The attractiveness of Science, Technology, Engineering and Mathematics subjects

Results from five countries
September 2019
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Executive Summary

In 2015, the Amgen Foundation conducted a survey to investigate what motivates US high-school students to study science subjects. Three years later, and in partnership with the European Schoolnet-run STEM Alliance initiative, the survey was adapted for European secondary school students, who were asked directly about the school subjects they liked, the type of teaching that would engage them more in science, technology, engineering and mathematics (STEM) lessons, their career aspirations and their key influencers for future career choices.

Published against the backdrop of growing concerns in the European Union about future shortages of STEM skills and competencies, the study brings forward the students’ voices in an attempt to understand why and how young people in Europe decide which study and career paths to pursue. The report’s findings are based on a total of 2,789 responses from students aged between 12 and 15 from 43 schools in the United Kingdom (England), Ireland, Spain, Italy and Greece.

The key findings

The key findings of the report cover four main areas of investigation: [1] what are the pupils’ perceptions of STEM subjects, [2] what classroom practices would motivate them more towards STEM studies, [3] what are their career aspirations and [4] what is the influence of gender in defining students’ perceptions of STEM and interest in STEM studies and careers.

[1] Subject interests and perceptions

**MAIN FINDINGS**

Across the five countries, 49% of the pupils surveyed indicate an interest in STEM, by far the most highly represented answer in the sample. While STEM subjects and careers may not always be at the very top of student preferences, they are perceived positively by the majority of the high-schoolers surveyed.

Around 80% of secondary schoolers think that STEM studies are “about helping others” and “have an impact on people’s lives”, but 65% also believe they are difficult and require too much education.

**RECOMMENDATIONS**

Pupils value learning STEM subjects, as well as their impact on the world; however, perception of STEM studies as being too challenging or difficult can hinder their interest later on. Educational systems should encourage more hands-on, inquiry-based approaches which demystify science and scientific processes in order to increase the students’ confidence in approaching STEM. Equally, STEM companies can contribute by showcasing role models or by providing more information to schools about career pathways in STEM.

[2] STEM Classroom practices

**MAIN FINDINGS**

Teachers appear to play a central role in influencing student perceptions about school subjects. Teachers making lessons fun, a good relationship with their teacher and doing many hands-on activities are the top three things that students say would make a classroom subject more enjoyable.

STEM lessons in particular would be more enjoyable if they included: field trips to learn outside the classroom, games and hands-on lab experiments or modelling. However, more than half the students say that games and field trips to learn outside the classroom never happen in their STEM lessons. More than half also never talk to people who use STEM in their jobs or learn about careers or jobs related to STEM as part of their STEM lessons.

**RECOMMENDATIONS**

Initiatives in STEM education should include aspects aimed at supporting teachers to include more interactive teaching, that takes students out of traditional settings and uses non-traditional tools and approaches.

Teacher training should prepare STEM teachers to approach new pedagogies in the classroom and to contextualise their teaching.

There is also a need for more collaboration with STEM industries, so that information about STEM careers can be shared as part of the normal classroom setting.
[3] Career aspirations

MAIN FINDINGS
Around half of the students surveyed show some interest in pursuing a career related to STEM. Interest in science careers fares slightly higher than interest in careers related to computing, technology and engineering.

Students appear to be confident in their career choices, with just 13% of them indicating they have not considered their career options yet. The most popular careers are Medicine, Health Studies and Sports; the least popular are Maths and Design and Technology.

Interestingly, 37% of students have never talked to a career counsellor to get information about careers and career pathways, and 39% have never discussed careers with a pupils’ organisation. Most students seem to have approached the topic of future possible careers with their teacher (only 16% say they have not). The results indicate that discussions about careers are mostly carried out in schools with teachers taking the role of career counsellors and acting as an important point of information about careers for their pupils.

RECOMMENDATIONS
The career aspirations findings clearly place teachers as main points of information about STEM careers. If teachers are taking on the role of career counsellors, there is a need to develop support systems, which will allow them to be qualified to appropriately guide pupils towards relevant careers. STEM industries can play an important role in bringing career information to schools and empowering teachers in their roles as career advisors.

[4] Gender differences in attitudes towards STEM

MAIN FINDINGS
Gender stands out as the main element which shapes student views and attitudes towards STEM careers.

A similar percentage of boys and girls have considered their future career options. But gender appears to play a role in the type of career pupils are planning to follow, with the most striking differences appearing for Computing and Engineering, areas in which boys are three times more likely to pursue a career than girls, and visual and performing arts, which are specialisations that are twice more likely to appeal to girls. Significantly, the gap is wide for Mathematics as well, which boys are almost twice more likely than girls to follow as a career. Biology remains the science subject, which girls clearly prefer more than boys.

In general, girls are slightly more likely than boys to perceive STEM studies as “difficult and confusing”, and less likely to feel they are good at these subjects.

RECOMMENDATIONS
The study provides additional confirmation that gender continues to play a role in the way girls see themselves in relation to STEM studies and careers. The factors influencing girls’ career choices are manifold, and school-related factors are just one element in the mix.

However, there are clear opportunities at the school level for addressing gender equality in STEM education, by adopting initiatives that look to strengthen girls’ confidence in approaching STEM, particularly technology, engineering and mathematics subjects.

STEM industries can also support education by providing schools with role models of women, who are successful in technical careers.
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Introduction

Rationale

Since the early 2000s, there has been a growing concern in the European Union about the prospect of insufficient supply of STEM workforce which may hinder further economic development and reduce the economic competitiveness of European countries. From 2003 to 2013 the number of people employed in STEM professions grew by 12% and by 2025, it is expected to grow by a further 13% (EU Skills Panorama 2014), yet the growing demand for these professions is mismatched by the recruitment difficulties reported across most EU countries.

Furthermore, the development of STEM skills and competencies among the general population has also been acknowledged as one of the top EU priorities (European Commission 2018) amid the realisation that such competencies are critical to innovation, social mobility and social justice. As technologies are playing a bigger role in all areas of work and life, STEM competencies and higher-level STEM skills are becoming the norm. Living and working in a technologically advanced and globalised economy requires STEM skills even from those employed in traditionally non-STEM occupations, such as arts or retail.

At the same time, international evidence provided by the Organisation for Economic Co-operation and Development (OECD) Programme for International Student Assessment (PISA) or the OECD Programme for the International Assessment of Adult Competencies (PIAAC) indicates that the share of people with insufficient basic skills remains high. According to the 2015 PISA report, one in five pupils had mathematics or science skills below the expected minimum (OECD 2016). The 2016 EC education monitor reported great inequality among EU countries in regard to adult qualifications and skills: in some countries, up to one third of adults are proficient at only the lowest levels in literacy and numeracy (European Commission 2016). 43% of the Union population have low or no (13%) digital skills (DESI 2018). Furthermore, the growing number of young people who are not in employment, education or training (NEETs) gives another ground for concern: in 2017 the EU proportion of 20-34 olds who met these criteria stood at 17.2 % (Eurostat 2018).

To address shortages in STEM skills and competencies, many countries are introducing key systemic changes in STEM education across all educational phases. Of special concern is education in secondary school aimed at 11-16-year olds. Research evidence indicates that these school years are critical in shaping young people’s interests and career perceptions, which, in turn, influence their choice of further studies as well as the careers they are going to pursue (Subotnik et al. 2010). According to a highly acclaimed study (ASPIRES 2013), students’ views and attitudes to STEM decline sharply between the age of 10 and 14 while their career aspirations are becoming largely formed (Lindahl 2007). Further evidence shows that educational interventions, especially if they are supported by STEM employers, may have a significant positive impact on student perceptions, academic outcomes, employability skills, career awareness and preferences (Mann, Rehill & Kashefpakdel 2018). However, for interventions to work effectively, especially if they are delivered on a European level, we need a clearer understanding of student experiences, views and perceptions regarding STEM. Equally, we need a better understanding of why and how young people in Europe decide on which study and career paths to pursue.

This report

STEM Alliance1 - InGenious Education and industry, is a Europe-wide initiative that brings together Industries, Ministries of Education and education stakeholders to promote STEM education and careers to young Europeans and address anticipated skills gaps within the European Union. Building on the success of the inGenious initiative (2011-2014)2, STEM Alliance works towards bridging the gap between the education sector and the industry world by facilitating STEM career education in schools and helping them to develop relevant STEM skills and competencies for students.

This report has been developed in the framework of STEM Alliance, with support from Amgen Europe3. Amgen has contributed significant resources over time to advancing science education programmes for young people. In particular, the Amgen Foundation programmes in Europe focus on a two-pronged approach to inspiring the next

1 http://www.stemalliance.eu/
2 http://www.ingenious-science.eu
3 https://www.amgen.com/
generation of innovators: investing in and supporting the professional development of science teachers; and creating hands-on opportunities for students (secondary and undergraduate). This work is advanced through a suite of STEM education initiatives in Europe such as Amgen Scholars⁴, Amgen Biotech Experience⁵, and Amgen Teach⁶.

With this research, STEM Alliance and Amgen joined forces to explore ways of making STEM studies and careers more appealing to the young people of Europe, explore factors influencing secondary school students’ perceptions, motivation and aspirations towards STEM and define effective strategies to promote STEM studies and careers among young people.

Aims

The study draws on the data collected through a large-scale survey answered by pupils from five European countries (England, Ireland, Spain, Italy and Greece) and aims to provide STEM employers, policy makers, and other relevant stakeholders with a better understanding of what works in STEM teaching and career education in secondary schools.

The study is guided by two research questions:

- What are the views and attitudes of European secondary school pupils towards STEM subjects and careers?
- Which factors account for these views and attitudes and what is the nature of these relationships?

By learning what motivates and what discourages young people in secondary school to choose STEM over other study fields, STEM industries will be able to reflect on their education projects, identify areas for improvement and, ultimately, help increase the effectiveness of their educational policies and initiatives aimed at promoting young people’s interest in learning STEM subjects in school and choosing STEM career paths.

