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OTA

ONLINE TEACHING ADVANCEMENT



OTA

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REPORT ON LEARNING NEEDS

OF TARGET GROUPS

COMPILED BY

CESIE

WITH

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1. INTRODUCTION

OTA- Online Teaching Advancement is a project focused on creating an open learning methodology based on arts and creativity for teaching science subjects as well as the necessary implementation tools that will enable teachers to support pupils, from 12 to 14, in science learning.

OTA project wants to improve pupils' integration in their school and community and enhance their wellbeing and learning results, to overcome barriers due to the ongoing Covid pandemic.

The first output was aimed to analyse the curricula of subjects as Maths, Chemistry and Physics in the primary or secondary schools and find the common topics among the partner countries, thus adopting a curriculum based cross-national comparative approach.

Therefore, the consortium analysed, at first, the curricula of Natural and Scientific subjects of each partner country and identified common topics across the countries; then, a survey online was administered to find the most challenging topics both for teachers and students in distance learning.

This report is a synthesis of quantitative and qualitative data, resulting from the online survey and focus groups in each partner country; and it aims to state how the results indicate the need for an intervention that can help improve the skills and competences of the target groups, leading to more effective and smooth learning of educational content and topics through tools that can be used in online teaching.

The path followed during these months of work consisted of three different moments.

- At the beginning each partner country studied its own national curriculum relating to the natural and scientific subjects: Maths, Chemistry and Physics.

Thanks to this research, a comparison of the four countries' curricula in S&N subjects was made and it was possible to define the common topics to be used and addressed in the survey in order to provide usable teaching materials in schools in all different countries.

- Once the common topics were identified, a survey was created and administered to Natural and scientific teachers
-
- At the same time each partner conducted a focus group (in the case of Slovenian partners, they conducted two different focus groups) in which different stakeholders were involved, aimed to investigate more on the challenges of online teaching.



2. CURRICULA

Each partner country prepared a document outlining all the topics covered in the curricula of the three subjects covered by the OTA project: Mathematics, Chemistry and Physics.

The countries were asked to describe the curricula and track some data specifically:

- Content
- Content subset
- Operational goals
- General competences
- Interdisciplinary integration

The aim was to find common topics within the four different curricula between the countries and on this basis to build the survey and the next project results.

Although the four curricula were somewhat different, the consortium managed to create a list of common topics and sub-topics.

These were then used and incorporated into the second part of the survey, the aim of which was to investigate which topics were considered by teachers to be the most difficult to teach online and which topics they perceived most difficult for their students during online learning.



3. SURVEY

After the definition of the common curricula, the creation of a survey and its administration was the next step: thus, an online questionnaire was prepared in order to identify the needs and challenges of science teachers, particularly in regard to online teaching and learning.

The survey represents an important milestone for the investigation of the learning needs of the target group because it allowed the consortium to have a privileged view on the difficulties that teachers and pupils faced during online teaching and allowed also to have both a quantitative and qualitative view.

It was very important to acquire the vision of those who everyday deal with the problems within the formal education institutions, especially during a delicate moment as online teaching has been and continues to be.

In order to have a wide view on what the strengths and weaknesses of online teaching are, as well as the risks and opportunities that derive from it, the survey was divided in three parts, to investigate different aspects.

In the *first part of the survey* the questions were aimed at investigating what the challenges were that teachers of natural and scientific subjects faced with online teaching; their feelings, experiences and methods experienced during the distance teaching.

This part was aimed at exploring how distance learning had changed the perspective of teachers in relation to their students and their profession, and at evaluating the degree of flexibility to which they were called on after such a radical didactic change.

The *second part of the survey* goes into much more detail; the questions refer specifically to the common topics resulting from the crossing research of the 4 national curriculum. The main objective of this part was investigated on:

- which subjects were most difficult for teachers to explain online
- which subjects were most difficult for students to learn online.

In this case the survey wanted to investigate both teachers' and pupils' difficulties: understand which subjects were the hardest to teach and learn in online mode.

The *last section of the survey* referred to the teachers' experiences and opinions on the STEAM interdisciplinary approach; in this case the survey was useful to understand the attitude of natural and scientific teachers to use art within their teaching.



4. FOCUS GROUP

Focus groups were organized in each partner country and were very important because they gave to the research a more qualitative input through group interviews.

The participants of the Focus Group have been encouraged to share their experiences, challenges and advice about online teaching tools, as well as any other relevant information that can improve their online teaching experience of N&S subjects.

People to be involved in this activity were N&S teachers, art/science museum pedagogues, art teachers, ICT teachers and teachers-to-be.

During the focus group the participants were guided by moderators, and they had the opportunity to talk about art as a tool in their work; explore the potential in combining art with N&S subjects; talk about the digital tools they already know, and exchange views on important issues related to the teaching of their subjects.

Each partner followed guidelines that divided the group interview in three parts:

Part 1:

Teacher's relationship to online teaching tools:

1. What are the quickest ways to capture the students' attention? (Individual, group approaches)
2. How do you handle broadcast interruptions / technical problems (freezing screens, unresponsive keyboards...)?
3. Do you incorporate movement into your online lessons or would you like to?
4. What would help you personally to support and improve on-line teaching?
5. What are the benefits of online teaching vs in-person teaching?

Student's relationship to online teaching tools:

6. How did you spot someone not following the lessons?
7. How could we mitigate this?
8. Is there a difference in how boys or girls perceive online / interdisciplinary lessons?



Part 2:

Teaching science through art

9. Have you ever used art as a learning/teaching tool for Nature and Science subjects before? What are your experiences?
10. How much educational background in visual art should we provide you with to implement our teaching tools successfully?
11. The group is presented with 10 works of art: which one would you choose to relate to your lesson? (Range of styles, motifs, colour palette, shapes, secular/religious motifs, etc.)

Good practices:

12. Do you have any further suggestions, comments, ideas to share with us?



5. RESULT ON LEARNING NEED IN EACH COUNTRY

5.1 SLOVENIA

Among the 50 Slovenian teachers that responded to the questionnaire, most of them were teachers who teach Maths (82 %); the 30 % of respondents teach physics, 12 % teach ICT subjects, and 5 of them teach chemistry.

On average, most of the respondents (72%) have been teaching for at least 10 years and this is an important data since they teach for many years, and they could be understanding the issue of their students better and with a greater awareness of those who have only been teaching for a short time.

Since OTA's innovation lies in digitalization of a didactic methodology it was important to value the digital competences of the teachers interviewed and understand how the period on online teaching has enabled them to improve these skills.

From the results of the survey, it seems that majority of Slovenian teachers noticed a very high improvement in ICT skills; these data were also confirmed by the focus group conducted by the National Gallery where some teachers observed that *"distance learning was more of a change for the teachers than the pupils - especially older primary school teachers had to quickly acquire new IT skills"*.

Teachers' opinions were also asked, both in the survey and in the focus group, about pupils' attention during the pandemic: many of them (42%) rated their attention as so-so compared to the traditional classroom, while some of them (38%) rated their attention as lower in online learning than in a traditional classroom.

In relation to this issue it is also important to note that Slovenian teachers had some problems when they found themselves in a hybrid system, i.e. with some pupils in the classroom and others in self-isolation at home; in fact, the teachers who participated in the focus group realized that, often, they found themselves focusing more on the pupils present in the classroom than on those who were participating online, risking, in this case, to penalise the pupils who are not present in the classroom.

Even with the difficulties, the teachers tried to maintain constant interaction with their pupils, rated good for 50 % of who responded to the survey and the middle for another 36 %; everyone has made use of digital tools for improving that interaction and the majority used online platforms and online classrooms.

Many of them also used digital tools to create a space of dialogues with the pupils; as reported by the survey, Slovenian teachers changed very much the way to



deliver the lessons and it was considered fundamental that children had constant contact and engagement with teachers.

As evidenced by a teacher in the focus group, “direct contact between pupils and teachers was crucial” and one of the best ways to sustain the motivation and participation of the pupils were live classes (using camera, Teams, Zoom, other tools) rather than just sending lesson material to children.

Therefore, the use of digital tools allows them to deal with distance teaching with a new and alternative language to the traditional one.

Another important element for OTA investigation was the teachers’ level of stress during the pandemic and understanding what was more stressful for them during that period.

For the survey’s respondents online teaching was quite stressful for a half of the participants (among them 22 % considered it extremely stressful).

They found most stressful the problems related to no live connection and the time management; others would have preferred to have more digital options and more digital skills.

CURRICULA

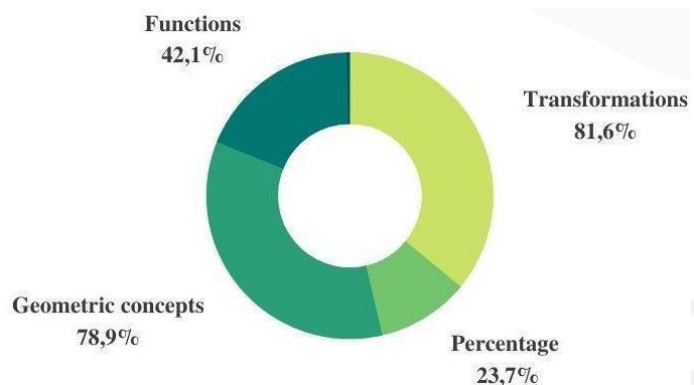
Regarding the most difficult subjects to teach and learn online, we notice that there is almost always a correspondence between the difficulties of the teachers and those of the students.

MATHS

TARGET GROUP: TEACHERS

For Maths the most difficult subjects in teaching online were:

- Transformation
- Geometric concepts
- Functions
- Percentage



Transformation was the hardest topic to teach online; the most difficult sub-topics were:

- *Concept of line bisectors and angle bisectors and solve construction problems*
- *Transformations (mirroring displacement, rotation) and their properties*



- Mirror a point, line, angle, character over a selected line over a point

The most difficult topics regarding **Geometric concepts** in teaching online were:

- Triangle and Other polygons
- Circle and Rectangle / square.

