0.747	0.052	0.006
Lithuania	0.399	0.510	0.080	0.011
Norway	0.245	0.726	0.022	0.007

Romania	0.526	0.446	0.018	0.010
Slovenia	0.376	0.539	0.073	0.012
Sweden	0.141	0.729	0.100	0.031
Turkey	0.441	0.554	0.000	0.005
England	0.253	0.708	0.037	0.002

5.2.2.20 When you teach science to this class, how do you use the following resources? "Science equipment and materials"

Country	Basic for instruction	Supplement	Not used	Omitted or invalid
Finland	0.386	0.606	0.006	0.002
Hungary	0.429	0.544	0.009	0.018
Israel	0.640	0.303	0.039	0.018
Italy	0.099	0.727	0.171	0.004
Lithuania	0.232	0.728	0.031	0.009
Norway	0.328	0.648	0.006	0.018
Romania	0.492	0.468	0.027	0.013
Slovenia	0.257	0.678	0.048	0.017
Sweden	0.608	0.357	0.005	0.029
Turkey	0.343	0.619	0.031	0.007
England	0.634	0.350	0.006	0.011

5.2.2.21 When you teach science to this class, how do you use the following resources? "Computer software for science instruction"

Country	Basic for instruction	Supplement	Not used	Omitted or invalid
Finland	0.025	0.645	0.324	0.005
Hungary	0.067	0.547	0.375	0.011
Israel	0.253	0.532	0.189	0.026
Italy	0.042	0.457	0.479	0.022
Lithuania	0.133	0.734	0.129	0.004
Norway	0.044	0.783	0.173	0.000
Romania	0.157	0.622	0.212	0.009
Slovenia	0.203	0.736	0.050	0.011
Sweden	0.014	0.440	0.513	0.033
Turkey	0.163	0.708	0.118	0.010
England	0.285	0.660	0.053	0.002

5.2.2.22 When you teach science to this class, how do you use the following resources? "Reference materials (e.g., encyclopedia, dictionary)"

Country	Basic for instruction	Supplement	Not used	Omitted or invalid
Finland	0.006	0.700	0.291	0.003
Hungary	0.037	0.805	0.148	0.010
Israel	0.098	0.712	0.168	0.022
Italy	0.010	0.792	0.179	0.018
Lithuania	0.062	0.898	0.032	0.008
Norway	0.020	0.801	0.179	0.000
Romania	0.188	0.755	0.047	0.010
Slovenia	0.016	0.893	0.080	0.011
Sweden	0.038	0.776	0.153	0.032
Turkey	0.034	0.681	0.280	0.005
England	0.019	0.557	0.421	0.004

5.2.2.23 Do the students in this class have computer(s) available to use during their science lessons?

Country	Yes	No	Omitted or invalid
Finland	0.601	0.398	0.002
Hungary	0.477	0.514	0.009
Israel	0.426	0.555	0.020
Italy	0.350	0.630	0.020
Lithuania	0.540	0.447	0.014
Norway	0.765	0.231	0.004
Romania	0.562	0.425	0.013
Slovenia	0.464	0.523	0.013
Sweden	0.560	0.417	0.024
Turkey	0.398	0.585	0.016
England	0.620	0.378	0.002

5.2.2.24 Do any of the computer(s) have access to the Internet?

country	1	2	6	9
Finland	0.573	0.006	0.398	0.023
Hungary	0.391	0.026	0.514	0.069
Israel	0.343	0.043	0.555	0.060

Italy	0.318	0.031	0.630	0.021
Lithuania	0.483	0.030	0.447	0.041
Norway	0.750	0.000	0.231	0.019
Romania	0.441	0.114	0.425	0.021
Slovenia	0.410	0.006	0.523	0.061
Sweden	0.524	0.002	0.417	0.057
Turkey	0.375	0.018	0.585	0.022
England	0.605	0.011	0.378	0.006

5.2.2.25 How often do you have the students do the following computer activities during science lessons? "Practice skills and procedures"

Country	Every or almost every day	Once or twice a week	Once or twice a month	Never or almost never	Not Applicable	Omitted or invalid
Finland	0.013	0.040	0.308	0.236	0.398	0.005
Hungary	0.027	0.072	0.256	0.120	0.514	0.012
Israel	0.026	0.093	0.193	0.102	0.555	0.032
Italy	0.006	0.025	0.148	0.163	0.630	0.028
Lithuania	0.026	0.079	0.324	0.098	0.447	0.027
Norway	0.000	0.056	0.473	0.227	0.231	0.012
Romania	0.032	0.174	0.287	0.057	0.425	0.026
Slovenia	0.002	0.024	0.275	0.157	0.523	0.020
Sweden	0.019	0.030	0.169	0.334	0.417	0.032
Turkey	0.036	0.159	0.127	0.065	0.585	0.028
England	0.009	0.030	0.262	0.310	0.378	0.012

5.2.2.26 How often do you have the students do the following computer activities during science lessons? "Look up ideas and information"

Country	Every or almost every day	Once or twice a week	Once or twice a month	Never or almost never	Not Applicable	Omitted or invalid
Finland	0.019	0.068	0.405	0.104	0.398	0.006
Hungary	0.035	0.134	0.271	0.032	0.514	0.014
Israel	0.018	0.093	0.251	0.060	0.555	0.023
Italy	0.012	0.044	0.240	0.048	0.630	0.025
Lithuania	0.033	0.113	0.336	0.051	0.447	0.020
Norway	0.003	0.118	0.588	0.056	0.231	0.004
Romania	0.066	0.192	0.248	0.045	0.425	0.025