Framing this study

Political and economic concerns about STEM labour shortages and STEM skill gaps have stimulated academic interest and inspired research on students’ interest, career aspirations and subject choices. Two questions are at the heart of these research studies: what influences student views, attitudes and decisions regarding STEM and how these views and decisions can be positively affected. A lot of interesting and important research studies have been carried out in the last two decades.

Below is a brief summary of the relevant key findings drawn from the literature:

1. Young people’s study and career choices are shaped by the interaction of interrelated individual (e.g. gender, dispositions) and structural factors, which include school-level (e.g. teaching pedagogies) and society-level characteristics (e.g. the system of vocational education or national STEM initiatives) (Blasko, Pokropek & Sikora 2018).

2. Teaching and learning experiences in school are very important and affect students’ interest in and enjoyment of STEM subjects (Cohen, Patterson, Kovarik, & Chowning 2013). In particular, it is argued that inquiry-based and hands-on learning as well as the use of real life and industry examples in curriculum teaching improves engagement and enjoyment of studying science disciplines for students of all ages (Piburn & Baker 1993, Dunn, Kudenko & Lyons 2018).

3. Academic abilities as well as positive attitudes towards and enjoyment of STEM subjects have the strongest correlation with positive views and study/career plans related to STEM subjects (Becker 2010). At the same time, making school STEM subjects interesting and engaging for students is only the first step towards building their career aspirations and preferences for STEM. The evidence from the UK project ASPIRES and the European project iGenious shows that many students who enjoy school science do not aspire to work in STEM careers (DeWitt, Archer & Osborne 2014, Kudenko & Gras-Velázquez 2016). Interest in STEM is a necessary but not sufficient condition for choosing STEM careers and needs to be supported with career learning activities that inspire young people to see STEM professions as ‘real’ and ‘thinkable’ for them personally.

⁴ http://www.amgeninspires.com/amgen-scholars
⁵ http://www.amgeninspires.com/amgen-biotech-experience/
⁶ http://www.amgeninspires.com/amgen-teach
4. Provision of careers education in school is seen by many researchers as a vital national strategy for increasing the number of STEM professionals (Department for Education 2017). Careers provision covers such areas as learning about STEM jobs and the required study pathways, teaching about the importance of STEM in society, building up student employability skills, giving students work experience and regular engagements with STEM professionals (Mann et. al. 2018).

5. Gender plays a crucial role in shaping the educational and career preferences of young people. Females are less likely to choose STEM professions, even when their academic attainment in STEM is higher than boys’ performance. Among those with interest in science professions, male and female students tend to choose different areas of science: girls prefer health-related professions while boys aspire to be scientists or engineers (Tyson et.al. 2007, PISA 2016). In addition, male students are more self-efficacious in mathematics than female students despite comparable achievements (Pajares 2005).

6. Student perceptions are influenced by their social environment, e.g. parents’ perceptions of their child’s potential or views on STEM jobs, expressed by their peers. This is well captured in the notion of science capital, which is understood as the sum of all science-related knowledge, attitudes, experiences and resources that an individual builds up through their life (ASPIRES 2013). The impact of social perceptions, images of STEM industry and careers, including popular stereotypes about STEM, has also been well researched, especially with regard to a damaging role of negative stereotypes (Sjøberg & Schreiner 2010).

7. While there are many positive influences on students’ choice of STEM study and career aspirations, there are certain ‘switch-off’ factors that explain why young people are less often pursuing STEM studies at higher levels and therefore losing the chance to pursue STEM careers. These include low quality teaching, perception of STEM as a difficult field of study and disappointment with secondary school science that does not meet the expectations students had at primary school (IET 2008).
Research design and methodology

The survey

Background and approach

The approach of the study is inspired by the 2015 research conducted in the United States by the Amgen Foundation to investigate what motivates US high-school students to study STEM subjects. The main research method used for the US study was an online survey completed by high school students (aged 14 to 18) attending public and private schools in the US. The collected data were weighted by ethnicity and region to mirror the US population. The findings were published in the report "Students on STEM: More Hands-on, Real-World Experiences".

The present European study uses an adapted version of this online survey to engage with European teenagers and investigate their perceptions of STEM subjects and careers as well as what influences these attitudes and career choices. The multi-national context of this research as well as some cultural differences between the American and European students required a number of adaptations in the survey design. Additional changes were needed to reflect the different data collection methodology, which utilised European Schoolnet’s network of national educational leads to recruit participants by selecting a balanced sample of national secondary schools.

The key elements of the European study are shown below. The survey is included in Appendix 3 of the present report.

- Student views and perceptions of STEM
  - General perception / interest in STEM subjects and careers (including those relative to non-STEM areas)
  - Studying of STEM subjects in school
  - Career awareness and career education
  - Extra-curricular engagements in STEM
- Student preferences
  - School subjects enjoyed
  - Class activities enjoyed
  - Usefulness of career education activities
- Influences on the student
  - Enjoyment of STEM subjects in school
  - Awareness of STEM careers and career paths
  - Choice of subjects for further study and career
- Barriers and enablers to the student
  - Selection of STEM study for post-compulsory education
  - STEM career aspirations
- The effects of
  - Gender
  - Socio-economic background
  - Age
  - National educational settings

Language

The language and complexity of questions used in the survey were adapted from the original US survey to reflect the younger age of participants and the fact that the survey will be completed in school during or after lessons. In addition, further alterations were made to accommodate the broader focus of the European study, which looks at all STEM subjects rather than just science and biology as was the case with the US survey.

The survey was translated into the languages of the participating countries and sense-checked for consistency and validity of statements. National questionnaires were tested with a small group of students in four of the five participating countries. Feedback from adults (teachers) who supervise the participating youngsters during the test survey was also incorporated in the final version of the survey. This information was used to assess the suitability of the survey questions and make further adjustment to the overall design and/or national translations.

Question types and analysis scales

Most questionnaire items consist of closed questions with a limited number of answer choices, and include: single- and multiple-choice questions, or three, four or five level Likert-type questions. To simplify interpretation, in 8 61 pupils aged from 12 and 15 tested the survey, as follows: 15 students aged 13 in England, 9 aged 14 to 15 in Ireland, 27 aged 14-15 in Spain, 9 in Italy (aged 12, 14 and 15). Greece did not participate in the piloting phase.
some cases, the different levels of the Likert scales are combined and redefined as “Low/Unfavourable” (levels 1+2) and High/Favourable (levels 3+4, or 4+5, depending on the granularity of the scale).

In other cases, a single item of the scale is analysed more closely. For instance, in the three level scales including the items “Never”, “Occasionally” and “Frequently”, the item “Never” is isolated; in other cases, “Occasionally” and “Frequently” are combined to better understand if a certain action happens at all.

Target group
The target group for this research are secondary school students from the United Kingdom (England), Ireland, Spain, Italy, and Greece in compulsory education, which most frequently includes maths and sciences but may also include computing, information technology, engineering or other STEM disciplines. Hence, all study participants have first-hand experience of being taught more than one STEM subject in the last 12 months. In most EU countries the ages of secondary school students range between 11 and 16 (see Appendix 1 for country-specific details).

In order to assess the motivation of students to choose STEM study options, the study targeted students who have not yet engaged in specific academic strands that prioritise STEM subjects – for the countries covered by the study, this means students aged between 12 and 15. If the sample included older students, who had already chosen a study path, the feedback collected would have been influenced by the quality of the practices implemented by their teachers and, therefore, we would not have been able to distinguish low motivation from bad experience in practice.

There are four grounds for selecting the United Kingdom (England), Ireland, Spain, Italy, and Greece as a background for this research. Firstly, these counties have similar systems of secondary education, which follow a common national curriculum. Hence, a selected sample of national schools is more likely to reflect the national population. Secondly, the educational systems of these countries are relatively well established and are not in the process of radical transformation (as may be the case in other countries). Thirdly, they share a common problem of declining student motivation for STEM studies and careers; and, according to the most recent research evidence, the career choices of students in these countries are affected by science enjoyment in school (Blasko et al. 2018).

Finally, despite the abovementioned similarities, these countries differ in terms of socio-economic affluence and national living standards, which will allow a more balanced mix of students on this criterion.

Sample selection
The recruitment of schools was done with the help of National Survey Coordinators, or NSCs, who were selected among the Scientix Ambassadors. Scientix (http://scientix.eu), the community for science education in Europe, promotes and supports a Europe-wide collaboration among STEM teachers, education researchers, policymakers and other STEM education professionals. Scientix is funded by the European Union’s Horizon 2020 research and innovation programme and coordinated by European Schoolnet. Scientix runs a network of almost 500 Scientix Ambassadors - STEM teachers from over 40 countries who help share Scientix activities at national level and play an active role in supporting innovation in STEM education in their countries.

One NSC per country was selected and appointed in order to identify participating schools in each country and then select a group of students within each school to complete a survey.

The schools were selected to mirror the national population using the following criteria:

- Geographical location (urban-rural and area affluence)
- Type of school (by fee, selection on entry and specialism in STEM)
- School size

A briefing document outlining the school characteristics was distributed among participating schools (Appendix 2). After selecting the schools, the NSCs together with the school administration identified the students participating in the study, taking particular care to achieve a balanced age and gender distribution among the sample. Written parental consent was collected by the schools for each participating student.

For more information: http://www.scientix.eu/in-your-country
Sample description

Selected schools
In total, 43 schools from all five countries participated in the survey. Half of the schools are located in a city, while the rest of the schools are located either in a town (35%) or in the countryside (16%). In accordance with the school characteristics, reported by the National Survey Coordinators, the majority of schools are non-fee paying and non-selective, with around 1,000 students or less. About one third of all schools include STEM specialisations.