About the **Functions**, Slovenian teachers believe that the hardest topics were:

- Definition of the linear function $y = kx + n$ and draw it
- Compose table and draw a graph variables

Finally, in **Percentage** (account and direct and inverse ratio) the hardest topics were
Graphically display P%, Calculation with p% and Solve real life problems.

TARGET GROUP: STUDENTS

For pupils, the most difficult maths subjects in learning online were the same of the teachers:

- Transformation
- Geometric concepts
- Functions
- Percentage

Transformation continues to be a hard topic also in learning online, especially with regard to:

- Transformations (mirroring displacement, rotation) and their properties
- Mirror a point, line, angle, character over a selected line over a point
- Concept of line bisectors and angle bisectors and solve construction problems

The most difficult topics in **Geometric concepts** to learn online for the students correspond to the teachers' ones and were:

- Triangle and Other polygons
- Circle and Rectangle / square



Regarding the **Functions** for the Slovenian teachers the hardest topics to learn online were:

- Definition of the linear function $y = kx + n$ and draw it
- Compose table and draw a graph variables

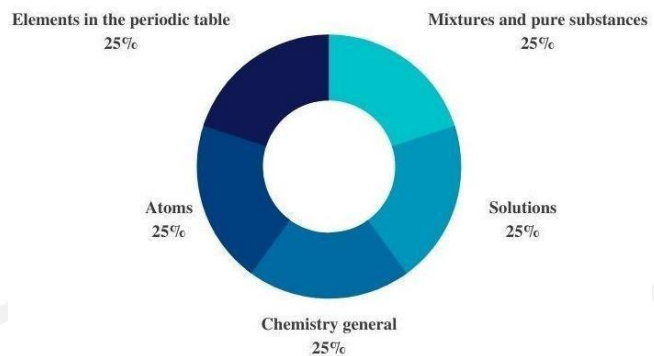
In **Percentage** (account and direct and inverse ratio) students had some problems with *Graphically display P%, Calculation with p% and Solve real life problems.*

CHEMISTRY

TARGET GROUP: TEACHERS

For Chemistry the most difficult topics in teaching online were:

- Element in the Periodic table
- Atoms
- Chemistry general
- Solution
- Mixtures and pure substances



Regarding the **Element in the Periodic table**, all respondents had troubles only with *Chemical elements classified in the periodic system and marked with symbols.*

Instead, regarding **Atoms** all teachers had some problems explaining *Electronic chains.*

In teaching **Chemistry general** the *Molecules* were difficult for more teachers and for **Solutions** the most difficult topic was *Concept of solubility of substances and saturation of solutions.*

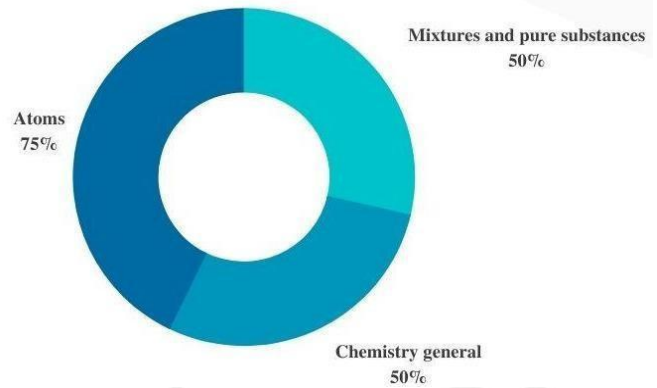
Finally, regarding **Mixtures and pure substances** *Methods for separating pure substances from mixtures (filtration, extraction, evaporation, distillation)* was the topic in which most of the teachers interviewed had the most problems.



TARGET GROUP: STUDENTS

For pupils, instead, the most difficult chemistry subjects in learning online were:

- Atoms
- Chemistry general
- Mixtures and pure substances



Atoms was the most difficult topic for students to learn online, according to the teacher's opinion, especially with regard to *Electronic chains*.

Next, there is **Mixtures and pure substances** that gave the students problems with:

- Methods for separating pure substances from mixtures (filtration, extraction, evaporation, distillation)
- Distinguish between pure substances and mixtures
- Chemical elements composed of one type of atom

At the same level we find **Chemistry general**, which was difficult to understand in relation to the topic of *Molecules*

PHYSICS

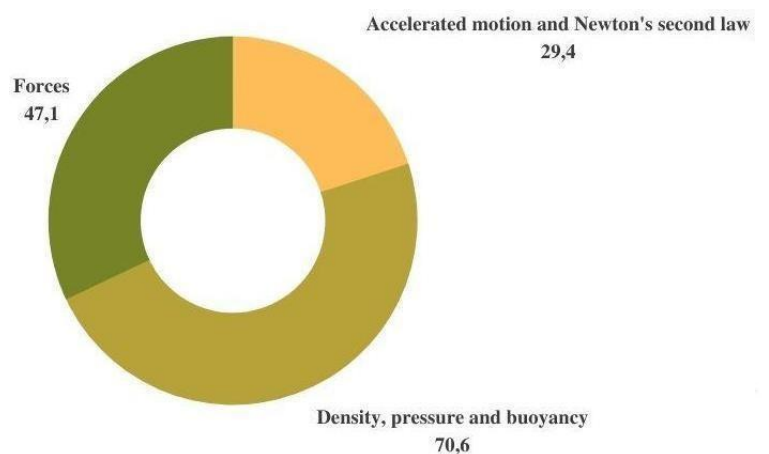
TARGET GROUP: TEACHERS

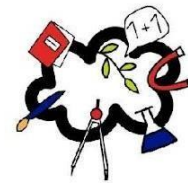
For Physics, the most difficult topics in teaching online were:

- Density, pressure and buoyancy
- Forces
- Accelerated motion and Newton's second law

The most difficult topic for the Slovenian physics teachers to teach online was **Density, pressure and buoyancy** in relation to:

- Buoyancy
- Density and specific gravity





Also, **Forces** were difficult to teach online, mostly in:

- *Assembling forces*
- *Drawing forces*
- *Balance and Measurement of forces*

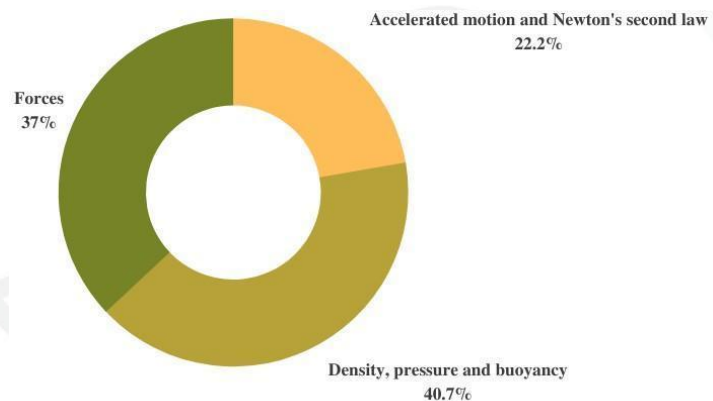
Finally, there is the topic related to **Accelerated motion and Newton's second law**, that was more difficult in relation with:

- *Path at steadily accelerated motion*
- *Relationship between mass, force and acceleration*
- *Free fall*

TARGET GROUP: STUDENTS

According to the Slovenian physics teachers, the most challenging topics in learning online were the same in teaching online:

- Density, pressure and buoyancy
- Forces
- Accelerated motion and Newton's second law



Regarding **Density, pressure and buoyancy** they found more difficulties in relation to:

- *Buoyancy*
- *Pressure due to the weight of the stationary fluid*
- *Density and specific gravity*
- *Fluid pressure*

In relation with **Forces** they found difficult to understand the concept of *Assembling forces* and *Drawing forces*, and *Balance of forces*; while **Accelerated motion and Newton's second law** has been problematic with regard to:

- *Relationship between mass, force and acceleration*
- *Path at steadily accelerated motion.*



STEAM APPROACH

Majority of the Slovenian teachers responding to the survey's questions never used the STEAM approach while teaching their subjects (62 %), some of them used it sometimes and someone else often, but none of participating teachers said they use it frequently.

Even they didn't use STEAM approach, seems that a large majority think that this methodology could help them explaining difficult concepts and make lessons more interesting for their pupils; despite the high percentage of interest in the interdisciplinary approach, it is interesting to note that 40% of teachers would not be willing to collaborate actively with their art colleagues, while for the rest 60% it would be feasible and useful.

A different and interesting perspective on the STEAM approach is offered by the teachers interviewed in the focus; in this case, in fact, they offer to OTA research many practices already experienced.

For example, the biology teacher talking to her students about plants is used to highlight the connection with art subjects and uses Van Gogh's Sunflowers or Islamic examples of floral designs as inspiration, linking them also to geometry.

Another emphasises this interconnection by arguing that *"teachers of natural courses have to teach children to be precise, so a link to aesthetics is also important"*.

Regarding the possibility to realize online STEAM methodology, most teachers (70%) don't know if it could be possible but as it is possible to note also in the focus group results, they seem really interested to have instruments that enable them to offer a complete and integrated lesson.

Also, because, one of the problems that emerged from both the survey and the focus group is the lack of time and organisation. As Slovenian teachers, and teachers from other countries, every path through the innovation in the school depends on the teacher's personal motivation: *"cross-curricular lessons are a heavy burden for the teachers who are already stretched - one great hour with pupils requires up to 15 hours of preparation. It is already difficult to complete the basic teaching goals without the extra work"*.

It is therefore essential to offer them tools, materials that allow them to use *"art as something more than just an illustrative example"*.

Those who think it could be possible suggest approaching this methodology similar to the face-to-face method, also constructing models, giving pupils instructions for the experiments, underlining the connection between art and transformations, planning an interdisciplinary agenda for all teachers included.



5.2 CYPRUS

In Cyprus, 65 teachers in total responded to the survey and most of them were Physics teachers (51 Physics teachers, 6 Maths teachers and 8 Chemistry teachers).

As in the case of Slovenia, half of the respondents have 11-20 years of teaching experience and 21.5% of them have been teaching for 20 years or more; they certainly have a clearer understanding of their own and their students' needs and challenges.