Slovenia	0.012	0.040	0.335	0.069	0.523	0.022
Sweden	0.026	0.086	0.386	0.055	0.417	0.031
Turkey	0.051	0.186	0.126	0.019	0.585	0.033
England	0.016	0.102	0.425	0.069	0.378	0.011

5.2.2.27 How often do you have the students do the following computer activities during science lessons? "Do scientific procedures or experiments"

Country	Every or almost every day	Once or twice a week	Once or twice a month	Never or almost never	Not Applicable	Omitted or invalid
Finland	0.006	0.017	0.150	0.417	0.398	0.012
Hungary	0.005	0.047	0.195	0.224	0.514	0.016
Israel	0.008	0.051	0.172	0.179	0.555	0.037
Italy	0.006	0.021	0.098	0.219	0.630	0.025
Lithuania	0.010	0.021	0.289	0.212	0.447	0.021
Norway	0.000	0.049	0.293	0.415	0.231	0.012
Romania	0.014	0.123	0.281	0.133	0.425	0.025
Slovenia	0.004	0.016	0.184	0.240	0.523	0.032
Sweden	0.011	0.017	0.098	0.422	0.417	0.036
Turkey	0.022	0.172	0.148	0.039	0.585	0.033
England	0.009	0.043	0.177	0.384	0.378	0.009

5.2.2.28 How often do you have the students do the following computer activities during science lessons? "Study natural phenomena through simulations"

Country	Every or almost every day	Once or twice a week	Once or twice a month	Never or almost never	Not Applicable	Omitted or invalid
Finland	0.002	0.014	0.192	0.384	0.398	0.009
Hungary	0.010	0.065	0.214	0.185	0.514	0.013
Israel	0.023	0.044	0.202	0.146	0.555	0.031
Italy	0.004	0.018	0.109	0.208	0.630	0.030
Lithuania	0.014	0.018	0.242	0.257	0.447	0.022
Norway	0.003	0.037	0.376	0.349	0.231	0.004
Romania	0.018	0.115	0.291	0.130	0.425	0.021
Slovenia	0.004	0.019	0.274	0.156	0.523	0.024

Sweden	0.000	0.021	0.120	0.407	0.417	0.036
Turkey	0.049	0.184	0.113	0.042	0.585	0.027
England	0.007	0.062	0.278	0.267	0.378	0.009

5.2.2.29 How often do you have the students do the following computer activities during science lessons? "Process and analyze data"

Country	Every or almost every day	Once or twice a week	Once or twice a month	Never or almost never	Not Applicable	Omitted or invalid
Finland	0.010	0.030	0.278	0.274	0.398	0.011
Hungary	0.012	0.064	0.219	0.179	0.514	0.012
Israel	0.024	0.039	0.194	0.159	0.555	0.029
Italy	0.001	0.033	0.160	0.146	0.630	0.029
Lithuania	0.022	0.044	0.334	0.132	0.447	0.021
Norway	0.000	0.027	0.311	0.427	0.231	0.004
Romania	0.027	0.116	0.269	0.145	0.425	0.019
Slovenia	0.006	0.022	0.252	0.167	0.523	0.030
Sweden	0.013	0.035	0.220	0.285	0.417	0.031
Turkey	0.032	0.143	0.122	0.084	0.585	0.033
England	0.008	0.068	0.301	0.239	0.378	0.007

5.2.2.30 The following list includes the main topics addressed by the proposed test. Choose the response that best describes when the students in this class have been taught each topic. "Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)"

Country	Mostly taught before this year	Mostly taught this year	Not yet taught or just introduced	Omitted or invalid
Finland	0.130	0.193	0.165	0.513
Hungary	0.261	0.018	0.005	0.716
Israel	0.816	0.094	0.000	0.090
Italy	0.922	0.052	0.017	0.009
Lithuania	0.184	0.059	0.115	0.641
Norway	0.026	0.729	0.218	0.028
Romania	0.193	0.157	0.020	0.630

Slovenia	0.045	0.172	0.187	0.597
Sweden	0.365	0.122	0.139	0.374
Turkey	0.395	0.601	0.000	0.003
England	0.550	0.199	0.130	0.121

5.2.2.31 The following list includes the main topics addressed by the proposed test. Choose the response that best describes when the students in this class have been taught each topic. "Energy forms, transformations, heat, and temperature"

Country	Mostly taught before this year	Mostly taught this year	Not yet taught or just introduced	Omitted or invalid
Finland	0.086	0.222	0.179	0.512
Hungary	0.244	0.029	0.010	0.717
Israel	0.170	0.713	0.017	0.100
Italy	0.603	0.323	0.072	0.002
Lithuania	0.079	0.149	0.128	0.644
Norway	0.029	0.301	0.651	0.019
Romania	0.191	0.153	0.021	0.634
Slovenia	0.032	0.219	0.150	0.598
Sweden	0.177	0.217	0.228	0.378
Turkey	0.315	0.664	0.018	0.002
England	0.389	0.439	0.051	0.121

5.2.2.32 The following list includes the main topics addressed by the proposed test. Choose the response that best describes when the students in this class have been taught each topic. "Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)"

Country	Mostly taught before this year	Mostly taught this year	Not yet taught or just introduced	Omitted or invalid
Finland	0.399	0.037	0.053	0.511
Hungary	0.004	0.115	0.166	0.715
Israel	0.111	0.070	0.715	0.104