Valid responses
A total of 3,065 responses from secondary school students were collected across the five countries, out of which a total of 2,789 were considered valid (complete) and thus form the basis of the present analysis. The total numbers and the split per country are detailed in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Submitted</th>
<th>Valid</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK (England)</td>
<td>571</td>
<td>488</td>
</tr>
<tr>
<td>IE</td>
<td>516</td>
<td>463</td>
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<tr>
<td>ES</td>
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<td>466</td>
<td>453</td>
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<td>Total</td>
<td>3,065</td>
<td>2,789</td>
</tr>
</tbody>
</table>

Table 1: Numbers of submitted responses (column Submitted) and included in the sample (column Valid)

Age and gender of respondents
With the exception of Ireland, where mostly girls’ schools took part in the survey, the gender distribution among the respondents is adequately balanced in the countries covered by the survey (Figure 1). As previously discussed, the survey targeted students aged 12 to 15. In Figure 2, we illustrate their distribution across the represented countries. As can be observed, the sample is relatively evenly distributed across the four age groups, with one in four students being aged 13, one in four, aged 15, 17% aged 12 and slightly more - 32% of total responses - received from 14-year olds.

Social background
Most respondents were born in the country where they currently live. UK (England) and Italy have the highest share of respondents born in a different country (15% of respondents), followed by Ireland (12%), Spain (6%) and Greece (4%). These figures are illustrated in Figure 3.
Most questionnaire respondents come from middle or high earning backgrounds – the highest proportion (41% of the sample) grew up in single-family homes or apartments, with residents with middle earning incomes; about one in four respondents grew up in large single-family homes or high-earning households (“luxury apartments” in the survey). Overall 35% of the sample is composed of students from working class backgrounds. The data, including the split per country is illustrated in Figure 4.

Interestingly, in the UK (England), 51% of responses belong to students who grew up in high-earning households, while in Italy and Spain the number of students growing up in similar conditions is three times lower. About a quarter of responses from Italy come from students who grew up in small single homes or apartments with families receiving welfare benefits. The majority (64%) of respondents have at least one parent or legal guardian with a university degree, and in many cases both parents are graduates.

When asked if their parent or legal guardian has a job related to STEM, about one in five students say that they do not know if this is the case in their families. From those who know, there is a close to equal split between “Yes” and “No” answers, with small variations between countries (Figure 5). In the case of Italy, 45% of parents or legal guardians have non-STEM related jobs; by contrast, 54% of students in the UK (England) have parents or legal guardians who hold a position in STEM-related fields.

Limitations of the study

This study has several inherent limitations. First, there is the geographical limitation: the study is based on responses from five European countries. While the educational systems of these countries are diverse enough to remind us of the heterogeneous landscape of the various systems in Europe, more research is needed in order to understand if the conclusions drawn here are valid at the whole EU level.

Secondly, there are limitations inherent to the design of the study: due to time and resource limitations, the survey could not follow a random sample distribution. In an effort to address sample biases, a downward limit of at least 400 responses per each country was imposed and deemed sufficient for the analysis. However, the fact that the survey did not have a randomised distribution means that the data collected may not be representative of the population of each country.

The third aspect to take into consideration is that working with one National Survey Coordinator per country limited the distribution of the survey to one or a few geographical areas. An additional “positive STEM bias” may have occurred as a consequence of the profile of the National Survey Coordinators, who were in charge of selecting and distributing the survey to schools. Selected among Scientix Ambassadors, the NSCs are teachers experienced in innovative STEM resources and teaching practices, who are likely to have teachers with a similar professional profile in their networks. This may have resulted in the responses appearing to be, to some extent, biased in displaying a positive attitude toward STEM.

Figure 4: The distribution of responses to the question “Thinking back to the neighbourhood you mainly grew up in, how would you characterise it?” [n=2,789]

<table>
<thead>
<tr>
<th>Country</th>
<th>Yes</th>
<th>No</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>24%</td>
<td>41%</td>
<td>18%</td>
</tr>
<tr>
<td>UK</td>
<td>51%</td>
<td>30%</td>
<td>9%</td>
</tr>
<tr>
<td>IE</td>
<td>47%</td>
<td>22%</td>
<td>17%</td>
</tr>
<tr>
<td>ES</td>
<td>47%</td>
<td>22%</td>
<td>18%</td>
</tr>
<tr>
<td>IT</td>
<td>47%</td>
<td>34%</td>
<td>28%</td>
</tr>
<tr>
<td>GR</td>
<td>28%</td>
<td>41%</td>
<td>12%</td>
</tr>
</tbody>
</table>

Figure 5: The distribution of responses to the question “Did your parent(s) or legal guardian(s) ever have a job related to science, technology or engineering?” [n=2,776]
Rounding of numbers

Because of rounding, some figures might not add up exactly to the totals; likewise, percentages might not add up to 100%. Percentages are always calculated based on exact numbers and are rounded only after calculation.

Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering and Mathematics</td>
</tr>
<tr>
<td>ES</td>
<td>Spain</td>
</tr>
<tr>
<td>GR</td>
<td>Greece</td>
</tr>
<tr>
<td>IE</td>
<td>Ireland</td>
</tr>
<tr>
<td>IT</td>
<td>Italy</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
</tbody>
</table>
Main findings

In this section, we present the main data findings related to four major lines of inquiry: [1] first, we investigate the interest and perceptions of STEM subjects among the survey respondents; [2] then, we look into STEM classroom practices as a comparison between what students wish to see in their lessons and what is being delivered at the classroom level; [3] next, we investigate views and attitudes towards STEM careers, and, finally, [4] we look more closely at gender differences in students’ attitudes and perceptions of STEM.

Subject interests and perceptions

Interest in STEM subjects
Determining interest is the first step in anticipating students’ career choices.

Across the five countries, 49% of the students surveyed indicate an interest in STEM, by far the most highly represented answer in the sample.

A multiple-choice question, offering answer options covering six general areas of knowledge, was introduced to determine the students’ general interest in STEM. The answer choices and the answers for each option across all countries, expressed as a percentage of the overall sample are presented below:

- Social Studies, e.g. history, geography, politics, philosophy - 22%
- Science, technology, engineering and maths (STEM), e.g. physics, medicine, programming - 49%
- Language Arts, e.g. literature, foreign languages - 18%
- Visual and performing Arts, e.g. painting, drama, playing an instrument - 22%
- None of the above (NOTA) - 12%
- Not sure - 9%

While encouraging, it must be noted that the relatively high interest in STEM subjects may be due to positive biases in the sample selection. As already indicated, schools were selected with the help of Scientix Ambassadors acting like NSCs. Scientix Ambassadors are innovative STEM teachers, highly active in reaching out to peer communities. With schools and students being selected through STEM-focused teachers, it is likely that the student preference towards STEM subjects is indicative of the type of teaching they were exposed to.

When do students start being interested in STEM?

For the 49% who indicated their interest in STEM fields, we also looked for the age when this interest started, as recognising when this interest starts to develop is an important step in learning how to maintain it.

Figure 6 displays the responses to the question “At what age did you become interested in STEM subjects?” as percentages from the total responses per country.

The result is a relatively balanced distribution of responses, covering the entire age range presented - albeit with slight variations. Amongst the most notable:

- Most students in Ireland, Greece and Spain most frequently report the ages of 10 and 12 as the time when they became interested in STEM subjects, placing their interest towards the final years of primary school.
- Students in England and Italy report the same for the ages 10, 11 and 12 - in these two countries, at the transition between primary and secondary education (final years of primary school/first years of secondary school).
- The distribution of total numbers shows two clearly defined peaks - for the ages of 10 and 12.
To understand if this distribution is affected by the respondents’ ages, in Figure 6b we look at the responses given by each age group. The 10- and 12-year-old peaks remain largely consistent across age groups, with small variations for 12-year-old respondents (some of whom place their interest at 8 years of age) and respondents who are aged 15 (many of whom also selected 14 as the age when they became interested in STEM subjects). The results are largely aligned with other studies: for example, Turner (2011) showed that attitudes towards science are fixed from early ages; however, positive attitudes tend to erode with students’ advancement in the educational system (Murphy and Beggs 2003).

Attitudes towards STEM subjects
To capture attitudes toward the subjects they studied in the last school year, survey respondents were asked to rate them on a four-point Likert-type scale with the following options: 1: Dislike a lot, 2: Dislike a little, 3: Like a little, 4: Like a lot. Option 0: Have not taken the subject(s) yet (understood as Not Applicable) was also introduced.

Across the sample (Figure 7), we see that positive attitudes (“Like a little” or “Like a lot”) towards STEM subjects such as Mathematics (64%) and Science (70%) are as frequent as positive attitudes towards social studies (66%), sports (81%), or foreign languages (69%).

“Engineering or architecture” is a remarkable outlier: the least “liked” topic from the list, only 36% of the sample selected that they liked it “a little” or “a lot”. On the opposing end, 81% of the sample stated they liked Sports (Physical education) - the most favoured subject from all those presented in the questionnaire.

STEM subjects may not be at the very top of student preferences, but apart from studies related to Engineering and Architecture, there are no strong signs that they are perceived negatively. This is an encouraging result, since school science is seen as the first segment of a pipeline that will select those who will continue their studies in STEM fields (OECD 2016).
Looking closely at the three main science subjects included in educational curricula, the results are largely consistent with the numbers expressed in Figure 7: across the sample, 56-67% of students share positive attitudes towards Biology, Chemistry and Physics, with Biology the most popular subject from the three (see Figure 8).

They also think that STEM studies “make an impact on people’s lives” (84%), although they “require too much education” (65%).

Perceptions of STEM subjects

Student perceptions about STEM subjects are largely positive. Respondents “Somewhat agree” or “Agree completely” that studies related to science and technology are “always changing and advancing” (88%), “about helping others” (80%) and “creative and fun” (72%); 52% of the sample also think that STEM disciplines are “difficult and confusing”.