For all the Cypriots teachers who responded to the survey, the online teaching constraints allowed them to improve their digital skills even if 70% of them reported a very good level of digital skills also at the start of the pandemic.

In the majority of cases (almost 70% of respondents) these digital skills allowed them to interact with their students in a more dynamic way: in relation to this it is important to note that a good 29% reported very good interaction with students during online teaching, while only 18.5% considered that interaction was rather poor.

To improve the interaction with their students, most of them, used some digital tools during online learning; examples of them are: Microsoft Teams, Zoom, Kahoot, Skype, Classroom, Google forms, Facebook, Youtube, Whiteboard, Simulations, Jamboard, Nearpod, WeBex, OneNote, Quiz, Wacom, Discord, Google meet, Excel, Word.

The challenges faced by teachers have interested also the way in which they delivered their lessons; as the survey results show, a large majority of Cypriot teachers interviewed declare that their online lessons were quite or completely different from those delivered face to face, while just only 10.8% report they were quite the same both in content and in the way of delivery.

Despite this, the level of students' attention remained within the average, but it's important to take in consideration 38,5% of the respondents that believe that the students' attention was lower or much lower online than in the classroom.

In general, both in survey and focus group, Cypriot teachers seem to be divided in their view of this period.

There are indeed some testimonies regarding the positive side of online teaching; according to the art teacher who spoke during the focus group for example, *"Online teaching gave students the opportunity to use tools they know well, developing their digital knowledge and creativity. Both teachers and students were obliged to adjust to this new reality and explore the new technological trends"*; another one noted that



“Online teaching gave him and his students more opportunities for autonomy and freedom than face to face lessons”.

On the other hand, there are many complaints on online teaching: a chemistry teacher noted, in fact, that *“students were disoriented in online learning”* and another one reported that *“online teaching deprived students from their need to socially communicate and the lack of social interaction had led to a decrease of their learning motivation in front of the screen”.*

Moreover, if for a physics & maths teacher interviewed in the focus group, online teaching represented a “discovery” in the explanation of the experiments, because it allows him to prepare the guidelines in advance and guide his pupils at a distance in repeating the experiment several times; for another teacher it has been a failure because most of students were just connected online, but not paying attention nor doing the tasks required.

Obviously, the world situation found the teachers unprepared and they had to face too many challenges at once: the data of 38.5% of the respondents who considered that they were stressed or overstressed by teaching is relevant and worrying and it is accompanied by another 36.9% who rated their stress level as average.

As also confirmed by the teachers involved in the focus group, the most stressful was time management; in fact, the main challenge according to a teacher was facing the short time slot of the online sessions compared to the huge volume of material they need to cover, according to the national curriculum.

Another need that emerged from the results regards digital innovation: there is a need for teachers to attend seminars and courses to keep up to date with new technologies, new tools and applications to use in their online lessons.



CURRICULA

MATHS

TARGET GROUP: TEACHERS

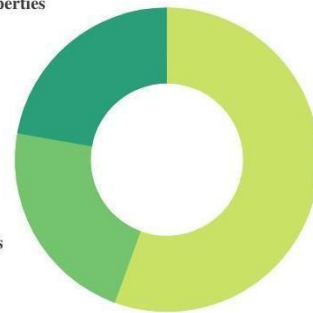
For Maths the most difficult subjects in teaching online were:

- Geometric concepts
- Accounting operations and their properties
- Functions

Accounting operations and their properties
33.3%

Functions
33.3%

Geometric concepts
83.3%



From **Geometric concepts**, the most difficult topics for teachers to teach online were:

- *Other polygons*
- *Circle*
- *Pythagorean theorem*

Regarding the topic **Accounting operations and their properties**, teachers found difficult:

- *Calculating with fractions, decimals and integers*
- *Solving real life problems*
- *Calculation with rational numbers*

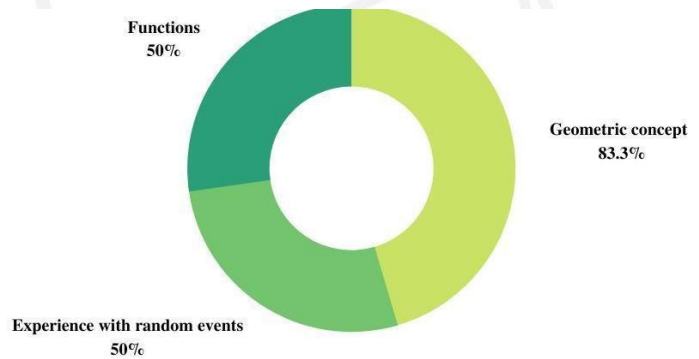
With regards to **Functions**, instead, they found *Reading graphs* challenging.



TARGET GROUP: STUDENTS

With regard to the students' point of view, the most difficult Maths subjects in learning online were:

- Geometric concepts
- Functions
- Experience with random events



We can note that, as for the topics hardest to teach online, **Geometric concepts** was considered by 83,3% of teachers, the most difficult topic for students to learn online, especially regarding *Polygons and Circle*.

With regards to **Functions**, instead, they found the topic *Reading graphs and Coordinate system, coordinate axes (abscissa, ordinate), grid and coordinates of given points* very challenging to teach online. Someone rated it difficult also *Definition of the linear function $y = kx + n$ and drawing it*.

Regarding **Experience with random events**, instead, teachers had some difficulties with *Collection, editing and analysis of the results of the experiment and Observation and prediction of the events*



CHEMISTRY

TARGET GROUP: TEACHERS

For Chemistry, the most difficult subjects in teaching online were:

- Atoms
- Mixtures and pure substances
- Chemistry general
- Solution

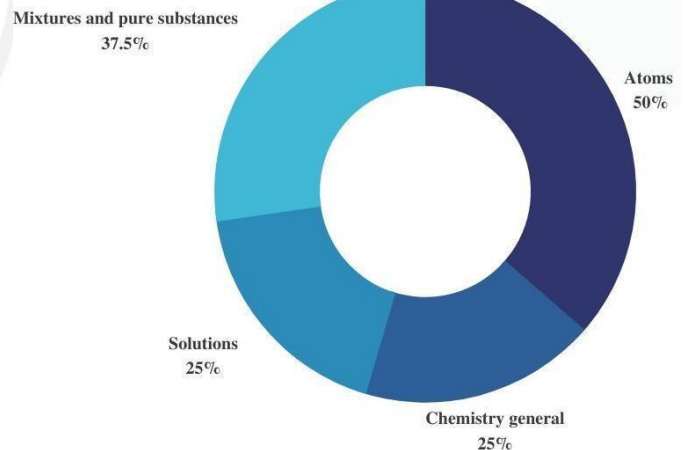
According to Chemistry teachers, the most difficult topic to teach online was **Atoms**, especially with regard to *Ions*, *Ions subatomic particles*, *Atom model* and *Electronic chain*.

For **Mixtures and pure substances** the most difficult topics were:

- *Methods of separating pure substances from mixtures;*
- *Physical and chemical changes of substances;*
- *Distinction between pure substances and mixtures.*

In **Chemistry General**, *Atoms* and *Molecules* were considered almost equally challenging in teaching online.

Finally, in **Solution**, *Concept of solubility of substances and saturation of solutions* is considered as the most challenging topic in online teaching, together with *Solutions as examples of mixtures and distinction between solvent and solute* and *Factors that affect the rate of dissolution of substances*.

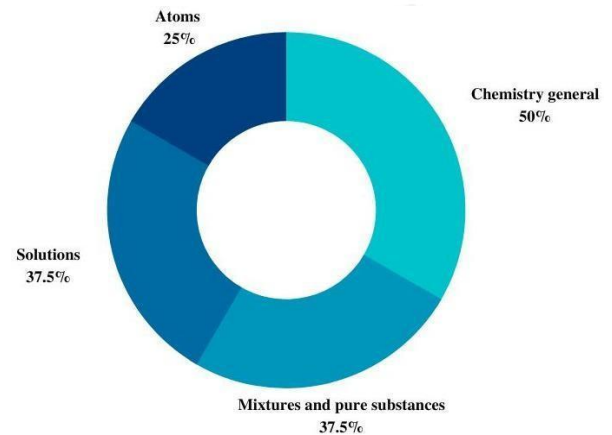




TARGET GROUP: STUDENTS

The subjects that chemistry teachers consider having been most difficult for their pupils online were the same subjects that they considered most difficult to teach online.

- Chemistry general
- Mixtures and pure substances
- Solution
- Atoms



In **Chemistry generally** both *Atoms* and *Molecules* were considered difficult to learn online for the students.

In **Mixtures and Pure substances**, the topic *Methods of separating pure substances from mixtures* is reported as the most challenging in online learning followed by the topic *Distinction between pure substances and mixtures*.

Regarding **Solutions**, the most difficult topics in learning online were *Concept of solubility of substances and saturation of solutions* and *Solutions as examples of mixtures and distinction between solvent and solute*.

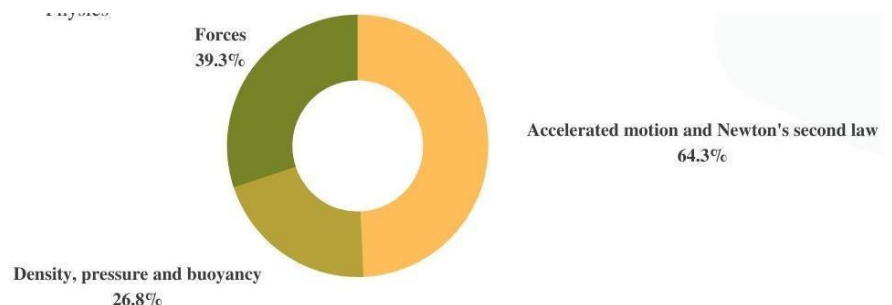
Finally, in **Atoms**, the topic *Ions* was absolutely the most difficult topic for the students to learn online.