Italy	0.148	0.166	0.684	0.002
Lithuania	0.112	0.112	0.125	0.651
Norway	0.024	0.057	0.904	0.016
Romania	0.291	0.054	0.021	0.634
Slovenia	0.291	0.019	0.102	0.588
Sweden	0.075	0.302	0.250	0.374
Turkey	0.781	0.192	0.021	0.007
England	0.532	0.258	0.089	0.121

5.2.2.33 The following list includes the main topics addressed by the proposed test. Choose the response that best describes when the students in this class have been taught each topic. "Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets"

Country	Mostly taught before this year	Mostly taught this year	Not yet taught or just introduced	Omitted or invalid
Finland	0.004	0.021	0.462	0.512
Hungary	0.021	0.255	0.008	0.717
Israel	0.031	0.813	0.060	0.096
Italy	0.020	0.435	0.530	0.015
Lithuania	0.068	0.028	0.259	0.645
Norway	0.030	0.019	0.936	0.016
Romania	0.108	0.239	0.018	0.635
Slovenia	0.029	0.022	0.341	0.607
Sweden	0.336	0.198	0.092	0.374
Turkey	0.706	0.208	0.083	0.003
England	0.506	0.261	0.110	0.123

5.2.2.34 The following list includes the main topics addressed by the proposed test. Choose the response that best describes when the students in this class have been taught each topic. "Forces and motion (types of forces, basic description of motion, effects of density and pressure)"

Country	Mostly taught before this year	Mostly taught this year	Not yet taught or just introduced	Omitted or invalid
Finland	0.013	0.278	0.192	0.517
Hungary	0.270	0.010	0.005	0.715
Israel	0.055	0.713	0.128	0.104
Italy	0.488	0.351	0.159	0.002
Lithuania	0.055	0.255	0.046	0.645
Norway	0.006	0.137	0.842	0.015
Romania	0.299	0.047	0.020	0.634
Slovenia	0.029	0.281	0.082	0.608
Sweden	0.317	0.153	0.157	0.373
Turkey	0.848	0.141	0.006	0.006
England	0.420	0.318	0.136	0.126

5.2.2.35 How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose "Not applicable." "Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)"

Country	Not applicable	Very well prepared	Somewhat prepared	Not well prepared	Omitted or invalid
Finland	0.325	0.334	0.048	0.006	0.287
Hungary	0.161	0.179	0.038	0.003	0.620
Israel	0.112	0.778	0.033	0.004	0.073
Italy	0.185	0.527	0.280	0.000	0.008
Lithuania	0.286	0.173	0.041	0.003	0.498
Norway	0.050	0.479	0.407	0.025	0.039
Romania	0.125	0.348	0.036	0.004	0.486

Slovenia	0.369	0.243	0.100	0.002	0.285
Sweden	0.224	0.438	0.139	0.002	0.196
Turkey	0.087	0.761	0.135	0.017	0.000
England	0.125	0.735	0.095	0.019	0.025

5.2.2.36 How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose "Not applicable." "Energy forms, transformations, heat, and temperature"

Country	Not applicable	Very well prepared	Somewhat prepared	Not well prepared	Omitted or invalid
Finland	0.306	0.353	0.049	0.005	0.287
Hungary	0.148	0.171	0.055	0.003	0.622
Israel	0.089	0.720	0.105	0.005	0.081
Italy	0.099	0.535	0.352	0.003	0.011
Lithuania	0.215	0.230	0.053	0.003	0.500
Norway	0.158	0.440	0.352	0.023	0.027
Romania	0.135	0.320	0.051	0.004	0.489
Slovenia	0.353	0.292	0.069	0.006	0.281
Sweden	0.206	0.481	0.117	0.004	0.192
Turkey	0.079	0.803	0.107	0.011	0.000
England	0.131	0.734	0.097	0.014	0.024

5.2.2.37 How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose "Not applicable." "Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)"

Country	Not applicable	Very well prepared	Somewhat prepared	Not well prepared	Omitted or invalid
Finland	0.384	0.252	0.065	0.004	0.294
Hungary	0.088	0.197	0.085	0.005	0.624
Israel	0.383	0.237	0.176	0.128	0.076

Italy	0.144	0.209	0.551	0.088	0.008
Lithuania	0.257	0.192	0.042	0.006	0.502
Norway	0.247	0.291	0.368	0.081	0.014
Romania	0.174	0.284	0.052	0.003	0.487
Slovenia	0.420	0.140	0.146	0.006	0.288
Sweden	0.216	0.454	0.111	0.018	0.202
Turkey	0.296	0.552	0.137	0.016	0.000
England	0.140	0.701	0.114	0.020	0.025

5.2.2.38 How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose "Not applicable." "Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets"

Country	Not applicable	Very well prepared	Somewhat prepared	Not well prepared	Omitted or invalid
Finland	0.393	0.246	0.052	0.014	0.294
Hungary	0.077	0.233	0.058	0.002	0.630
Israel	0.095	0.636	0.131	0.053	0.085
Italy	0.080	0.325	0.529	0.055	0.011
Lithuania	0.329	0.127	0.028	0.017	0.499
Norway	0.254	0.313	0.327	0.075	0.031
Romania	0.127	0.347	0.029	0.007	0.490
Slovenia	0.444	0.196	0.055	0.011	0.293
Sweden	0.206	0.447	0.141	0.011	0.195
Turkey	0.199	0.620	0.156	0.020	0.005
England	0.134	0.689	0.129	0.023	0.024