Further on in this report we look more closely at possible factors accounting for these views.

Nonetheless, when asked about selecting future studies for various career tracks, students respond that they feel strongly about choosing Maths and Science as major studies (Figure 9 [a];[b]).
Figure 9(a): When you get to select the subjects for further studies, which do you intend to choose? The overview for each country
When considering the subjects for further studies, the top three subject preferences indicated are Science (45%), Mathematics (40%) and Sports (40%).

STEM Classroom practices

What students want

Positive attitudes towards science are encouraging, and classroom practices that support student engagement with science lessons are important in cultivating them further. It was therefore interesting to investigate what classroom activities make students like and enjoy a school subject, as well as what practices make school subjects appear unattractive and dislikeable. Looking at students’ answers (Table 2),

the central role played by teachers and the pedagogical approaches they use in influencing student perceptions about school subjects is unequivocal.

When it comes to classroom activities, students strongly agree that uninteresting teaching (e.g. teaching mostly from a textbook), having a bad relationship with a teacher and having too much to memorise makes a school subject unattractive and dislikeable. In addition, feeling that they are not good at a subject and finding the subject difficult are also factors that influence students’ perceptions about school subjects. This finding is in line with previous reviews which note that perceptions of science and technology as being too difficult or abstract can put off talented young people from pursuing studies and careers in these domains (Becker, 2010).

Table 2: Classroom practices: what makes a school subject unattractive and dislikeable versus what makes students enjoy subjects in school [n=2,789]

<table>
<thead>
<tr>
<th>What makes a school subject unattractive and dislikeable?</th>
<th>What makes you like and enjoy a subject in school?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Uninteresting teaching (e.g. teaching mostly from a textbook) - 65%</td>
<td>Teachers making lessons fun - 78%</td>
</tr>
<tr>
<td>2 Having bad relationship with a teacher(s) - 56%</td>
<td>Having good relationship with a teacher(s) - 63%</td>
</tr>
<tr>
<td>3 Having too much to memorise - 51%</td>
<td>Doing many interesting hands-on activities - 62%</td>
</tr>
<tr>
<td>4 Feeling that you are not good at this subject - 49%</td>
<td>Learning skills that are (or will be) useful and relevant to me - 61%</td>
</tr>
<tr>
<td>5 Finding the subject difficult - 49%</td>
<td>Learning about real world applications of what we study - 56%</td>
</tr>
</tbody>
</table>
On the other hand, the main activities that make school students like and enjoy a school subject: teachers making lessons fun, a good relationship with their teacher and doing many hands on activities. Learning about real world applications of what is being studied and learning relevant skills are other important factors that positively influence students’ perceptions about what they learn at school (Table 2). The way teachers teach in the classroom appears essential in shaping attitudes toward the domain taught. Looking specifically at STEM subjects, three out of four students say that field trips to learn outside the classroom would make STEM lessons more enjoyable, and more than half say the same about games (68%), hands on lab experiments or modelling (67%), class discussions (61%) and practical demonstrations (56%). Displayed in Table 3, these findings are in line with the data previously presented in this section.

More interactive teaching, which takes students out of traditional settings and uses non-traditional tools and approaches, has a positive impact on students’ attitudes towards STEM subjects.

<table>
<thead>
<tr>
<th>Look at the list of class activities below. Which of them, in your view, will make your lessons in STEM subjects more enjoyable?</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Field trips to learn outside the classroom</td>
<td>75%</td>
</tr>
<tr>
<td>2 Games</td>
<td>68%</td>
</tr>
<tr>
<td>3 Hands-on lab experiments or modelling</td>
<td>67%</td>
</tr>
<tr>
<td>4 Class discussions</td>
<td>61%</td>
</tr>
<tr>
<td>5 Practical demonstrations by a teacher or technician</td>
<td>56%</td>
</tr>
</tbody>
</table>

What happens in the classroom

The findings presented so far illustrating student preferences towards classroom activities are in line with previous research that shows that students prefer active learning strategies such as hands-on activities, group work and fewer lectures (Piburn & Baker 1993). But in addition to making STEM subjects more attractive, there is evidence that classroom approaches such as experiments and hands-on activities can scaffold students’ development of conceptual understanding of scientific ideas and skills, such as critical thinking (OECD 2016). From this perspective, it is particularly interesting to understand how student preferences compare with the activities that are happening in the classroom. Table 4 illustrates the top five activity types that students say Never happen in their classrooms.

<table>
<thead>
<tr>
<th>Activities that never happen in STEM lessons</th>
<th>Total</th>
<th>Activities that happen in STEM lessons</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Talking to people who use STEM in their jobs</td>
<td>67%</td>
<td>Doing test papers or written exams</td>
<td>90%</td>
</tr>
<tr>
<td>2 Learning about careers or jobs related to STEM</td>
<td>56%</td>
<td>Teaching straight from the textbook</td>
<td>81%</td>
</tr>
<tr>
<td>3 Games</td>
<td>55%</td>
<td>Class discussions</td>
<td>77%</td>
</tr>
<tr>
<td>4 Field trips to learn outside the classroom</td>
<td>54%</td>
<td>Practical demonstrations by a teacher or technician</td>
<td>77%</td>
</tr>
<tr>
<td>5 Projects that relate to the use of STEM in real life (e.g. Studying local water quality and making suggestions for improvements)</td>
<td>50%</td>
<td>Hands-on lab experiments or modelling</td>
<td>70%</td>
</tr>
</tbody>
</table>
67% of all respondents say that they never experience talking to people who use STEM in their jobs as part of their classroom activities, and 56% say they never learn about careers or jobs related to STEM in their classrooms. Games, field trips and projects that relate to the use of STEM in real life are also opportunities for improving students’ perceptions of STEM which remain largely untapped in classroom teaching practices.

In addition to the common findings across countries, at the level of each country, there are specific actions which many students say never happen, but which would trigger students’ interest in STEM lessons:

- In Greece and England: 55% and 53% of students say they would like to learn about careers or jobs related to STEM, but 71% of English respondents and 41% of Greek respondents say that learning about careers or jobs related to STEM never happens in their classrooms.
- In Spain: 56% of students are interested in learning about how people use STEM knowledge in the real world, but 39% of Spanish respondents say they never learn about how people use STEM knowledge in the real world in their STEM classes.
- 58% in England and 56% in Ireland claimed they would enjoy designing their own experiments or projects, but 48% of English respondents and 44% of Irish respondents say they are not offered these opportunities in STEM lessons.
- Simulated experiments or other virtual activities would bring additional interest to STEM classes in Italy (55%), Greece (58%), and Spain (60%), but almost half of the respondents from Italy and Spain (48%) and a quarter from Greece (25%) say these activities never happen as part of their STEM lessons.

By contrast, tests and written exams and teaching straight from a textbook are things that are happening in most classrooms, at least occasionally. Again, these findings are largely aligned with conclusions drawn from other studies, which report that traditional instruction remains one of the most frequently used educational approaches in STEM teaching across Europe (Nistor et.al. 2018).
Career aspirations

Future career choices

Around half of the students surveyed show some interest in pursuing a career related to STEM. Interest in science careers fares slightly higher than interest in careers related to computing, technology and engineering.

57% of the overall sample said they are either “Somewhat interested” (29%) or “Extremely interested” in pursuing a career related to science. Apart from Greece, where three out of four students indicate interest in science careers, these responses are somewhat consistent among the countries surveyed, with only small variations in answers. When asked about which science subjects they are considering for their future careers, almost half of those who expressed interest in careers related to science (48%) indicated Biology as their preferred subject. Again, student choices appear to be largely similar across countries, apart from Italy, the only country for which student preferences lean more towards Physics (33% of responses) than Chemistry or Biology.

A slightly lower percentage (48%) of the sample expressed an interest in pursuing a career related to computing, technology or engineering. Interestingly, country differences are much more significant in this case, with English and Irish students showing the least interest in careers related to these subjects (40% and 42% of the sample, respectively), and Greek students showing the highest (57% of Greek respondents).

Of those expressing interest in careers related to computing, technology and engineering, 43% consider computing for their future career, 41% Engineering, 37% Design and Technology and 36% Mathematics.

A further question, this time looking to capture attitudes towards careers not related to STEM, was addressed to all questionnaire participants. In this case, most students chose “Sports” (37% from all responses) as a non-STEM career preference, followed closely by “Medicine and Health Studies” (32% of responses), “Social Studies” and “Visual and Performing Arts”, each at 25% of the sample.

Students aged 12 to 15 appear to be confident about their career aspirations. The most popular career interests are Sports and Medicine and Health Studies. The least popular are Maths and Design and Technology. Figure 10 illustrates cumulatively the career interests of all

![Figure 10: Students' careers interests combined: In green, we represent the students' answers as percentage of respondents who indicated they are “Somewhat interested” or “Extremely interested” in: a) pursuing a career related to Science [n=1,494] and b) pursuing a career related to Computing, technology and engineering [n=1,248]. In red, we represent students' answers as percentage of the overall sample. “Other” career choices are expressed as percentages of the overall sample only [n=2,623].](image)
students surveyed, represented as percentages of the entire data sample.

For Biology, Chemistry and Physics, the students’ answers are also illustrated as percentages of respondents who indicated they are “Somewhat interested” or “Extremely interested” in a career related to Science; similarly, for Engineering, Design and Technology, Maths and Computing, career choices are also illustrated as percentage of respondents who indicated interest in a career related to Computing, technology and engineering.

Students appear to be confident in their career choices, with just 13% of them indicating they have not considered their career options yet.

Across the sample, the most common career choice is Sports (37% of all responses), followed by Medicine and Health Studies (32% of responses), Biology (27%), Social Studies (25%) and Visual and Performing Arts (25%). At the other end of the spectrum, the least popular career choices are Design and Technology (17%), Maths (17%) and Physics (19% of overall responses).