PHYSIC

TARGET GROUP: TEACHERS

For Physics, the most difficult subjects in teaching online were:

- Accelerated motion and Newton's second law
- Forces
- Density, pressure and buoyancy





According to Physics teachers, the most challenging topic to teach online was the **Accelerated motion and Newton's second law**; Cypriot professors found it particularly difficult to teach:

- *Description of movement and straight steady movement and repetition*
- *Relationship between mass, force and acceleration*
- *Path at steadily accelerated motion*
- *Free fall*

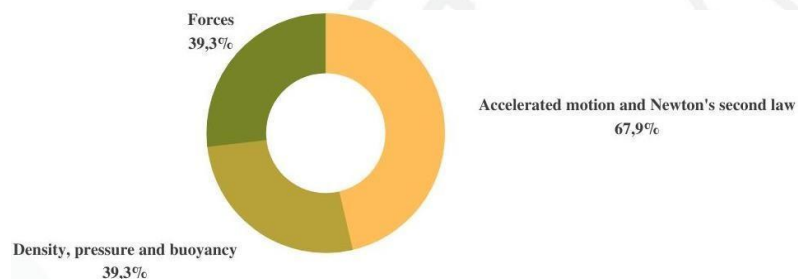
In **Forces**, they found difficult topics like *Interaction Act, Friction and resistance, Measurement of forces and Spring balance, Balance of forces and Center of gravity.*

Regarding **Density, pressure and buoyancy**, all teachers interviewed consider *Atmospheric phenomena and weather* the most difficult topic to teach online; they also found difficult: *Density and specific gravity and Fluid pressure.*

TARGET GROUP: STUDENTS

For students, the most difficult Physics subjects in learning online correspond to topics that were difficult for teachers:

- Accelerated motion and Newton's second law
- Forces
- Density, pressure and buoyancy



Most Physics teachers agree that the most challenging topic for students to learn online was the **Accelerated motion and Newton's second law**, in particular:

Path at steadily accelerated motion, Description of movement and straight steady movement and repetition, Free fall and Relationship between mass, force and acceleration.

In second place we find **Forces** and **Density, pressure and buoyancy**.

For the first one *Interaction Act, Friction and resistance, Measurement of forces and Balance of forces* were considered the most difficult topics to learn online.



For the second one, instead, the teachers believe that *Density and specific gravity, Fluid pressure, Atmospheric phenomena and weather and Buoyancy* were the most difficult topics for students.

STEAM APPROACH

Regarding the STEAM approach the Cypriot framework reveals a different point of view. The results of the survey show that most of the respondents (58.5%) has never used the interdisciplinary STEAM approach to teach their subject, someone declared to have rarely or occasionally used it and only 6 respondents out of 65 used STEAM methodology.

Although the majority of teachers are not so familiar with the interdisciplinary teaching methodology, they believe that it can help them explain complex concepts more easily.

On the contrary, the focus group participants seem to have used an interdisciplinary approach, combining their science subjects with several topics, not only with art, but also with history, geography and computer science.

As commented by the art teacher interviewed, with an interdisciplinary method “students had the opportunity to research and develop their own project and gain spherical and cohesive knowledge, while teachers had the chance for a fruitful collaboration”; she also comments: “art can be used as a starting point in any lesson”.

Another important message came from the maths teacher interviewed. She combined mathematics with art both in online and offline teaching and she noted that most of her students showed a great interest, although there were some who did not respond.

The vast majority of Cypriot respondents believe that using a creative approach could make their lessons more interesting for students, not for the final result but for the cognitive process that accompanies the students.

Regarding this, a teacher commented: “when combining science with art, the aim is not to assess a project made by the student, or his/her ability to draw. Art will be used as a tool to achieve aims and results, not as an end-a”.

This positive flow is also confirmed by the wish for more collaboration between teachers, evident both in survey and focus group, since 70.8% of respondents expressed an unequivocal favourable opinion of collaborating with their art colleagues and most respondents considered this collaboration very useful for teaching and student involvement.

Even though most of them don't know how the STEAM approach could be realized online, they seem really interested in OTA purposes.



5.3 FINLAND

Among the 49 Finnish teachers that responded to the questionnaire the majority of them were teachers who teach maths (81 %); the 67 % of respondents teach physics, 12 % teach ICT subjects, and 5 of them teach chemistry.

In Finland, the majority of the respondents to the survey have more than 10 years of experience in teaching, and a good 22% have been teaching more than 6 years.

Also, in this case teachers who responded to the survey confirmed that the online teaching challenge allowed them to do lots of experience and improve their digital skills already considered very high!

The ratings of Finnish teachers interviewed in the focus group revealed some problems during online teaching and the main problem they faced was the polarization within the classroom that had deepened during the pandemic.

In fact, they noted that even if some pupils were very active and prompt, able to control their online work, some were not motivated and have lowered the level of attention considerably; these data are also confirmed by the teachers who responded to the survey, who considered the attention level of their students to be significantly lowered.

Despite this and even though they rated the level of interaction with their students as low, Finnish teachers did not make much use of digital tools.

The few who did use them mentioned Google Classroom, Teams, Zoom, Jamboard, Meets, WhatsApp.

The teachers who responded to the questionnaire stated that they had significantly changed the online lessons compared to the face-to-face ones, both in content and in the way of delivering the lesson: also, for this reason, the teachers interviewed noted a high level of stress due to distance learning.

The main causes of stress, as in the cases of the other partner countries, were time management and problems related to the internet connection.

The teachers in the focus group also added that it was frustrating, during the online connections, to see the pupils not concentrating and some specifically with their cameras off.



CURRICULA

MATHS:

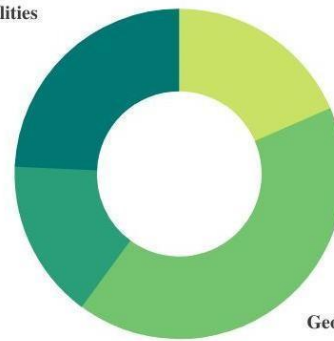
TARGET GROUP: TEACHERS

For Maths the most difficult subjects in teaching online were:

- Geometric concepts
- Equation and inequalities
- Accounting operations and their properties
- Functions

Equations and inequalities
43.8%

Accounting operations and their properties
33.3%



Function
28.1%

Geometric concepts
75%

Finnish Maths teachers believe that the most difficult topic in teaching online was **Geometric concepts**, with regard to these sub-topics: *Triangle, Circle, Other polygons*.

Regarding **Equation and inequalities**, instead, they found difficult topics related to *Solve equations* and *Solve inequalities*, and *Express the unknown from the formula*.

In **Accounting operations and their properties**: *Skilfully calculating* and *Calculating with fractions, decimals, integers*.

In **Functions** the most difficult topics in teaching online were:

- *Compose a table and draw a graph variables;*
- *Definition of the linear function $y = kx + n$ and drawing it;*
- *Read graphs*



TARGET GROUP: STUDENTS

For students, the most difficult Maths subjects in learning online were:

- Geometric concepts
- Equations and inequalities
- Percentage

Equations and inequalities
46.9%



Geometric concepts
56.3%

Percentage (percentage) account and direct and inverse ratio
25%

Finnish maths teachers consider **Geometric concepts** the most difficult topic in learning online, especially regarding:

- Circle
- Other polygons
- Triangle
- Pythagorean theorem

According to teachers' opinion, in **Equations and inequalities**, students experienced more difficulties in:

- Solve equations (with table, with diagram and with consideration)
- Express the unknown from the formula
- Solve the inequality (Real numbers); computationally solve the equation and do the test.

Regarding **Percentage**, teachers considered *Solve real life problems*, *Use of pocket calculator* and *Calculate with %*, the most difficult topics for students in learning online.



CHEMISTRY

TARGET GROUP: TEACHERS

For Chemistry, the most difficult subjects in teaching online were:

- General and safety
- Solution
- Chemistry general
- Element in the periodic table
- Mixture and pure substances

According to Finnish chemistry teachers the most difficult topic in teaching online was **General and safety**.

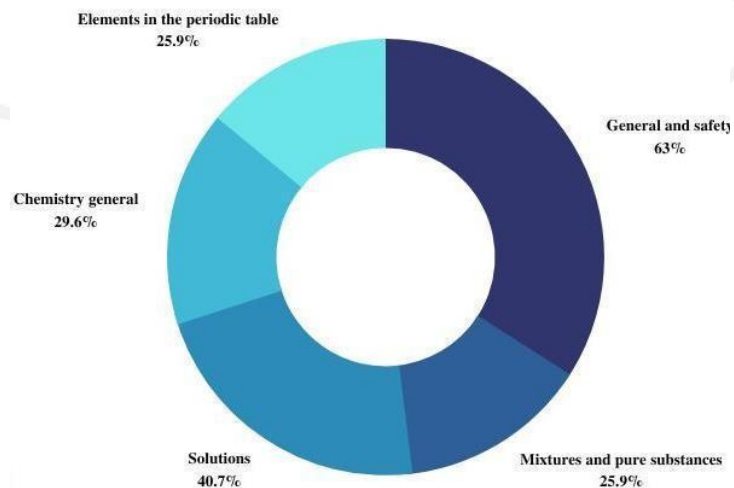
They also found it difficult to face the **Solution**, with regard to *Concept of solubility of substances and saturation of solutions and Solutions as examples of mixtures and distinguish between solvent and solute*.

Regarding **Chemistry general** teachers found most difficulties with the sub-topic *Molecules*.

In **Elements in the periodic table**, the most challenging topic was *Chemical elements are classified in periodic systems and marked with symbols*.

Finally, in **Mixtures and pure substances** teachers found more difficulties in teaching *Methods for separating pure substances from mixtures (filtration, extraction, evaporation, distillation)*.