5.2.2.39 How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose "Not applicable." "Forces and motion (types of forces, basic description of motion, effects of density and pressure)"

Country	Not applicable	Very well prepared	Somewhat prepared	Not well prepared	Omitted or invalid
Finland	0.288	0.353	0.058	0.007	0.293
Hungary	0.177	0.154	0.041	0.003	0.625
Israel	0.105	0.553	0.185	0.070	0.087
Italy	0.150	0.409	0.424	0.007	0.011
Lithuania	0.197	0.255	0.035	0.008	0.505
Norway	0.163	0.370	0.401	0.046	0.020
Romania	0.168	0.300	0.037	0.006	0.488
Slovenia	0.405	0.244	0.043	0.009	0.300
Sweden	0.239	0.471	0.092	0.002	0.196
Turkey	0.361	0.512	0.103	0.008	0.015
England	0.131	0.666	0.143	0.034	0.026

5.2.3 Section for the schools

5.2.3.1 Does your school have a science laboratory that can be used by <eighth-grade> students?

Country	Yes	No	Omitted or invalid
Finland	0.912	0.088	0.000
Hungary	0.355	0.637	0.007
Israel	0.854	0.138	0.008
Italy	0.731	0.257	0.012
Lithuania	0.129	0.864	0.007
Norway	0.887	0.103	0.010
Romania	0.661	0.339	0.000
Slovenia	0.483	0.517	0.000
Sweden	0.965	0.008	0.027
Turkey	0.828	0.167	0.005
England	1.000	0.000	0.000

5.2.3.2 Do teachers usually have assistance available when students are conducting science experiments?

Country	Yes	No	Omitted or invalid
Finland	0.100	0.886	0.014
Hungary	0.108	0.892	0.000
Israel	0.837	0.155	0.008
Italy	0.089	0.890	0.021
Lithuania	0.184	0.803	0.013
Norway	0.243	0.751	0.006
Romania	0.255	0.745	0.000
Slovenia	0.762	0.238	0.000
Sweden	0.107	0.845	0.048
Turkey	0.119	0.873	0.008
England	0.743	0.247	0.010

5.2.3.3 How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the technologically competent staff?

Country	Not at all	A little	Some	A lot	Omitted or invalid
Finland	0.293	0.477	0.196	0.013	0.021
Hungary	0.313	0.333	0.242	0.067	0.044
Israel	0.358	0.269	0.146	0.194	0.034
Italy	0.098	0.362	0.387	0.141	0.011
Lithuania	0.478	0.219	0.207	0.073	0.024
Norway	0.270	0.580	0.142	0.000	0.007
Romania	0.324	0.343	0.236	0.090	0.007
Slovenia	0.621	0.315	0.024	0.008	0.032
Sweden	0.436	0.357	0.132	0.014	0.061
Turkey	0.122	0.227	0.444	0.206	0.002
England	0.518	0.385	0.098	0.000	0.000

5.2.3.4 How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the teachers with a specialization in science?

Country	Not at all	A little	Some	A lot	Omitted or invalid
Finland	0.857	0.066	0.023	0.046	0.008
Hungary	0.653	0.119	0.060	0.153	0.015

Israel	0.484	0.202	0.070	0.237	0.008
Italy	0.363	0.362	0.186	0.077	0.012
Lithuania	0.815	0.117	0.009	0.036	0.024
Norway	0.426	0.424	0.127	0.016	0.006
Romania	0.648	0.158	0.032	0.156	0.006
Slovenia	0.925	0.059	0.003	0.000	0.014
Sweden	0.472	0.276	0.169	0.032	0.052
Turkey	0.107	0.047	0.094	0.748	0.004
England	0.653	0.244	0.077	0.025	0.000

5.2.3.5 How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the computers for science instruction?

Country	Not at all	A little	Some	A lot	Omitted or invalid
Finland	0.204	0.482	0.251	0.049	0.014
Hungary	0.371	0.274	0.240	0.099	0.015
Israel	0.252	0.318	0.246	0.177	0.008
Italy	0.203	0.475	0.254	0.063	0.005
Lithuania	0.272	0.362	0.265	0.077	0.024
Norway	0.482	0.335	0.158	0.025	0.000
Romania	0.244	0.284	0.351	0.115	0.006
Slovenia	0.577	0.325	0.059	0.016	0.023
Sweden	0.299	0.314	0.282	0.044	0.061
Turkey	0.097	0.170	0.463	0.259	0.012
England	0.429	0.309	0.220	0.042	0.000

5.2.3.6 How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the computer software for science instruction?

Country	Not at all	A little	Some	A lot	Omitted or invalid
Finland	0.172	0.448	0.287	0.079	0.015
Hungary	0.202	0.410	0.277	0.096	0.015
Israel	0.250	0.225	0.260	0.245	0.019
Italy	0.120	0.427	0.378	0.074	0.001
Lithuania	0.104	0.374	0.410	0.088	0.024
Norway	0.310	0.467	0.200	0.022	0.000
Romania	0.158	0.335	0.338	0.156	0.012
Slovenia	0.344	0.508	0.135	0.003	0.010

Sweden	0.170	0.416	0.299	0.059	0.057
Turkey	0.128	0.214	0.484	0.170	0.004
England	0.445	0.345	0.191	0.019	0.000