Interestingly, apart from Mathematics, career choices are largely consistent with students’ attitudes towards STEM subjects. Sports (81%), Science (70%) and Mathematics (64%) were among the subjects most liked by students, as well as the top three areas considered by them for their further studies (Figure 10). When looking at career choices, Sports and, from the sciences, Health Studies and Biology remain at the top of student preferences, with Mathematics lagging as one of the most unpopular topics for future careers.

Indeed, as discussed previously, a strong interest in STEM is not the only factor determining future career choices; interests must be supported further by activities which support students in understanding what are the career options they can pursue in relation to STEM subjects.

Information about STEM careers
Access to information about careers is key in shaping students’ decisions about their professional paths. A little more than half the sample (56%) personally know someone with a STEM-related job, and a total of 44% do not, or are not aware if they know a person with a STEM job (Figure 11), which indicates that most students can already receive information about STEM careers through personal connections.

![Figure 11: Personal exposure to information about STEM careers](n=2,610)

Two questions were included to capture students’ other possible information channels about careers (Table 6) and their importance in guiding their career decisions (Table 5).

Among those who have experienced the various opportunities to learn about possible future careers, around 80% have found them helpful (Table 5).

Interestingly, 37% of students have never talked to a career counsellor to get information about careers and career pathways, and 39% have never discussed careers with a students’ organisation.

Most students seem to have approached the topic of possible future careers with their teacher (only 16% say they have not) and many have learnt about careers during their lessons (only roughly one in four students say they have not learned about relevant careers during their lessons).
Below is a list of opportunities that may help young people get information about careers and career pathways.

Which of these opportunities have you experienced and how helpful did you find them?

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Total</th>
<th>UK</th>
<th>IE</th>
<th>ES</th>
<th>IT</th>
<th>GR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talking to a career counsellor</td>
<td>79%</td>
<td>70%</td>
<td>77%</td>
<td>79%</td>
<td>90%</td>
<td>76%</td>
</tr>
<tr>
<td>Talking to a teacher</td>
<td>82%</td>
<td>83%</td>
<td>83%</td>
<td>81%</td>
<td>84%</td>
<td>82%</td>
</tr>
<tr>
<td>Learning about relevant careers in lessons</td>
<td>86%</td>
<td>86%</td>
<td>90%</td>
<td>79%</td>
<td>89%</td>
<td>88%</td>
</tr>
<tr>
<td>An organization for students who are interested in this career</td>
<td>79%</td>
<td>76%</td>
<td>85%</td>
<td>78%</td>
<td>78%</td>
<td>78%</td>
</tr>
<tr>
<td>Attending an after-school club</td>
<td>77%</td>
<td>75%</td>
<td>69%</td>
<td>81%</td>
<td>80%</td>
<td>77%</td>
</tr>
</tbody>
</table>

Table 5: Percentage of students who thought the different opportunities to learn about possible career paths were “Somewhat helpful” or “Very helpful” [n=2,542]

Table 6: Percentage of students who have “never experienced” different career information outlets [n=2,542]

Here is another list of options that may help young people get information about careers and career pathways.

Which of these opportunities have you experienced and how helpful did you find them?

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Total</th>
<th>UK</th>
<th>IE</th>
<th>ES</th>
<th>IT</th>
<th>GR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volunteering related to your career</td>
<td>82%</td>
<td>83%</td>
<td>88%</td>
<td>78%</td>
<td>84%</td>
<td>82%</td>
</tr>
<tr>
<td>Job shadowing or work experience</td>
<td>83%</td>
<td>83%</td>
<td>90%</td>
<td>78%</td>
<td>87%</td>
<td>86%</td>
</tr>
<tr>
<td>Visiting relevant work places or universities</td>
<td>85%</td>
<td>85%</td>
<td>91%</td>
<td>83%</td>
<td>88%</td>
<td>83%</td>
</tr>
<tr>
<td>Meeting people who work in this job</td>
<td>88%</td>
<td>86%</td>
<td>94%</td>
<td>85%</td>
<td>91%</td>
<td>87%</td>
</tr>
<tr>
<td>Mentoring programme supported by people who work in this job</td>
<td>79%</td>
<td>83%</td>
<td>82%</td>
<td>77%</td>
<td>78%</td>
<td>80%</td>
</tr>
<tr>
<td>Career aptitude testing</td>
<td>74%</td>
<td>75%</td>
<td>66%</td>
<td>77%</td>
<td>67%</td>
<td>79%</td>
</tr>
<tr>
<td>Mock interviews</td>
<td>73%</td>
<td>79%</td>
<td>76%</td>
<td>70%</td>
<td>78%</td>
<td>70%</td>
</tr>
<tr>
<td>Simulation (imitation) of job tasks virtually</td>
<td>78%</td>
<td>78%</td>
<td>88%</td>
<td>78%</td>
<td>81%</td>
<td>73%</td>
</tr>
</tbody>
</table>

Table 7: Percentage of students who have “never experienced” different career information outlets [n=2,542]
Pupils are even less exposed to hands-on learning about future careers; as can be observed in Table 6, around half the pupils had never experienced a mock interview (50%) or a mentoring programme (49%), and 25% say they have not met people who worked on the job.

The results indicate that discussions about careers are mostly carried out in schools, with teachers taking the role of career counsellors, and acting as an important point of information about careers for their students.

Students’ influencers
To understand what factors play into the students’ STEM career decisions, the focus fell on the major influencers directing students to a STEM career: family members and family friends, teachers, friends or peers, other acquaintances, media (books or films), previous work experience (a volunteer opportunity or a job, a summer programme or internship, a job shadowing opportunity or a mentoring opportunity), classroom experiences, or extracurricular activities (an after-school programme or a field trip). Student responses are illustrated in Figure 12 below.

Overwhelmingly, students indicate family members or relatives (46% of the overall sample) as a major influencer in guiding career choices, a result which is consistent across countries. Across the sample, 23% of pupils say they were influenced by a book they read or a film they watched, and only in third place do they indicate teachers (21%) as a major influencer group.

The result clearly indicates that, if teachers are essential in making STEM subjects more attractive and in conveying information about STEM careers to their pupils, family members play the most important role in the students’ decisions about future careers.
Gender differences in attitudes towards STEM

Gender stands out as the main element which shapes student views and attitudes towards STEM subjects and careers.

While correlations between other factors - such as age, socio-economic background, and engagement in extracurricular activities - were also investigated for this report, we found no strong relationships between student’s interest in science or their career aspirations and their age, social background, or involvement in extracurricular activities. We acknowledge that the lack of correlations can be due to the limitations in the data sample described in the introductory chapters of this report and should be investigated further in a separate study extended over a larger number of European countries.

In this section, we return to some of the findings of this report and investigate them further, from the gender perspective. We seek to identify in particular: [1] if there are any differences between boys and girls with regard to their attitude towards STEM studies and careers, and [2] what factors might shape these differences.

Attitudes towards STEM studies

Looking at the subjects that pupils like from a gender perspective reveals a complicated state of play (Figure 13). Focusing on STEM subjects, we first notice that there are no significant differences between girls' and boys' attitudes towards Mathematics and Science (Biology, Anatomy, Chemistry, Physics, Zoology, Agriculture etc.), and only a small difference (slightly more boys, with 11% expressing a liking) for Design and Technology (Materials technology, Electronic materials, Food technology, etc.).
The most notable differences appear for Computing (Computer Science, Information Technology, Programming, etc.) - a subject which is preferred by 22% more boys and Engineering or Architecture - 18% more boys said they liked this subject. Conversely, from the non-STEM topics, 26% more girls prefer Visual and Performing Arts, and 24% more Language Arts.

Furthermore, these variations are largely reflected in the pupils’ preferences for future studies.

Boys are more than twice more likely than girls to choose computing in the future, and twice more likely to continue studying Engineering or Architecture.

Across countries, girls are twice more likely than boys to follow Visual and Performing Arts in their future studies (Table 7). Encouragingly however, no significant disparities appear between boys’ and girls’ options related to choosing Mathematics or Science for further study.

As already mentioned, there are no significant disparities between boys’ and girls’ attitudes towards science topics, although notable differences appear in specific countries. We looked more in detail into three science subjects - biology, chemistry, and physics - and asked students if they like the idea of studying these subjects in the future. Interestingly, when it comes to specific science topics, boys’ and girls’ interests diverge: girls tend to be more likely to want to pursue Biology, while boys are more inclined to want to study Physics in the future (Figure 14). Chemistry is equally interesting to both genders as a future subject to study. A notable exception is Italy, where girls’ general interest in science topics appears considerably lower - when compared with girls from the other four countries, or to boys from the same country.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Girls</th>
<th>Boys</th>
<th>Difference in perceptions (girls-boys)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Studies (History, Geography, Philosophy, Political Science, etc.)</td>
<td>31%</td>
<td>25%</td>
<td>6%</td>
</tr>
<tr>
<td>Maths (Statistics, Algebra, Geometry, Calculus, etc.)</td>
<td>39%</td>
<td>43%</td>
<td>-4%</td>
</tr>
<tr>
<td>Engineering or Architecture (Mechanical, Electrical, Chemical, Civil, etc.)</td>
<td>17%</td>
<td>38%</td>
<td>-20%</td>
</tr>
<tr>
<td>Computing (Computer Science, Information Technology, Programming, etc.)</td>
<td>20%</td>
<td>45%</td>
<td>-25%</td>
</tr>
<tr>
<td>Design and technology (Materials technology, Electronic materials, Food technology, etc.)</td>
<td>22%</td>
<td>33%</td>
<td>-11%</td>
</tr>
<tr>
<td>Science (Biology, Anatomy, Chemistry, Physics, Zoology, Agriculture etc.)</td>
<td>49%</td>
<td>40%</td>
<td>9%</td>
</tr>
<tr>
<td>Foreign Languages</td>
<td>43%</td>
<td>28%</td>
<td>15%</td>
</tr>
<tr>
<td>Language Arts ([National language(s)], Literature, Journalism, etc.)</td>
<td>27%</td>
<td>14%</td>
<td>13%</td>
</tr>
<tr>
<td>Visual and Performing Arts (Drawing, Photography, Choir, Band, Orchestra, etc.)</td>
<td>39%</td>
<td>17%</td>
<td>22%</td>
</tr>
<tr>
<td>Sports (Physical education)</td>
<td>35%</td>
<td>45%</td>
<td>-10%</td>
</tr>
<tr>
<td>Not sure or have not thought about it yet</td>
<td>12%</td>
<td>9%</td>
<td>3%</td>
</tr>
</tbody>
</table>
Perceptions of STEM studies