TARGET GROUP: STUDENTS





For students, the most difficult Chemistry subjects in learning online were:

- Element in the periodic table
- General and safety
- Chemistry general
- Solution

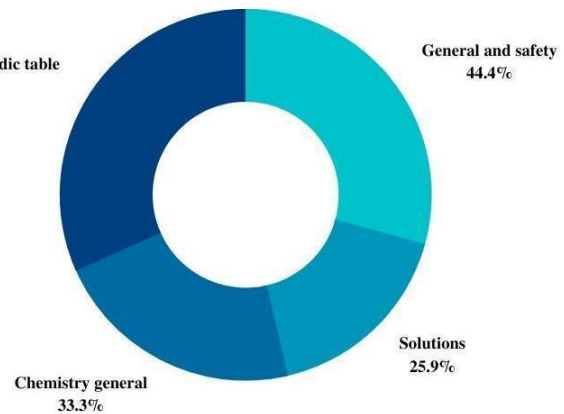
According to the Finnish teachers the most difficult topic in learning online was **Elements in the periodic table**, especially with regard to *Chemical elements that are classified in periodic systems and marked with symbols*.

They believe that also **General and safety** was challenging to understand for their students, regarding:

- Laboratory equipment
- Safety in laboratory
- Laboratory equipment Safety

Molecules was the hardest topic for what concerned **Chemistry general**, while the teachers who rated difficult for the students to learn **Solution** noted more difficulties when they addressed the *Concept of solubility of substances and saturation of solutions* and the *Solutions as examples of mixtures and distinguish between solvent and solute*.

Elements in the periodic table
48.1%



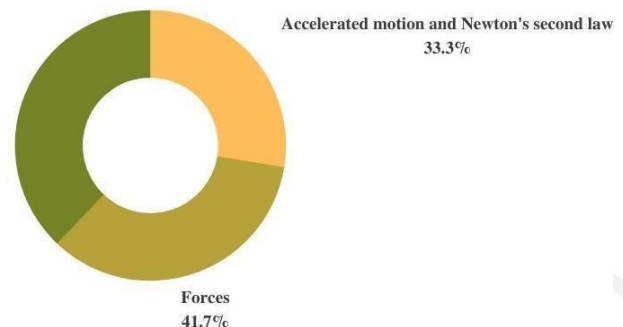
PHYSICS

TARGET GROUP: TEACHERS

For Physics, the most difficult subjects in teaching online were:

- Density, pressure and buoyancy
- Forces
- Accelerated motion and Newton's second law

Density, pressure and buoyancy
45.8%





The most difficult topic for the Finnish physics teachers to teach online was **Density, pressure and buoyancy** in relation to:

- *Mass and volume measurement;*
- *Area measurement;*
- *Buoyancy*

Also, **Forces** were difficult to teach online, mostly in:

- *Measurement of forces*
- *Drawing forces*
- *Interaction Act*

Finally, there teachers found difficulties teaching online **Accelerated motion and Newton's second law**, especially in relation with:

- *Path at steadily accelerated motion*
- *Relationship between mass, force and acceleration.*

TARGET GROUP: STUDENTS

According to the Finnish physics teachers, the students found more difficulties in the same subjects defined as difficult by the teachers themselves:

- Forces
- Accelerated motion and Newton's second law
- Density, pressure and buoyancy

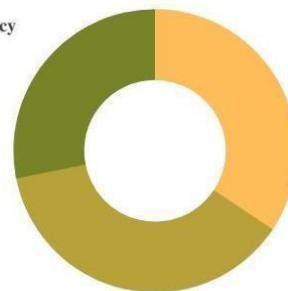
In relation to **Forces**, they found it more difficult to understand the concept of *Measurement of forces* and *Drawing forces*.

Accelerated motion and Newton's second law has been difficult for students with regard to:

- *Path at steadily accelerated motion;*
- *Relationship between mass, force and acceleration*

Regarding **Density, pressure and buoyancy** they found more difficulties in relation to:

Density, pressure and buoyancy
37.5%



Accelerated motion and Newton's second law
45.8%

Forces
50%



- Mass and volume measurement
- Area measurement
- Buoyancy

STEAM APPROACH

As commented by the teachers during the focus group, STEAM approach is much discussed in Finland and cross disciplinary in the Finnish curriculum is challenging.

The Finnish teachers interviewed both in the questionnaire and in the focus group complain, as is also the case in other countries, of an excessive workload to be met in order to complete the programme.

The idea of alternative methodologies appeals to the teachers who believe that, supporting teaching materials can be very useful, if they give basic information of subjects in hand (thermodynamics, electrochemistry, organic chemistry etc.), and easy to use; as commented by a teacher during the focus group *"Teachers have no time for orientation or extra reading, so the materials should be ready-to-use"*.

Even if the teachers did not express a real judgement towards the STEAM approach, and especially if they believe it can be implemented online, there are many inputs and suggestions coming from Finland.

First, for Finnish professors, the prerequisite for the adoption of this methodology is collaborative work between professors; it is necessary to plan the work together.

We can deduce this from the teachers' answers regarding possible collaboration with art teachers: 63% expressed interest in collaborating with their colleagues. However, it is interesting to note that when asked about the usefulness of this collaboration, 45% expressed a positive rating, but the remainder seemed to be fairly divided in their assessment.

According to them, one good practice is to have a virtual wall of fame for example: *at the end of a course (a club, a camp) the participants send a picture of what they have done, and the teacher/guide spots some of them for discussion. This does not work for normal classes, since there is no time for all these discussions, and the results of the pupils might not be very exciting (a calculation task, a calculation of physics etc.)*

Another solution is to offer teaching materials for diverging the teaching: if some of the pupils need much guidance, others may get bored if they haven't got anything extra to do. Those extra materials (5-15 minutes duration), with self-guidance solutions (like answers for the questions to check if you got it right), can be more challenging and deeper. New ways to issues (like using art as a starting point) are welcome there, since those pupils using this kind of extra material are capable of more challenging thinking.



The Finnish teachers' comments and ideas thus seem to be in line with what the project wants to pursue.

The approach that OTA wants to bring into schools meets, according to the Finnish teachers, the urgent need to manage the classes in a more interactive way and to diversify the material, not asking for even more efforts from the already overworked teachers.



5.4 ITALY

Among the 32 Italian teachers, who responded to the questionnaire, 25 teach Mathematics, 3 Chemistry and 3 Physics; the majority of the interviewed have more than 10 years of experience in teaching so we can suppose that they are aware about the needs of the school system and above all the needs of the students.

Majority of Italian teachers, who have responded to the survey, rated their digital skills at the start of the Covid-9 pandemic as well as improved them after the recent years.

During the focus group teachers commented that the online teaching challenge led them to experiment with different tools that could have helped them to give a more playful approach to the lessons.

This allows them to improve their digital competences and study other ways to teach and interact with their students.

This improvement underlines the willingness of teachers to be closer to the needs of their students.

The results that focus groups show are confirmed also by the evaluation of those who responded to the survey about the students' level of attention. Most of them, in fact, don't consider their students' attention to be drastically reduced but rated it on average. In support of this evaluation, it's important to take in consideration what results also from the focus group: despite all the problems that distance learning has created, some of the teachers interviewed noticed a greater concentration during distance learning and a different participation. All teachers agree, for example, that during distance learning, the shyest pupils, who normally hardly interacted, were able to express themselves; it was as if the online dimension made them feel more at ease, outside the classroom dynamics.

Another important data is how teachers evaluated the interaction with their students. If half of the respondents to the survey rated this interaction in the average, what arouses the most curiosity is the 35,5% of teachers who believe that the interaction with the students, during the online teaching was very good!

Almost all teachers used some digital tools to improve the interaction with the pupils Meet, Classroom, Jam board, GeoGebra, Virtual whiteboard, Quiz online, Quiz Zoom, Google documents, We school, Games, WhatsApp, Argo platform.



They used these tools also in delivering lessons, since most of them changed at least a little the content and the way of delivering the lessons and someone has even drastically changed them.

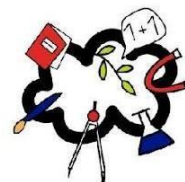
From the focus group what emerged in relation to this issue is that the *integrated teaching* - where all documents were shared and allowed simultaneous interaction with the students- has greatly helped the fluidity of lessons.

According to a teacher *“enabling students to work in a shared way through interactive apps and tools, gave them the feeling that they were not the recipients of the lesson but the co-creators”*.

Of course, seeing the positive side of things should not prevent us from noticing what doesn't work. Almost all of the teachers who answered the survey rated stressful teaching remotely during Covid-19 pandemic.

For the teachers interviewed the most stressful when teaching online was the time management, but also the lack of digital tools options and no live connection represented a problem in online teaching.

As a teacher said during the focus group: *“This period has made us realise that when we are in the classroom, we are all more traditionalist, whereas online we have experimented more. The problem that schools face today is the lack of time to devote to the experience that pupils have in relation to what they learn. The curriculum we have to follow is too wide and often we don't manage to dedicate time to developing skills but only theories”*.



CURRICULA

MATHS

TARGET GROUP: TEACHERS

For Maths the most difficult subjects in teaching online were:

- Transformation
- Geometric concepts
- Functions

According to the Italian teachers **Transformation** was the hardest maths topic to teach online; they found difficulties especially in

Transformations (mirroring displacement, rotation) and their properties.

In addition, they rated the **Geometric concepts** as difficult, regarding the topics of *Circle* and the *Pythagorean theorem*.

According to the Italian results it seems that, with regard to the **Functions**, *Read a graphs* and *Compose a table and draw a graph variable* were the most challenging topics to teach online.

Transformation
s
62.5%



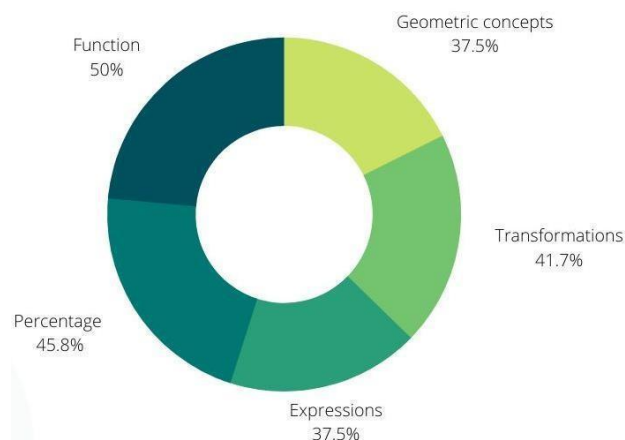
Geometric
concepts
45.8%

Function
50%

TARGET GROUP: STUDENTS

For students, the most difficult Maths subjects in learning online were:

- Functions
- Percentage
- Transformation
- Geometric concepts
- Expression



Percentage
45.8%

Expressions
37.5%

Transformations
41.7%

Geometric concepts
37.5%



Functions seem to be the most difficult topic in learning online, according to the Italian teachers; *Read a graph* and *Compose a table and draw a graph variable* were the most complicated sub-topics.