5.2.3.7 How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the library materials relevant to science instruction?

Country	Not at all	A little	Some	A lot	Omitted or invalid
Finland	0.302	0.449	0.195	0.039	0.015
Hungary	0.320	0.399	0.219	0.038	0.025
Israel	0.359	0.250	0.203	0.180	0.008
Italy	0.130	0.498	0.313	0.055	0.004
Lithuania	0.192	0.442	0.309	0.028	0.029
Norway	0.275	0.536	0.135	0.054	0.000
Romania	0.193	0.378	0.344	0.079	0.006
Slovenia	0.585	0.352	0.051	0.000	0.012
Sweden	0.284	0.375	0.265	0.024	0.052
Turkey	0.110	0.255	0.406	0.222	0.008
England	0.418	0.410	0.153	0.019	0.000

5.2.3.8 How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the audio-visual resources for science instruction?

Country	Not at all	A little	Some	A lot	Omitted or invalid
Finland	0.284	0.408	0.242	0.058	0.008
Hungary	0.177	0.438	0.300	0.070	0.015
Israel	0.261	0.296	0.229	0.207	0.008
Italy	0.147	0.477	0.315	0.047	0.014
Lithuania	0.105	0.421	0.323	0.128	0.024
Norway	0.426	0.450	0.111	0.013	0.000
Romania	0.136	0.331	0.377	0.149	0.006
Slovenia	0.373	0.485	0.109	0.000	0.033
Sweden	0.390	0.298	0.230	0.031	0.052
Turkey	0.046	0.151	0.354	0.441	0.008
England	0.528	0.347	0.098	0.027	0.000

5.2.3.9 How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the calculators for science instruction?

Country	Not at all	A little	Some	A lot	Omitted or invalid
Finland	0.663	0.272	0.043	0.014	0.008
Hungary	0.492	0.291	0.171	0.024	0.021
Israel	0.482	0.283	0.133	0.095	0.008
Italy	0.455	0.341	0.123	0.050	0.031
Lithuania	0.469	0.307	0.158	0.042	0.024
Norway	0.912	0.046	0.016	0.026	0.000
Romania	0.204	0.322	0.345	0.124	0.006
Slovenia	0.635	0.281	0.060	0.014	0.010
Sweden	0.794	0.124	0.006	0.016	0.060
Turkey	0.428	0.337	0.177	0.054	0.004
England	0.707	0.210	0.064	0.019	0.000

5.2.3.10 How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the science equipment and materials?

Country	Not at all	A little	Some	A lot	Omitted or invalid
Finland	0.248	0.476	0.215	0.053	0.008
Hungary	0.176	0.336	0.375	0.099	0.015
Israel	0.338	0.255	0.182	0.202	0.023
Italy	0.136	0.410	0.302	0.151	0.001
Lithuania	0.081	0.368	0.422	0.105	0.024
Norway	0.313	0.506	0.140	0.041	0.000
Romania	0.127	0.353	0.409	0.105	0.006
Slovenia	0.251	0.532	0.188	0.019	0.010
Sweden	0.457	0.353	0.087	0.051	0.052
Turkey	0.069	0.129	0.257	0.541	0.004
England	0.487	0.349	0.137	0.027	0.000

5.3 Data for the WoP partners' countries not included in TIMSS

5.3.1 Cyprus

The tool was administered to one school, one teacher and 18 students.

5.3.1.1 Analysis at the school level

What is the total number of computers that can be used for instructional purposes by <eighth-grade> students?
110

Does your school have a science laboratory that can be used by <eighth-grade> students?	
yes	no
1	0

Do teachers usually have assistance available when students are conducting science experiments?	
yes	no
0	1

How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the following?				
	Not at all	*A little*	*Some*	*A lot*
Technologically competent staff				1
Teachers with a specialization in science				1
Computers for science instruction				1
Computer software for science				1

instruction				
Library materials relevant to science instruction				1
Audio-visual resources for science instruction				1
Calculators for science instruction				1
Science equipment and materials				1

5.3.1.2 Analysis at the teacher level

Do you use computers in your teaching in any of the following ways?		
	yes	no
a) a) For preparation	1	
b) b) For administration	1	
c) c) In your classroom instruction	1	

How much do you agree with the following statements about using computers in your classroom instruction?				
	Agree a lot,	*Agree a little,*	*Disagree a little*	*Disagree a lot*
a) I feel comfortable using computers in my teaching	1			
b) When I have technical problems, I have ready access to computer support staff in my school	1			
c) I receive adequate support for integrating computers in my teaching activities	1			

In teaching science to the students in this class, how often do you usually ask them to do the following?				
	Every or almost every lesson	*About half the lessons*	*Some lessons*	*Never*
a) Observe natural phenomena and describe what they see			1	
b) Watch me demonstrate an experiment or Investigation			1	
c) Design or plan experiments or investigations			1	
d) Conduct experiments or investigations			1	
e) Read their textbooks or other resource materials				1
f) Have students memorize facts and principles				1
g) Use scientific formulas and laws to solve routine problems			1	
h) Give explanations about something they are studying		1		
i) Relate what they are learning in science to their daily lives			1	

j) Do field work outside of class				1
k) Take a written test or quiz			1	

When you teach science to this class, how do you use the following resources?			
	Basis for instruction	*Supplement*	*Not used*
a) Textbooks	1		
b) Workbooks or worksheets	1		
c) Science equipment and materials	1		
d) Computer software for science instruction		1	
e) Reference materials (e.g., encyclopedia, dictionary)			1

Do the students in this class have computer(s) available to use during their science lessons?	
yes	no
1	

Do any of the computer(s) have access to the Internet?	
yes	no
1	

6. How often do you have the students do the following computer activities during science lessons?				
	Every or almost every day	*Once or twice a week*	*Once or twice a month*	*Never or almost never*
a) Practice skills and			1	

procedures				
b) Look up ideas and information			1	
c) Do scientific procedures or experiments		1		
d) Study natural phenomena through simulations		1		
e) Process and analyze data		1		

The following list includes the main topics addressed by the proposedtest. Choose the response that best describes when the students in this class have been taught each topic.