Previous research indicates differences in the persistence of students in following a STEM path based on gender (for example, Tyson, Lee, Borman & Hanson 2007). To learn what factors may influence perceptions of STEM subjects and STEM careers, we asked respondents to express their agreement with a number of opinion statements regarding STEM disciplines. In Table 8 we present the percentage of boys and girls who expressed agreement (as “Somewhat agree” or “Agree strongly”) with the various statements. It is interesting to note that, regardless of gender, students have a shared understanding that science and technology is always changing and advancing. More girls agree that studies related to science and technology are difficult and confusing, while significantly more boys say STEM is something they are good at, which confirms that male students are more self-efficacious in the exact sciences, especially mathematics (Pajares, F. 2005), than female students despite comparable achievements.

Boys also feel they are tech savvy, while girls indicate less confidence and feel they are not good enough with technology.

Table 8: Boys vs. Girls: Focusing on knowledge related to STEM disciplines, tell us how much you agree or disagree with the statements below. Studies related to science and technology are...

<table>
<thead>
<tr>
<th>Study-related to science and technology are...</th>
<th>Girls</th>
<th>Boys</th>
<th>Difference in perceptions (girls-boys)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult and confusing</td>
<td>55%</td>
<td>48%</td>
<td>7%</td>
</tr>
<tr>
<td>Something that only clever people can do</td>
<td>23%</td>
<td>30%</td>
<td>-7%</td>
</tr>
<tr>
<td>Creative and fun</td>
<td>71%</td>
<td>74%</td>
<td>-3%</td>
</tr>
<tr>
<td>Always changing or advancing</td>
<td>89%</td>
<td>88%</td>
<td>1%</td>
</tr>
<tr>
<td>For anti-social people</td>
<td>12%</td>
<td>14%</td>
<td>-2%</td>
</tr>
<tr>
<td>Something I am good at</td>
<td>68%</td>
<td>78%</td>
<td>-10%</td>
</tr>
<tr>
<td>About helping others</td>
<td>81%</td>
<td>79%</td>
<td>2%</td>
</tr>
<tr>
<td>Require too much education</td>
<td>65%</td>
<td>66%</td>
<td>-1%</td>
</tr>
<tr>
<td>Isn’t something that I feel is useful to learn</td>
<td>16%</td>
<td>17%</td>
<td>-2%</td>
</tr>
<tr>
<td>Make a big impact on people’s lives</td>
<td>86%</td>
<td>83%</td>
<td>3%</td>
</tr>
<tr>
<td>Should be studied by all</td>
<td>61%</td>
<td>64%</td>
<td>-3%</td>
</tr>
</tbody>
</table>
Career aspirations

Finally, in Table 9, we look at how career aspirations are influenced by gender. First, we notice that there is no difference between the girls’ and boys’ decisiveness with regard to their future careers: in close to equal shares, both girls and boys have considered their future career options.

But gender does appear to play a role in the type of career pupils are planning to follow, with the most striking differences appearing for Computing and Engineering, areas in which boys are three times more likely to pursue a career than girls and visual and performing arts, specialisations that are twice more likely to appeal to girls. Interestingly, the gap widens for Mathematics as well, which boys are now almost twice more likely to follow as a career. Biology remains the science subject which girls clearly prefer more than boys.

Indeed, these findings are in line with data collected elsewhere, which indicates that boys and girls tend to think of working in different fields of science: girls view themselves as health professionals while boys see themselves as becoming scientists or engineers more than girls do (OECD 2016); and that the vast majority of degrees awarded in engineering, computer sciences and physics and more than the half of the degrees awarded in mathematics usually go to men (NSF 2018).

Table 9: Girls vs Boys: Career interests

<table>
<thead>
<tr>
<th>Career interests</th>
<th>Girls</th>
<th>Boys</th>
<th>Difference (girls-boys)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>33%</td>
<td>21%</td>
<td>12%</td>
</tr>
<tr>
<td>Chemistry</td>
<td>24%</td>
<td>20%</td>
<td>3%</td>
</tr>
<tr>
<td>Physics</td>
<td>15%</td>
<td>24%</td>
<td>-9%</td>
</tr>
<tr>
<td>Engineering</td>
<td>10%</td>
<td>31%</td>
<td>-20%</td>
</tr>
<tr>
<td>Design and technology</td>
<td>14%</td>
<td>22%</td>
<td>-8%</td>
</tr>
<tr>
<td>Maths</td>
<td>13%</td>
<td>23%</td>
<td>-10%</td>
</tr>
<tr>
<td>Computing</td>
<td>10%</td>
<td>33%</td>
<td>-23%</td>
</tr>
<tr>
<td>Social Studies (e.g. History, Geography, Politics, Philosophy)</td>
<td>24%</td>
<td>26%</td>
<td>-2%</td>
</tr>
<tr>
<td>Medicine and Health Studies</td>
<td>39%</td>
<td>25%</td>
<td>14%</td>
</tr>
<tr>
<td>Language Arts (e.g. literature, foreign languages)</td>
<td>28%</td>
<td>15%</td>
<td>13%</td>
</tr>
<tr>
<td>Visual and performing Arts (e.g. painting, drama, playing an instrument)</td>
<td>33%</td>
<td>15%</td>
<td>18%</td>
</tr>
<tr>
<td>Economics</td>
<td>18%</td>
<td>24%</td>
<td>-5%</td>
</tr>
<tr>
<td>Sports</td>
<td>29%</td>
<td>46%</td>
<td>-17%</td>
</tr>
<tr>
<td>I haven’t thought about it yet</td>
<td>12%</td>
<td>13%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Conclusions

The present report responds to the need to achieve a better understanding of students’ experiences, views and perceptions regarding STEM studies and of the factors influencing their future career choices. The study is framed by previous research on STEM education and draws on the data from 2,789 responses from pupils 12 to 15 in five different countries: Greece, Italy, Spain, Ireland and the United Kingdom (England).

Research evidence indicates that these school years are critical in shaping young pupils’ interests and career perceptions, which, in turn, influence their choice of further studies as well as the careers they are going to pursue. These are also the ages when educational interventions aimed at encouraging student interest in STEM are more likely to succeed. It is envisioned that by learning about students’ interests and perceptions regarding STEM subjects, their perception of STEM teaching practice, their career aspirations and the factors which may impact them, STEM industries will be able to reflect on their education projects and increase the effectiveness of their educational initiatives aimed at promoting young people’s interest in school and choosing STEM career paths.

The study shows that most young people are highly interested in STEM disciplines and that their perception of STEM subjects and careers is rather positive. For instance, the majority of pupils surveyed think that STEM studies are “about helping others” and “have an impact on people’s lives”. However, more than half (and significantly more girls than boys) also think they are difficult and require too much study. Looking further, at future career choices, around half of the students surveyed show some interest in pursuing a career related to STEM, with interest in science careers faring slightly higher than interest in those related to computing, technology and engineering.

The pupils’ responses also indicate that teachers play a central role in influencing student perceptions about school subjects on one hand, and on guiding students towards their future professions, on the other. It is clear that interventions directed at increasing the attractiveness of STEM studies and careers should also include elements addressing teachers.

Gender is one important element that impacts on student views and attitudes towards STEM careers - boys are three times more likely than girls to pursue a career in Computing and Engineering and almost twice more likely than girls to follow a career in Mathematics. Girls are also slightly more likely than boys to perceive STEM studies as “difficult and confusing”, and less likely to feel they are good at these subjects.

Most of the findings - students’ perception that STEM subjects are difficult, or girls’ lack of confidence in their own ability to perform well in STEM-related fields - are challenges already identified in previous research. But despite these challenges, the study shows that the pupils surveyed have a high interest in STEM fields (though this result may have been affected by good STEM teaching practice). Future studies could focus on further investigating the impact of different teaching methodologies (such as inquiry-based science education) on pupils’ perception of STEM studies and their attitudes towards future careers.
Acknowledgements

We would like to thank the National Survey Coordinators - Scientix Ambassadors in Greece, Ireland, Italy, Spain, and United Kingdom - for their contribution in the implementation of the study. From providing feedback in the piloting phase of the study to contacting and supporting teachers in their respective countries to run this European-wide survey, their support and flexibility were vital to the success of the project.

The study would not have been possible without the valuable contributions from the schools and teachers in Greece, Ireland, Italy, Spain, and UK as well as the headteachers and school administrations, who supported the research taking place in their schools. Last but not least we thank all the students who took part in the survey and provided their vision on STEM subjects. We wish them the best of luck in their future careers.