Italian maths teachers believe that also **Percentage** gave some problems to the students, especially regarding *Calculation with p%*.

Transformation in general was a hard topic for the students, who found it difficult especially regarding *their properties*.

Geometric concepts gave some difficulties regarding the *Circle and Other polygons*.

Finally, for the **Expression** the teachers think that the topics most difficult to learn online for their students were *Solve real life problems* and *Calculate with algebraic expressions*.

CHEMISTRY

TARGET GROUP: TEACHER

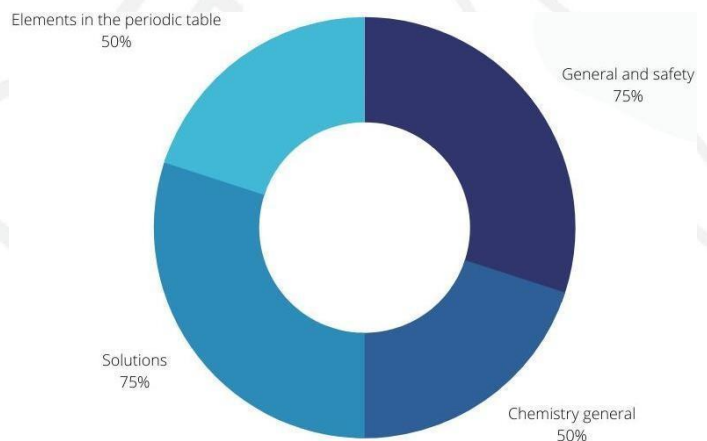
For Chemistry, the most difficult subjects in teaching online were:

- General and safety
- Solution
- Chemistry general
- Element in the periodic table

According to the Italian chemistry teachers the most difficult topic in teaching online was **General and safety**.

They also found many difficulties in teaching **Solution**, with regard to *Concept of solubility of substances and saturation of solutions; Solutions as examples of mixtures and distinguish between solvent and Solute and Factors that affect the rate of dissolution of substances*.

Regarding **Chemistry general** teachers found most difficulties with the sub-topic *Atoms*; while in the **Element in the periodic table**, the most challenging topic was *Chemical elements are classified in periodic system and marked with symbols*.





TARGET GROUP: STUDENTS

For students, the most difficult Chemistry subjects in learning online were:

- Mixtures and pure substances
- Atoms
- General and safety
- Solution
- Chemistry general

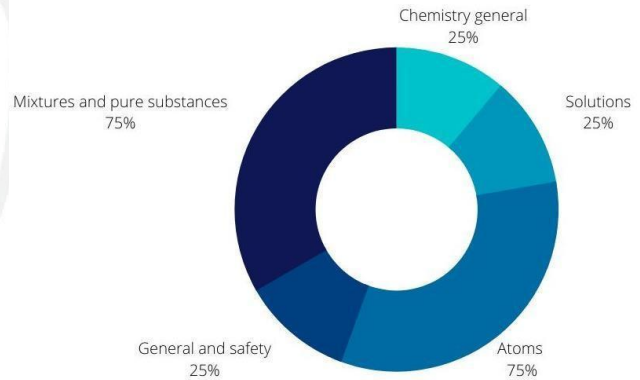
Mixtures and Pure substances, is the most difficult topic in learning online the topic *Methods of separating pure substances from mixtures*.

In addition, the topic **Atoms** gave some problems to the students, regarding the *Structure of the atom* and the *Atom model*.

Regarding **General and safety** students had problems in understanding the *Role of chemistry especially in everyday life*.

Regarding **Solutions**, the most difficult topics in learning online were *Factors that affect the rate of dissolution of substances* and *Concept of solubility of substances and saturation of solutions*.

Finally, with regard to **Chemistry general** teachers think that *Molecules* was a hard topic for the students.

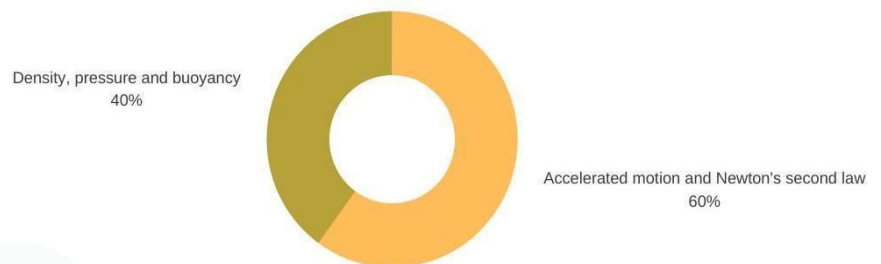


PHYSICS

TARGET GROUP: TEACHERS

For Physics, the most difficult subjects in teaching online were:

- Accelerated motion and Newton's second law
- Density, pressure and buoyancy





The most difficult topic for the Italian physics teachers to teach online was **Accelerated motion and Newton's second law**, especially in relation with:

- *Description of movement and straight steady movement and repetition;*
- *Steady accelerated movement;*
- *Path at steadily accelerated motion.*

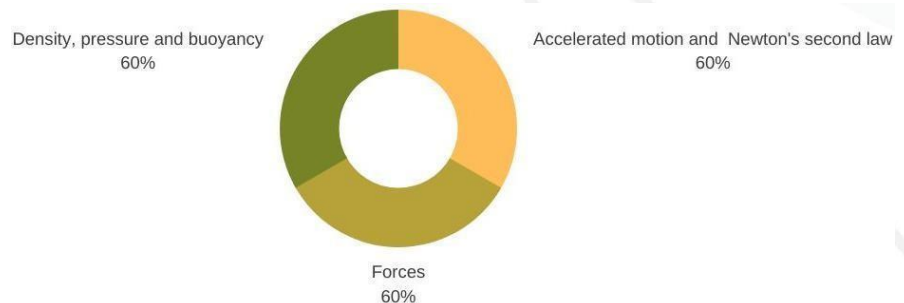
They, also, found difficulties in teaching **Density, pressure and buoyancy** in relation to:

- Density and specific gravity;
- Fluid pressure;
- Pressure due to the weight of the stationary fluid;
- Atmospheric phenomena and weather.

TARGET GROUP: STUDENTS

For students, the most difficult Physics subjects in learning online were:

- Forces
- Accelerated motion and Newton's second law
- Density, pressure and buoyancy



In relation to **Forces** they found it more difficult to understand the concept of *Description of forces, Spring balance and Drawing forces.*

Accelerated motion and Newton's second law has been difficult for students about: *Relationship between mass and weight and Steady accelerated movement.*

Regarding **Density, pressure and buoyancy** they found more difficulties in relation to:

- *Density and specific gravity*
- *Fluid pressure*
- *Pressure due to the weight of the stationary fluid*
- *Buoyancy*



STEAM APPROACH

As in the case of the other countries, Italian teachers called to express their opinion about the STEAM approach reveals that the majority have never used the STEAM approach but also in this case the information obtained from the focus group shows a strong presence of creativity in the lessons and wellnesses to collaborate with other colleagues.

In fact, all the teachers interviewed by Italian partners already connected their subjects with other ones and some of them discovered it during online teaching because they had to adapt to a radically changed modality and search for a different way to speak as simply as possible.

What is interesting to note, is the surprise with which teachers talk about the simplicity with which their students understand the connection among different subjects.

Despite the initial scepticism, in fact, they reconsidered the importance of the interdisciplinary method also thanks to the easiness with which their pupils immediately found the connection between the different subjects.

Another example to be taken in consideration comes from the experience of a science teacher who experimented the interdisciplinary method with a student having some communication problems.

Through an exercise regarding the pollution, she asked him to represent his idea of pollution with a drawing and, according to the teacher, the results were extraordinary.

This open mindedness is also evidenced by the high percentage of survey's respondents who believe that using a creative approach in their lessons could arouse the interest of the students and highlight some of their creative skills that would not otherwise emerge.

As reported by a participant of the focus group, *"when a teacher gives the task of preparing a presentation, the students are no longer limited to a simple power point, they are ingenious and experience several languages, bringing originality to the presentation or a nice and creative graphics for example"*.

What is denoted by both the focus group and the survey is the importance of collaboration between teachers; as the survey respondents also, the teachers interviewed consider the cooperation of colleagues the only way to achieve shared and transversal pathways.

The results of the questionnaire also give reason to be optimistic in this respect. The 81.7% of the natural sciences teachers responding to the survey, expressed a wish to cooperate with the art teachers, and 70% of them rated this cooperation as very useful.



So, by the Italian side the analysis shows the wish of teachers to experience new and dynamic methods; according to them, distance learning was an example of how, with a bit of creativity it could be possible to innovate and enrich the teachers' modus operandi.

Therefore, the OTA project seems interesting for them because it could be a support in teaching and can allow them to use well-made contents that try to combine the learning of classical theories with the tools that technology allows us to have.