	Mostly taught before this year	*Mostly taught this year*	*Not yet taught or just introduced*
a) Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)			1
b) Energy forms, transformations, heat, and temperature			1
c) Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)			1

d) Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets			1
e) Forces and motion (types of forces, basic description of motion, effects of density and pressure)			1

How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose "Not applicable."

	Not applicable	*Very well prepared*	*Somewhat prepared*	*Not well prepared*
a) Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)	1			
b) Energy forms, transformations, heat, and temperature	1			
c) Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)		1		
d) Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent		1		

magnets and electromagnets				
e) Forces and motion (types of forces, basic description of motion, effects of density and pressure)		1		

5.3.1.3 Analysis at the student level

How often do you use a computer in each of these places?				
	Every day or almost every day	*Once or twice a week*	*Once or twice a month*	*Never or almost never*
At home	9	8	1	
At school		11	7	
Some other place		1	6	11

How much do you agree with these statements about learning science?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I enjoy learning science	8	9	1	
b) I wish I did not have to study science	2	1	3	11
c) I read about science in my spare time	1	9	5	3
d) Science is boring	1	2	3	12
e) I learn many interesting things in science	12	6		
f) I like science	9	7	1	1
g) It is important to do well	14	3	1	

in science				

How much do you agree with these statements about your science lessons?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I know what my teacher expects me to do	8	7	3	
b) I think of things not related to the lesson	1	4	7	5
c) My teacher is easy to understand	12	5	1	
d) I am interested in what my teacher says	6	8	4	
e) My teacher gives me interesting things to do	2	12	2	2

How much do you agree with these statements about science?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I usually do well in science	8	8	2	
b) Science is more difficult for me than for many of my classmates	1	2	8	7
c) Science is not one of my strengths	1	2	6	9
d) I learn things quickly in science	4	9	4	1
e) Science makes me confused and nervous	1	6	4	7

f) I am good at working out difficult science problems	4	10	3	1
g) My teacher thinks I can do well in science <programs/classes/lessons> with difficult materials	4	9	5	
h) My teacher tells me I am good at science	4	10	4	
i) Science is harder for me than any other subject		4	4	10
j) I think learning science will help me in my daily life	9	5	2	2
k) I need science to learn other school subjects	2	8	7	
l) I need to do well in science to get into the <university> of my choice	12	5		
m) I need to do well in science to get the job I want	11	5	2	
n) I would like a job that involves using science	7	7	3	1

How often does your teacher give you homework in science?	
Every day	6
or 4 times a week	6
1 or 2 times a week	6
Less than once a week	
Never	

When your teacher gives you science homework, about how many minutes do you usually spend on your homework?	
My teacher never gives me homework in science	
1–15 minutes	
16–30 minutes	11
31–60 minutes	5
61–90 minutes	1
More than 90 minutes	1

5.3.2 Greece

5.3.2.1 Analysis at the school level

What is the total number of computers that can be used for instructional purposes by <eighth-grade> students?				
22	25			

Does your school have a science laboratory that can be used by <eighth-grade> students?	
yes	no
1	1

Do teachers usually have assistance available when students are conducting science experiments?	
yes	no
	2

How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the following?				
	Not at all	*A little*	*Some*	*A lot*
Technologically competent staff		1		1
Teachers with a specialization in	1			1

science				
Computers for science instruction				2
Computer software for science instruction				2
Library materials relevant to science instruction		1		1
Audio-visual resources for science instruction		1		1
Calculators for science instruction	1	1		
Science equipment and materials				2

5.3.2.2 Analysis at the teacher level

Do you use computers in your teaching in any of the following ways?		
	yes	no
a) For preparation	8	
b) For administration	7	1
c) In your classroom instruction	6	2

How much do you agree with the following statements about using computers in your classroom instruction?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I feel comfortable using computers in my teaching	5	2	1	0
b) When I have technical problems, I have ready access to computer support staff in my	4	1	1	2

school				
c) I receive adequate support for integrating computers in my teaching activities	2	3	2	1

In teaching science to the students in this class, how often do you usually ask them to do the following?				
	Every or almost every lesson	*About half the lessons*	*Some lessons*	*Never*
a) Observe natural phenomena and describe what they see	2	2	4	0
b) Watch me demonstrate an experiment or Investigation	1	1	6	0
c) Design or plan experiments or investigations	1	0	4	3
d) Conduct experiments or investigations	1	1	5	1
e) Read their textbooks or other resource materials	5	2	1	0
f) Have students memorize facts and principles	1	5	2	0
g) Use scientific formulas and laws to solve routine problems	3	4	1	0

h) Give explanations about something they are studying	3	3	2	0
i) Relate what they are learning in science to their daily lives	4	3	1	0
j) Do field work outside of class	2	1	4	1
k) Take a written test or quiz	1	0	7	0

When you teach science to this class, how do you use the following resources?