List of Scientix Ambassadors who acted as National Survey Coordinators for this study:

- Xanthi Almpanaki, Scientix Ambassador in Greece
- Michelle Dunne, Scientix Ambassador in Ireland
- Daniele Molaro, Scientix Ambassador in Italy
- Rafael Montero, Scientix Ambassador in Spain
- Caroline Neuberg, Scientix Ambassador in UK

List of schools in which the study was carried out:

**Greece**
- A Gymnasium Anatolia College
- B Gymnasium Anatolia College
- A Lyceum Anatolia College
- B Lyceum Anatolia College
- 5th Junior High School of Palaio Faliro
- Experimental Junior High School of the University of Macedonia
- 1st Vocational School of Eleftheroupoli (1st EPAL of Eleftheroupoli)
- Junior High School (Gymnasium) of Eleftheroupoli
- 7th Junior High School (Gymnasium)
- Geniko Lykeio Iasmou
- 2nd Junior High School (Gymnasium)

**Ireland**
- St Joseph’s College in Lucan
- St Joseph’s Patrician College
- Santa Sabina Dominican College
- Intermediate School in Killorglin
- St Mary’s Secondary School in Mallow
- Presentation Convent in Mitchelstown
- Clonaslee College
Italy
- Liceo Artistico “Franco Russoli” di Pisa e Cascina
- Istituto di Istruzione Superiore “Galilei - Artiglio”
- Liceo Linguistico Internazionale “Grazia Deledda”
- Istituto Superiore d’Istruzione “Carlo Piaggia”
- Istituto Comprensivo Torregrotta - Scuola secondaria di I° grado “Dante Alighieri”
- Scuola Secondaria di Primo grado “A. Belvedere”
- Istituto Tecnico Tecnologico Statale “Carlo Grassi”
- Istituto di Istruzione Superiore “Quinto Ennio”
- Istituto Comprensivo “Iqbal Masih”
- Istituto di Istruzione Superiore “Giovanni Silva - Matteo Ricci”

Spain
- Colegio Corazón de María
- IES Fernández Vallín
- IES de Candás
- Colegio Pedro Poveda
- IES St Vicent Ferrer
- La Salle-Legazpi
- Colegio Agustiniano
- IES de Vilalonga
- Colegio San Gabriel
- CES San Valero
- Colegio Virgen Mediadora
- IES Riu Túria

United Kingdom (England)
- Mount St Mary’s Catholic High School
- The Grammar School, Leeds
- Fulneck School
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Piburn, M. D. & Baker, D. R. (1993). If I were the teacher... Qualitative study of attitude toward science. Science Education. https://doi.org/10.1002/sce.3730770404


Subotnik, R. F ., Tai, R. H. & Rickoff, R. (2010). Specialized public high schools of science, mathematics, and technology and the STEM pipeline: What do we know now and what will we know in 5 years? Roeper Review, 32, 7-16


Appendix 1. Respondent sample: overview of ages and academic strands per country

Below we offer an overview of the ages in which students are allowed to choose between different academic strands or subjects, per country.

<table>
<thead>
<tr>
<th>Country</th>
<th>Students follow general academic strands (ages)</th>
<th>Students are allowed different academic choices (ages)</th>
</tr>
</thead>
<tbody>
<tr>
<td>England¹⁰</td>
<td>11-16</td>
<td>16-18</td>
</tr>
<tr>
<td>Ireland¹¹</td>
<td>12-15/16</td>
<td>15-18/19</td>
</tr>
<tr>
<td>Italy¹²</td>
<td>11-14</td>
<td>14-18</td>
</tr>
<tr>
<td>Spain¹³</td>
<td>12-16</td>
<td>16-18</td>
</tr>
<tr>
<td>Greece</td>
<td>12-15</td>
<td>15-18</td>
</tr>
</tbody>
</table>

11 [https://www.education.ie/en/The-Education-System/Post-Primary/](https://www.education.ie/en/The-Education-System/Post-Primary/)
Appendix 2. School characteristics proforma

In addition to pupils’ responses to the survey, we wanted to know in which type of schools the questionnaire is completed. In order to collect detailed information about schools you can use a template of the table provided below to collect information that is of a particular interest for this study.

<table>
<thead>
<tr>
<th>Criteria:</th>
<th>Sub-criteria (one choice per category)</th>
<th>School 1</th>
<th>School 2</th>
<th>School 3</th>
<th>School 4</th>
<th>School 5</th>
<th>School 6</th>
<th>School 7</th>
<th>School 8</th>
<th>School 9</th>
<th>School 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
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<tr>
<td></td>
<td>1 - city</td>
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<td>2 - town</td>
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<td>3 - countryside</td>
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<tr>
<td>School fee</td>
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<td>1 - fee paying</td>
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<tr>
<td></td>
<td>0 - non-fee</td>
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<td>School selection on entry</td>
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<tr>
<td></td>
<td>1 - selective</td>
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<tr>
<td></td>
<td>0 - non-selective</td>
<td></td>
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<td>School size</td>
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<tr>
<td></td>
<td>1 - more than 1500 students</td>
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<td></td>
<td>2 - between 1000 and 1500 students</td>
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<tr>
<td></td>
<td>3 - between 500 and 1000 students</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>4 - less than 500 students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>School STEM specialism</td>
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<td></td>
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<tr>
<td></td>
<td>1 - yes</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>0 - no</td>
<td></td>
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</tbody>
</table>

The attractiveness of Science, Technology, Engineering and Mathematics subjects. Results from five countries
Appendix 3. Attractiveness of STEM studies questionnaire

INTRODUCTION

If you are between 12 and 15 years old, you are invited to participate in a Europe-wide study about the factors influencing young people’s interest in science, technology, engineering and maths (STEM) subjects. We would very much appreciate it if you would share with us your views on and interests in the school subjects you are currently studying, and your hopes for future education and careers by filling out the questionnaire below.

Thank you for helping us with this questionnaire!

This questionnaire was developed under the umbrella of the STEM Alliance project with special support from Amgen Europe. STEM Alliance is an initiative that provides real-life examples of what a job in STEM might look like and brings in experts from industry who talk to teachers and pupils about their day-to-day activities and opportunities for employment in companies. As a proactive partner of the STEM Alliance, Amgen (Europe) is a biotechnological company, which invests in science education in order to shape a better tomorrow by providing hands-on experience in science to pupils and professional development on STEM topics for teachers.

The questionnaire will be filled out by young people like yourself in five countries: England, France, Ireland, Spain and Italy.

Via this questionnaire, we would like to collect your own experiences and opinions, and therefore there are no correct or incorrect answers.

Please note that this questionnaire should only be completed if you are between 12 and 15 years old. If you are under 12 or over 15, please do not complete the questionnaire although we do appreciate your interest in the subject area.

Participating in the questionnaire is on a voluntary basis and you will receive no payment or reward for completing the survey. If you are not sure whether you should participate, then please discuss it with your parent(s), legal guardian or teacher.

Answering this questionnaire should require no more than 25 minutes.

Before starting the survey, please read carefully our privacy policy. To go to the next page, please press Next button.

PRIVACY POLICY

1. Data collection and processing
The questionnaire is anonymous and we do not want to be able to identify you. Consequently, please do not send us any personal data or anything that would identify you, including your first name, family name, e-mail address, home address or telephone number. In order to fully protect you, we will not collect your IP address. Our approach to the questionnaire and keeping the contents anonymous will ensure that we act fully in line with the European Union’s laws on Data Protection, called the General Data Protection Regulation or GDPR for short.
If you feel worried or concerned by any of the questions or issues raised in the questionnaire, please do not hesitate to talk to your parent(s) or legal guardian or your teacher.

The data collected in this survey will be used for research purposes only, strictly in line with the objectives defined above.

Overall (what we refer to as “aggregated”) results collected via this questionnaire will be made freely available online (open access) before the end of 2019 at http://www.stemalliance.eu.

EUN Partnership AISBL is managing and coordinating the process of response collection and analysis for this questionnaire. In the unlikely event that any personal data is collected, EUN Partnership AISBL will act as the Data Controller with respect to such data which will be processed in accordance with the EU’s General Data Protection Regulation.

The individual responses of users received via the questionnaire (for example, your age or gender) will not be shared outside EUN Partnership AISBL, will not be shared with Amgen (Europe) GmbH, will be used only according to the purposes declared in this questionnaire and will be deleted at the end of 2019. You can safely express your personal opinions via this questionnaire, as no one from your school (teachers, headmasters, other pupils) will have access to the individual responses EUN Partnership AISBL is collecting. We are also asking you not to share the results with your teacher or classmates.

2. Sharing of Data (age, gender, school’s location) - Please read carefully

Please note that we use a third-party processor (Survey Monkey) to process the survey and any data relating to it (age, gender, school’s location). Such processing will be carried out in accordance with Survey Monkey’s terms and conditions (see https://www.surveymonkey.com/mp/legal/privacy-policy/).

3. Important Note:

By completing the survey you are consenting to the terms and conditions detailed in sections 1 and 2 above.

4. Contacts

If you have any questions regarding this survey, please contact Anastasiya Boiko (anastasiya.boiko@eun.org), questionnaire coordinator at EUN Partnership AISBL.