6. CONCLUSION

6.1 CONSIDERATION ABOUT THE COMMON TOPICS:

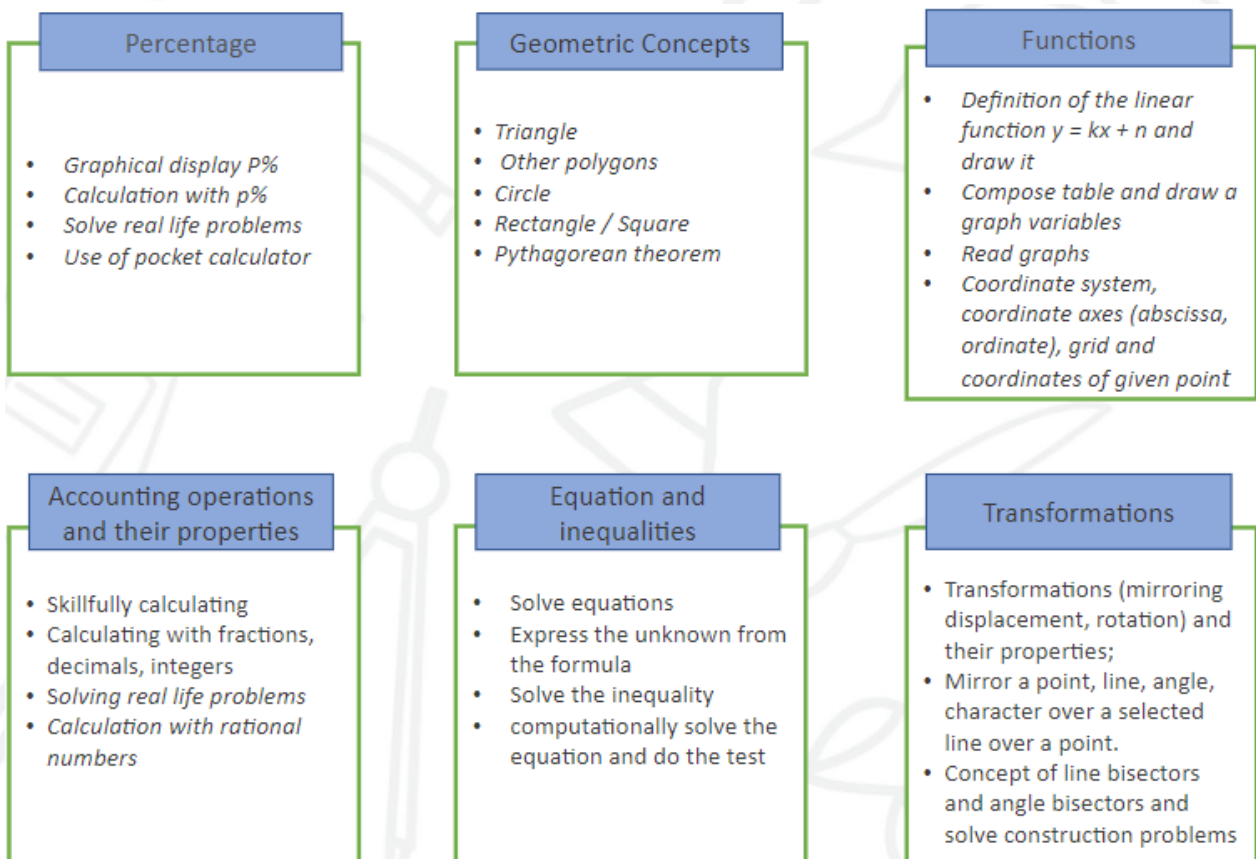
From the data resulting from the analysis of teachers' and students' needs it is possible to focus attention on two points in particular.

The first is that almost always the subjects identified by teachers as the most difficult to teach online were equally difficult for students to learn online.

The second is that the difficulties encountered are the same in the four partner countries

From the synthesis achieved by comparing the difficulties encountered by teachers, we can conclude that for **Mathematics**, the topics and subtopics on which both teachers and students are experiencing difficulties are:

- Percentage
- Geometric concepts
- Functions
- Accounting operations and their properties
- Equation and inequalities
- Transformation



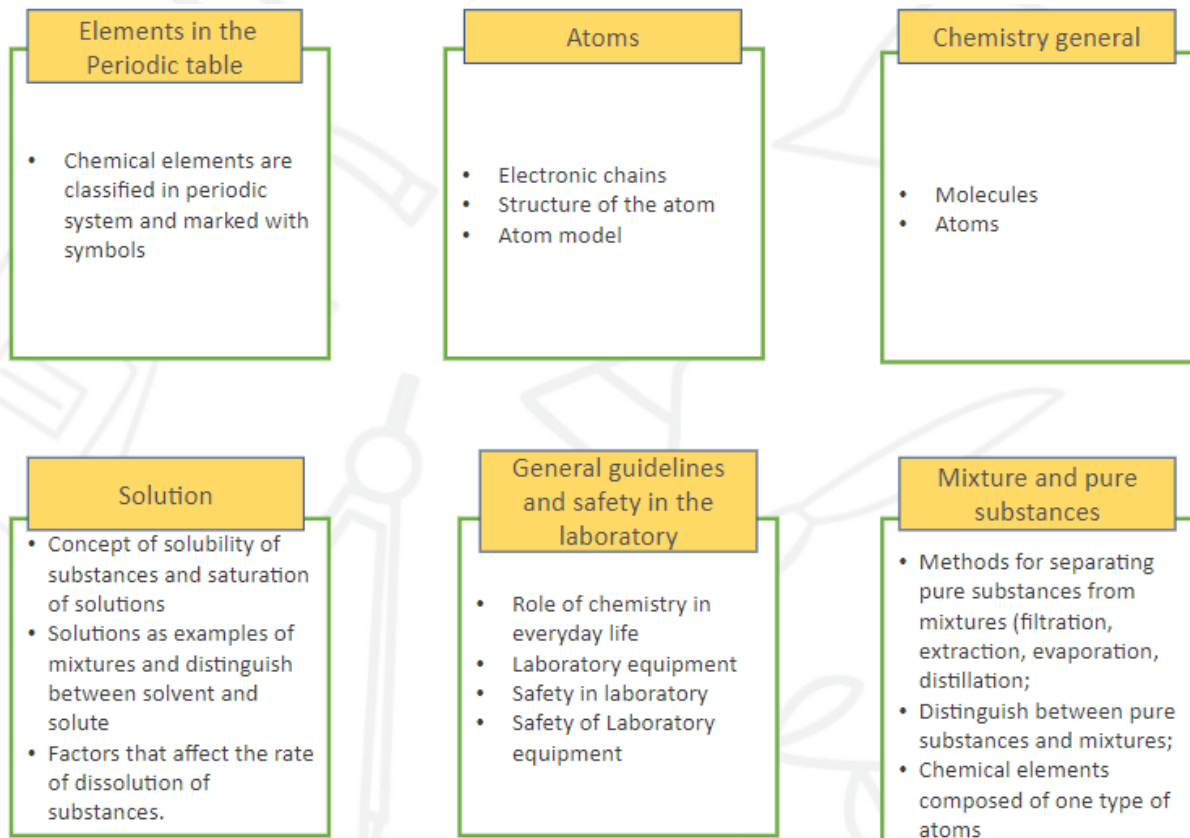


Some difficulties were also found for:

- Expressions, specifically in *Solve real life problems* and *Calculate with algebraic expressions*;
- Experience with random events, specifically in *Collection, editing and analysis of the results of the experiment* and *Observation and prediction of the event.s*

In the case of **Chemistry**, the topics considered difficult to learn online are among those in which teachers have found difficulties in teaching online and are:

- Elements in the Periodic table
- Atoms
- Chemistry general
- Solution
- Mixture and pure substances
- General and safety





Finally in the topics of **Physics** all partner countries expressed themselves equally, both in terms of teachers' and students' needs and the subjects in question were

- Forces
- Density, pressure and buoyancy
- Accelerated motion and Newton's second law.

Forces

- Assembling forces
- Drawing forces
- Measurement of forces
- Description of forces
- Interaction Act
- Friction and resistance
- Spring balance
- Balance of forces
- Center of gravity

Density, pressure and buoyancy

- Buoyancy
- Density and specific gravity
- Mass and volume measurement
- Area measurement
- Atmospheric phenomena and weather
- Fluid pressure
- Pressure due to the weight of the stationary fluid

Accelerated motion and Newton's second law.

- Path at steadily accelerated motion
- Relationship between mass, force and acceleration
- Free fall
- Description of movement and straight steady movement and repetition
- Steady accelerated movement



6.2 CONSIDERATION ABOUT STEAM METHODOLOGY:

It is significant that all the teachers answered "no" to the question "do you use the STEAM method?" , while during the focus groups of all the country members it was noted that each teacher already incorporates this methodology in their lessons almost autonomously.

The experiences shared by the teachers and the problems related to them reveal an urgent need for new material, closer to the language of the new generations and which takes advantage of the tools that technology makes available.

The case of distance learning, which has in any case generated many gaps in all the countries concerned, has highlighted the excessively broad nature of the national curricula. Teachers are not only overloaded with activities to be carried out, but also with the thought of having to complete the vast programme.

As we can see from some of the testimonies given during the focus groups, this does not allow for the development of other competences of the children, because most of the time, there is no time.

Distance learning has completely overturned, in all cases, the relationship between teacher-didactics, teacher-pupil and pupil-school; breaking down a system considered by teachers as "traditional" and not very inclined to keep up with the times.

Despite the stress and lack of time, complained about by teachers in the four partner countries, there was a strong interest on the part of teachers to embrace innovation, to be more flexible and to be more versatile when teaching their subjects.

In a period of emergency such as the one they experienced, and which some continue to experience, due to the global pandemic, they were able to reinvent a way of being teachers.

Perhaps it is because of this attitude experienced in recent years that most of the interviewees, although not completely familiar with the STEAM method and the digitisation of teaching, welcome the production of new materials that are made available to teachers.

According to them, on the one hand, this would allow a more fluid and interactive communication with students, and, on the other hand, it would make it easier for teachers themselves by relieving them of the need to invent new materials and at the same time pay attention to the growth of their pupils.



Another element noted by the analysis is that teachers have realised how indispensable it is to make students more involved.

The "co-creation" process used during distance learning, where classic theory has given way to applications, games and interactive whiteboards, has had good results.

As witnessed by some teachers, some of the practices discovered in distance learning have been integrated into their teaching methods.