	Basis for instruction	*Supplement*	*Not used*
a) Textbooks	7	1	0
b) Workbooks or worksheets	1	5	2
c) Science equipment and materials	1	6	1
d) Computer software for science instruction	4	2	2
e) Reference materials (e.g., encyclopedia, dictionary)	1	1	6

Do the students in this class have computer(s) available to use during their science lessons?

yes	no
3	5

Do any of the computer(s) have access to the Internet?

yes	no
3	2

6. How often do you have the students do the following computer activities during science lessons?				
	Every or almost every day	*Once or twice a week*	*Once or twice a month*	*Never or almost never*
a) Practice skills and procedures	2	1	4	1
b) Look up ideas and information	2	0	5	1
c) Do scientific procedures or experiments	1	0	6	1
d) Study natural phenomena through simulations	1	3	2	2
e) Process and analyze data	1	3	2	2

The following list includes the main topics addressed by the proposed test. Choose the response that best describes when the students in this class have been taught each topic.			
	Mostly taught before this year	*Mostly taught this year*	*Not yet taught or just introduced*
a) Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)	2	6	0
b) Energy forms, transformations, heat, and temperature	1	5	2

c) Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)	4	6	6
d) Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets	4	2	10
e) Forces and motion (types of forces, basic description of motion, effects of density and pressure)	8	8	0

How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose "Not applicable."

	Not applicable	*Very well prepared*	*Somewhat prepared*	*Not well prepared*
a) Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)	1	6	1	
b) Energy forms, transformations, heat, and temperature	1	6	1	
c) Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency,				

relative speed of light and sound)				
d) Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets				
e) Forces and motion (types of forces, basic description of motion, effects of density and pressure)				

5.3.2.3 Analysis at the student level

How often do you use a computer in each of these places?				
	Every day or almost every day	*Once or twice a week*	*Once or twice a month*	*Never or almost never*
At home	23			
At school		17	4	2
Some other place		6	5	12

How much do you agree with these statements about learning science?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I enjoy learning science	8	5	8	2
b) I wish I did not have to study science	4	10	6	3
c) I read about science in	2	9	2	10

my spare time				
d) Science is boring	9	5	3	6
e) I learn many interesting things in science	8	9	5	1
f) I like science	8	11	2	2
g) It is important to do well in science	15	6	0	2

How much do you agree with these statements about your science lessons?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I know what my teacher expects me to do	3	14	5	1
b) I think of things not related to the lesson	6	10	3	4
c) My teacher is easy to understand	7	10	6	0
d) I am interested in what my teacher says	10	10	3	0
e) My teacher gives me interesting things to do	9	12	2	0

How much do you agree with these statements about science?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
a) I usually do well in science	4	11	7	1
b) Science is more difficult for me than for many of my classmates	6	11	2	4

c) Science is not one of my strengths	9	6	4	4
d) I learn things quickly in science	3	7	11	2
e) Science makes me confused and nervous	10	7	4	2
f) I am good at working out difficult science problems	3	4	9	7
g) My teacher thinks I can do well in science <programs/classes/lessons> with difficult materials	7	8	7	1
h) My teacher tells me I am good at science	5	4	10	4
i) Science is harder for me than any other subject	16	5	1	1
j) I think learning science will help me in my daily life	16	7	0	0
k) I need science to learn other school subjects	15	8	0	0
l) I need to do well in science to get into the <university> of my choice	16	4	3	0
m) I need to do well in science to get the job I want	12	9	2	0
n) I would like a job that involves using science	9	8	5	1

How often does your teacher give you homework in science?	
Every day	
or 4 times a week	8
1 or 2 times a week	11
Less than once a week	4
Never	

When your teacher gives you science homework, about how many minutes do you usually spend on your homework?	
My teacher never gives me homework in science	
1–15 minutes	1
16–30 minutes	4
31–60 minutes	9
61–90 minutes	6
More than 90 minutes	3

5.3.3 Slovakia

The tool was administered to five schools, ten teachers and 94 students.

5.3.3.1 Analysis at the school level

What is the total number of computers that can be used for instructional purposes by <eighth-grade> students?				
17	120	60	20	8

Does your school have a science laboratory that can be used by <eighth-grade> students?

yes	no
4	1

Do teachers usually have assistance available when students are conducting science experiments?	
yes	no
5	0

How much is your school's capacity to provide instruction affected by a shortage or inadequacy of the following?				
	Not at all	*A little*	*Some*	*A lot*
Technologically competent staff	2	3	0	0
Teachers with a specialization in science	4	1	0	0
Computers for science instruction	2	0	3	0
Computer software for science instruction	0	2	3	0
Library materials relevant to science instruction	1	2	0	2
Audio-visual resources for science instruction	1	2	0	2
Calculators for science instruction	0	1	2	2
Science equipment and materials	0	2	1	2

5.3.3.2 Analysis at the teacher level

Do you use computers in your teaching in any of the following ways?		
	yes	no
d) For preparation	10	0
e) For administration	10	0

f)	In your classroom instruction	8	2

How much do you agree with the following statements about using computers in your classroom instruction?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
d) I feel comfortable using computers in my teaching	6	3	0	0
e) When I have technical problems, I have ready access to computer support staff in my school	5	2	1	0
f) I receive adequate support for integrating computers in my teaching activities	4	1	3	0

In teaching science to the students in this class, how often do you usually ask them to do the following?				
	Every or almost every lesson	*About half the lessons*	*Some lessons*	*Never*
l) Observe natural phenomena and describe what they see	1	6	3	0
m) Watch me demonstrate an experiment or Investigation	2	5	3	0
n) Design or plan	2	5	0	3

experiments or investigations				
o) Conduct experiments or investigations	2	5	0	2
p) Read their textbooks or other resource materials	5	1	3	1
q) Have students memorize facts and principles	6	0	3	1
r) Use scientific formulas and laws to solve routine problems	3	3	3	1
s) Give explanations about something they are studying	6	2	2	0
t) Relate what they are learning in science to their daily lives	3	2	4	1
u) Do field work outside of class	0	0	6	3
v) Take a written test or quiz	5	1	4	0

When you teach science to this class, how do you use the following resources?			
	Basis for instruction	*Supplement*	*Not used*
f) Textbooks	10	0	0
g) Workbooks or worksheets	2	4	3
h) Science equipment and materials	4	3	3

i)	Computer software for science instruction	1	4	5
j)	Reference materials (e.g., encyclopedia, dictionary)	0	8	2

Do the students in this class have computer(s) available to use during their science lessons?	
yes	no
6	4

Do any of the computer(s) have access to the Internet?	
yes	no
6	2

6. How often do you have the students do the following computer activities during science lessons?				
	Every or almost every day	*Once or twice a week*	*Once or twice a month*	*Never or almost never*
f) Practice skills and procedures	0	3	4	3
g) Look up ideas and information	4	1	2	3
h) Do scientific procedures or experiments	0	1	6	3
i) Study natural phenomena through simulations	1	2	3	4
j) Process and analyze data	1	2	2	5

The following list includes the main topics addressed by the proposed test. Choose the response that best describes when the students in this class have been taught each topic.			
	Mostly taught before this year	*Mostly taught this year*	*Not yet taught or just introduced*
f) Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)	4	5	1
g) Energy forms, transformations, heat, and temperature	3	7	0
h) Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)	0	7	3
i) Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets	2	5	3
j) Forces and motion (types of forces, basic description of motion, effects of density and pressure)	7	2	1

How well prepared do you feel you are to teach the following science topics? If a topic is not in the <eighth-grade> curriculum or you are not responsible for teaching this topic, please choose "Not applicable."				
	Not applicable	*Very well prepared*	*Somewhat prepared*	*Not well prepared*

f) Physical states and changes in matter (explanations of properties in terms of movement and distance between particles; phase change, thermal expansion, and changes in volume and/or pressure)	4	4	2	0
g) Energy forms, transformations, heat, and temperature	2	7	1	0
h) Basic properties/behaviors of light (reflection, refraction, light and color, simple ray diagrams) and sound (transmission through media, loudness, pitch, amplitude, frequency, relative speed of light and sound)	4	5	1	0
i) Electric circuits (flow of current; types of circuits - parallel/series; current/voltage relationship) and properties and uses of permanent magnets and electromagnets	3	6	1	0
j) Forces and motion (types of forces, basic description of motion, effects of density and pressure)	5	5	0	0

5.3.3.3 Analysis at the student level

How often do you use a computer in each of these places?				
	Every day or almost every day	*Once or twice a week*	*Once or twice a month*	*Never or almost never*
At home	72	18	4	0
At school	21	58	8	5

Some other place	11	25	20	37

How much do you agree with these statements about learning science?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
h) I enjoy learning science	21	31	31	10
i) I wish I did not have to study science	21	38	31	4
j) I read about science in my spare time	14	15	40	24
k) Science is boring	19	35	34	5
l) I learn many interesting things in science	16	52	21	5
m) I like science	9	40	33	12
n) It is important to do well in science	18	41	29	6

How much do you agree with these statements about your science lessons?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
f) I know what my teacher expects me to do	18	49	21	5
g) I think of things not related to the lesson	28	45	18	2
h) My teacher is easy to understand	13	33	36	11
i) I am interested in what my teacher says	7	50	27	9
j) My teacher gives me interesting things to do	15	22	39	17

How much do you agree with these statements about science?				
	Agree a lot	*Agree a little*	*Disagree a little*	*Disagree a lot*
o) I usually do well in science	23	31	31	8
p) Science is more difficult for me than for many of my classmates	15	32	34	11
q) Science is not one of my strengths	25	40	23	5
r) I learn things quickly in science	10	36	35	13
s) Science makes me confused and nervous	29	26	30	8
t) I am good at working out difficult science problems	15	21	39	18
u) My teacher thinks I can do well in science <programs/classes/lessons> with difficult materials	21	33	26	13
v) My teacher tells me I am good at science	15	25	31	23
w) Science is harder for me than any other subject	30	37	23	4
x) I think learning science will help me in my daily life	12	56	18	8
y) I need science to learn other school subjects	15	41	31	7
z) I need to do well in science to get into the	17	26	34	17

<university> of my choice				
aa) I need to do well in science to get the job I want	16	24	34	20
bb) I would like a job that involves using science	18	22	28	25

How often does your teacher give you homework in science?	
Every day	25
or 4 times a week	8
1 or 2 times a week	10
Less than once a week	40
Never	11

When your teacher gives you science homework, about how many minutes do you usually spend on your homework?	
My teacher never gives me homework in science	
1–15 minutes	29
16–30 minutes	35
31–60 minutes	14
61–90 minutes	2
More than 90 minutes	4