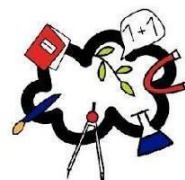
For some teachers, the digitisation of an interdisciplinary approach such as OTA, could also allow them to create materials that help diversify their teaching and help students to always exercise their critical and creative side

To support this, a Finnish teacher stressed that very often the heterogeneous composition of a class risks slowing down the cognitive processes of some pupils; in fact, teachers often must slow down to avoid leaving some pupils behind others. The production of extra material, lasting 5-15 minutes, with self-guided solutions that also include answers to questions to check if you have understood correctly, could be very useful.

In this case, art could be that plus, that diversified language which would allow the development of critical thinking.

Last but not least, many teachers pointed out that it would be useful to establish a relationship with the parents of the pupils, because during distance learning they noticed a profound difference between those who were followed by their families and those who were not!

The challenge that online learning has raised is not only an issue for those who are 'physically' inside the schools, but it must concern all those who are involved, and parents are among them.



ANNEX A

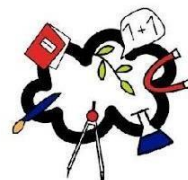
COMMON TOPICS

MATHS:

General topics	Specific topics
Geometric concepts	<ul style="list-style-type: none"> - Triangle (drawing, circumference, area, arches ...) - Rectangle / square (drawing, circumference, area, arches...) - Other polygons (drawing, circumference, area, arches...) - Circle (drawing, circumference, area, arches..., π, circular arch/sections...) - Pythagorean theorem
Transformations	<ul style="list-style-type: none"> - Transformations (mirroring, displacement, rotation) and their properties - Mirror a point, line, line, angle, character over a selected line or over a point - Concept of line bisectors and angle bisectors and solve construction problems
Natural numbers	<ul style="list-style-type: none"> - Composite & prime numbers - Computational operations - Divide number into pre-factors - Determine the largest common divisor or the smallest common multiple of numbers - Divisibility rules with 4, with 8, and with 10^n - Solve real life problems
Rational numbers	<ul style="list-style-type: none"> - Fractions - Find the lowest common denominator of a given fraction - Computational operations - Solve real life problems - Expand and shorten a fraction - Break the fraction into a whole part and a fraction smaller than 1 or decimal - Compare the fractions
Real numbers	<ul style="list-style-type: none"> - Distinguish between sets N, Z, Q, R and understand the relationship between them - The opposite, absolute, inverse of the number and calculate - Sort numbers by size - Computational operations - Solve real life problems - Pocket computer
Functions	<ul style="list-style-type: none"> - Coordinate system, coordinate axes (abscissa, ordinate), grid, coordinates of given point - Compose a table and draw a graph variables - Read graphs - Definition of the linear function $y = kx + n$ (graph, use and meaning of coefficients k and n, position of the point with respect to the line) and drawing it
Accounting operations and their properties	<ul style="list-style-type: none"> - Calculating with fractions, decimals, integers - Skilfully calculating - Calculate with rational numbers - Solve real life problems



Powers	<ul style="list-style-type: none"> - Large and small numbers - Powers - Square - Difference between $(-a)^n$ and $-a^n$ - Calculate with power and square - Use of pocket calculator - Partly root, rationalize the denominator of a fraction - Solve real life problems
Expressions	<ul style="list-style-type: none"> - Algebraic expressions - Meanings of variables, terms and factors in expressions - Calculate with algebraic expressions - Solve real life problems
Percentage (percentage) account and direct and inverse ratio	<ul style="list-style-type: none"> - Graphical display p% - Calculate with p% - Solve real life problems - Use of pocket calculator
Collection, editing and presentation of data	<ul style="list-style-type: none"> - Computer created spreadsheet and graph - Compose and use a questionnaire, empiric investigation, critical use of collected data - Presentation of the collected data - Arithmetic mean, mode and median of given data - Use of pocket calculator - Solve real life problems
Equations and inequalities	<ul style="list-style-type: none"> - Solve equations (with table, with diagram and with consideration) - Express the unknown from the formula - Solve the inequality (Real numbers); computationally solve the equation and do the test - Solve real life problems
Experience with random events	<ul style="list-style-type: none"> - Collect, edit, analyse the results of the experiment and in concrete cases (experiments) - Observation and prediction of the events - Connection of the concepts of statistical and mathematical probability



CHEMISTRY

General topics	Specific topics
General and safety	<ul style="list-style-type: none"> - Role of chemistry - What is chemistry? - Chemistry in everyday life - Laboratory equipment - Safety in laboratory - Laboratory equipment Safety - Signs of dangerous for risk management
Mixtures and pure substances	<ul style="list-style-type: none"> - Definition of mixtures - Types of mixtures - Methods for separating pure substances from mixtures (filtration, extraction, evaporation, distillation) - Physical and chemical changes of substances - Chemical compounds - Distinguish between pure substances and mixtures - Pure substances - Chemical elements are composed of one type of atoms - Atoms compounds of several elements are interconnected - Air is a mixture of gases and compare the properties of gases in air
Solutions	<ul style="list-style-type: none"> - Solutions as examples of mixtures and distinguish between solvent and solute, - Factors that affect the rate of dissolution of substances - Concept of solubility of substances and saturation of solutions - Understand the concept of water hardness and the importance of water softening - Understand the connection between water hardness and soap foaming
Water	<ul style="list-style-type: none"> - Distinguish between species or sources of water in nature, depending on what is dissolved in them (rainwater), spring water, groundwater, sea water, mineral water) - Water hardness
Chemistry general	<ul style="list-style-type: none"> - Atoms - Molecules
Atoms	<ul style="list-style-type: none"> - Structure of the atom - Atom model - Ions Subatomic particles, - Electronic chains - Ions
Elements in the periodic table	<ul style="list-style-type: none"> - Elements - Chemical elements are classified in periodic system and marked with symbols - Atomic number



PHYSICS

General topics	Specific topics
Introduction to physics	<ul style="list-style-type: none"> - Fields of physics and its significance - Forms and methods of work in physics - Measurement and measurement system
Steady movement	<ul style="list-style-type: none"> - Description of movement - Line uniform movement
Accelerated motion and Newton's second law	<ul style="list-style-type: none"> - Description of movement and straight steady movement and repetition - Steady accelerated movement - Path at steadily accelerated motion - Relationship between mass, force and acceleration - Free fall - Relationship between mass and weight - Circulation
Forces	<ul style="list-style-type: none"> - Description of forces - Measurement of forces - Spring balance - Drawing forces - Centre of gravity - Balance of forces - Friction and resistance - Interaction Act - Assembling forces
Density, pressure and buoyancy	<ul style="list-style-type: none"> - Area measurement - Pressure in solids - Mass and volume measurement - Density and specific gravity - Fluid pressure - Pressure due to the weight of the stationary fluid - Atmospheric phenomena and weather - Buoyancy - Swimming



ANNEX B

SURVEY'S QUESTIONS

FIRST PART: ONLINE TEACHING

1) What role do you play within the school?

- Mathematics teacher
- Physics teacher
- Chemistry teacher
- ITC Technical
- Other

2) How long have you been in this role?

- 1 year
- 2-5 years
- 6-10 years
- 11-20 years
- More than 20 years

3) On a scale of 1 to 5, how do you evaluate your e-skills in online teaching at the start of the Covid-19 pandemic?

1. Very low

5. Very high

4) On a scale of 1 to 5, how do you evaluate your e-skills in online teaching after two years from the start of the pandemic?

1. Not at all improved

5. Much improved



5) On a scale of 1 to 5, how do you rate the students' level of attention during online learning?

1. Much lower than that in class

5. Higher than that in class

6) On a scale of 1 to 5, how do you rate the quality of your interaction with your students during online learning?

1. Poor

5. Excellent

7) Did you use some digital tools (i.e Zoom, Classroom, Jamboard) to improve the interaction with your students during online learning?

Yes

No

8) If yes, what digital tools did you use?

9) On a scale of 1 to 5, how were your online lessons compared to face to face ones? 1. Same, both in content and in the way of delivery

5. Completely different from those given in person

10) On a scale of 1 to 5, how stressful did you find teaching remotely during Covid-19 pandemic?

1. Not excessively

5. A lot

11) What was more stressful about teaching remotely?

Time management

Lack of digital capabilities

Lack of digital tools

Absence of relationships with students

Nothing

Other:



What do you teach?

- Mathematics
- Physics
- Chemistry

SECOND PART: CURRICULUM

For each subject (mathematics, chemistry and physics) teachers were asked to mark which of the identified common topics both general and specific (Annex A), they thought were the most difficult to teach online and which were the most difficult for their students to learn online.

MATHS

From Question 12 to Question 25 --> Please select from the following topics those that, in your experience, are the most difficult to TEACH online

From Q.26 to q.39 --> Please select from the following topics those that, in your experience, are the most difficult to LEARN online from students

CHEMISTRY

From Q.41 to Q.48 --> Please select from the following topics those that, in your experience, are the most difficult to TEACH online

From Q.49 to Q.56 --> Please select from the following topics those that, in your experience, are the most difficult to LEARN online from students

PHYSICS

From Q.57 to Q.62 --> Please select from the following topics those that, in your experience, are the most difficult to TEACH online

From Q.62 to Q.68 --> Please select from the following topics those that, in your experience, are the most difficult to LEARN online from students



THIRD PART: STEAM INTERDISCIPLINARY APPROACH

69) Have you ever used the interdisciplinary STEAM (Science, Technology, Engineering, Arts and Mathematics) approach to teach your subject?

- Never
- Yes, I have already used/use it

70) Do you think that an interdisciplinary teaching methodology can help you to explain complex concepts more easily?

1. Poorly

5. Very Much

71) Do you think that using a creative approach could make your lessons more interesting for students?

1. Poorly

5. Very Much

72) Would you like to collaborate with your colleagues, art teachers, during your lessons?

- No
- Yes

73) If yes: how would you evaluate this collaboration from 1

to 5? 1. Not useful

5. Very useful

74) Do you think the STEAM approach can be used online?

- Yes
- No
- I don't know

75) If you answered yes: how do you think it can be used online?

76) Do you have any good practices to suggest?



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