If you feel that we have not respected your data protection rights or wish to make an official complaint, please contact either the data protection authorities in the Member State where you are resident or the Belgian Data Protection Authorities (where EUN is resident):

Belgian Data Protection Authority

Rue de la Presse, 35, 1000 Bruxelles
+32 (0)2 274 48 00
+32 (0)2 274 48 35
contact(at)apd-gba.be

When you are ready to take the questionnaire, please press Next button.
ABOUT YOU

A1. First, are you? [SINGLE CHOICE]
   o Male
   o Female
   o Prefer not to say

A2. How old are you? [SINGLE CHOICE]
   o 12
   o 13
   o 14
   o 15
   o Other [if this option is selected -> CUSTOM DISQUALIFICATION PAGE]

A3. What language do you speak in your home the majority of the time? [SINGLE CHOICE]
   o English
   o Other language(s) - please specify

A4. Were you born in the country where you live now? [SINGLE CHOICE]
   o Yes
   o No [if this option is selected -> A4a]
   o I don’t know
   o Prefer not to say

A4a. Were you born in a country which is a member of the European Union? [SINGLE CHOICE; next question -> A5]
   o Yes
   o No
   o I don’t know
   o Prefer not to say

A5. Thinking back to the neighbourhood you mainly grew up in, how would you characterise it? [SINGLE CHOICE - RANDOMISED]
   o Large single-family homes or luxury apartments, most adult residents worked in the higher-earning professional sector (e.g., lawyers, doctors, business leaders, scientists, etc.)
   o Single-family homes or apartments, most adult residents worked in the middle-earning professional sector (e.g., teachers, police officers, military officers, etc.)
   o Small single-family homes or apartments, most adult residents worked in the service industry (e.g., maintenance, customer service, military infantry, etc.)
   o Small single-family homes or apartments, most adult residents worked in the service industry, some families in the neighbourhood may have received welfare benefits

---

14 In this type of question, the respondents were asked to choose one answer from the list of answer choices.
15 If this option was chosen, it redirected respondents to the termination screen. For this study we haven’t collected responses from students younger than 12 and older than 15 years old.
16 For England. For each of other countries a county-specific list of official languages was used.
17 Randomisation of answers shuffles the sequence of options for each respondent, so that the list of answers appeared for each respondent in a different sequence.
A6. While growing up, who did you live with? [SINGLE CHOICE]

- Both parents (including step-parents) or two legal guardians [if this option is selected -> A6b]
- Just one parent or one step-parent or one legal guardian [if this option is selected -> A6b]
- Other relative(s) (grandparent, sibling, aunt, etc.) [if this option is selected -> A7]
- Prefer not to say [if this option is selected -> A7]
- Other (Please specify) [if this option is selected -> A7]

A6a. If ONE PARENT HOUSEHOLD: Does your parent/guardian have a university degree? ¹⁸ [SINGLE CHOICE; next question -> A7]

- Yes
- No
- I don’t know

A6b. If TWO PARENT HOUSEHOLD: Do either of your parents or guardians have a university degree? ¹⁹ [SINGLE CHOICE; next question -> A7]

- Yes, both of my parents or guardians have degrees
- Yes, but only one of my parents or guardians has a degree
- No, neither of my parents or guardians has a degree
- I don’t know

A7. Did your parent(s) or legal guardian(s) ever have a job related to science, technology or engineering? [SINGLE CHOICE]

- Yes
- No
- I don’t know

A8. How much do you agree or disagree that the following statements describe you? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Statement</th>
<th>Disagree completely</th>
<th>Somewhat disagree</th>
<th>Somewhat agree</th>
<th>Agree completely</th>
</tr>
</thead>
<tbody>
<tr>
<td>I’m the type of person who knows what I want and goes to get it</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Being active is important to me</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I am a carefree person</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I like to try new things</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

TRANSITION SCREEN: Great! Now that we know more about you, we’d like to find out what academic interests you have.

¹⁸ If one-parent household.
¹⁹ If two-parent household.
SUBJECT INTERESTS AND PERCEPTIONS

S1. Thinking about general areas of knowledge, which of them are you interested in? [MULTIPLE CHOICE]
   - Social Studies, e.g. history, geography, politics, philosophy
   - Science, technology, engineering and maths (STEM), e.g. physics, medicine, programming [if this option is selected -> S1a + S1b]
   - Language Arts, e.g. literature, foreign languages
   - Visual and Performing Arts, e.g. painting, drama, playing an instrument
   - None of the above
   - Not sure

S1a. At what age did you become interested in STEM subjects? [SINGLE CHOICE, DROP DOWN MENU]
   - 5 or younger
   - 6
   - 7
   - 8
   - 9
   - 10
   - 11
   - 12
   - 13
   - 14
   - 15
   - Not sure

S1b. What do you like about STEM subjects? Why do you find this area of knowledge interesting? [OPEN END]

S2. Focusing on knowledge related to STEM disciplines, tell us how much you agree or disagree with the statements below. [MATRIX - RANDOMISED]

Studies related to science and technology are...

<table>
<thead>
<tr>
<th></th>
<th>Disagree completely</th>
<th>Somewhat disagree</th>
<th>Somewhat agree</th>
<th>Agree completely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult and confusing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Something that only clever people can do</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creative and fun</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Always changing or advancing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For anti-social people</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Something I am good at</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>About helping others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

20 In this type of question, the respondents were asked to choose at least one answer from the list of answer choices.
S3. And how much do you agree or disagree with these statements about STEM disciplines? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Statement</th>
<th>Disagree completely</th>
<th>Somewhat disagree</th>
<th>Somewhat agree</th>
<th>Agree completely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Require too much education</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Isn’t something that I feel is useful to learn</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Make a big impact on people’s lives</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Should be studied by all</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

S4. Now, think about the subjects that you have been studying in school in the last year. Which statement below best describes your feelings towards the following subjects? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Subject</th>
<th>Dislike a lot</th>
<th>Dislike a little</th>
<th>Like a little</th>
<th>Like a lot</th>
<th>Have not taken the subject(s) yet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Studies (History, Geography, Political Science, etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Maths (Statistics, Algebra, Geometry, Calculus, etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Engineering or Architecture (Mechanical, Electrical, Chemical, Civil, etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Design and technology (Materials technology, Electronic materials, Food technology, etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Language Arts (your national language(s), Literature, Journalism, etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

S5. And which statement below best describes your feelings towards the following subjects? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Subject</th>
<th>Dislike a lot</th>
<th>Dislike a little</th>
<th>Like a little</th>
<th>Like a lot</th>
<th>Have not taken the subject(s) yet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computing (Computer Science, Information Technology, Programming, etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Science (Biology, Anatomy, Chemistry, Physics, Zoology, Agriculture etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Foreign Languages</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Visual and Performing Arts (Drawing, Photography, Choir, Band, Orchestra, etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Sports (Physical education)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
S6. And how do you feel about studying each of the following science subjects? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Subject</th>
<th>Dislike a lot</th>
<th>Dislike a little</th>
<th>Like a little</th>
<th>Like a lot</th>
<th>Have not taken the subject(s) yet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S7. In your view, what makes a school subject unattractive and dislikeable? Please select the statements that you strongly agree with. [MULTIPLE CHOICE - RANDOMISED]

- Having too much to memorise
- Uninteresting teaching (e.g. teaching mostly from a textbook)
- Not enough of interactive or hands-on activities
- Having bad relationship with a teacher(s)
- Having too much homework
- Feeling that you are not good at this subject
- Finding the subject difficult
- Having no freedom in picking projects or activities and how we learn a subject
- Not seeing relevance of this subject to real life
- Other (please specify)

S8. And what makes you like and enjoy a subject in school? Please select the statements that you strongly agree with. [MULTIPLE CHOICE - RANDOMISED]

- Teachers making lessons fun
- Doing many interesting hands-on activities
- Doing own investigations or research projects
- Learning skills that are (or will be) useful and relevant to me
- Having some freedom to pick projects or pick how we learn about the subject
- Learning about real-world applications of what we study
- Having good relationship with a teacher(s)
- Other (please specify)

S9. How much do you agree or disagree that the following statements describe you? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Statement</th>
<th>Disagree completely</th>
<th>Somewhat disagree</th>
<th>Somewhat agree</th>
<th>Agree completely</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am a creative person</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education is important to me</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I’m tech savvy (I have practical knowledge in using technology)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like to master new skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
S10. Thinking about activities used in lessons for STEM subjects, how frequently do the following activities happen in your classes? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Activity</th>
<th>NEVER (or very rarely)</th>
<th>OCCASIONALLY (from time to time)</th>
<th>FREQUENTLY (nearly every class)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class discussions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hands-on lab experiments or modelling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practical demonstrations by a teacher or technician</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning about careers or jobs related to STEM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching straight from the textbook</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presenting your own findings to the class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development of your own hypotheses or theories before experimenting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Designing your own experiments or projects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing test papers or written exams</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S11. And how frequently do the following activities happen in lessons for STEM subjects? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Activity</th>
<th>NEVER (or very rarely)</th>
<th>OCCASIONALLY (from time to time)</th>
<th>FREQUENTLY (nearly every class)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field trips to learn outside the classroom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Games</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning about how people use STEM knowledge in the real world</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projects that relate to the use of STEM in real life (e.g. studying local water quality and making suggestions for improvements)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talking to people who use STEM in their jobs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis of information to come up with your own finding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choosing the specific topics you’d like to explore more in-depth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simulated experiments or other activities virtually</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
S12. Look at the list of class activities below. Which of them, in your view, will make your lessons in STEM subjects more enjoyable? Please select the statements that you strongly agree with. [MULTIPE CHOICE - RANDOMISED]

- Class discussions
- Field trips to learn outside the classroom
- Hands-on lab experiments or modelling
- Games
- Practical demonstrations by a teacher or technician
- Learning about careers or jobs related to STEM
- Learning about how people use STEM knowledge in the real world
- Projects that relate to the use of STEM in real life (e.g. studying local water quality and making suggestions for improvements)
- Talking to people who use STEM in their jobs
- Teaching straight from the textbook
- Simulated experiments or other activities virtually
- Presenting your own findings to the class
- Development of your own hypotheses or theories before experimenting
- Choosing the specific topics you’d like to explore more in-depth
- Designing your own experiments or projects
- Analysis of information to come up with your own finding
- Doing test papers
- Other (please specify)

S13. When you get to select the subjects for further studies, which do you intend to choose? Please select all relevant options. [MULTIPLE CHOICE - RANDOMISED]

- Social Studies (History, Geography, Philosophy, Political Science, etc.)
- Maths (Statistics, Algebra, Geometry, Calculus, etc.)
- Engineering or Architecture (Mechanical, Electrical, Chemical, Civil, etc.)
- Computing (Computer Science, Information Technology, Programming, etc.)
- Design and technology (Materials technology, Electronic materials, Food technology, etc.)
- Science (Biology, Anatomy, Chemistry, Physics, Zoology, Agriculture etc.)
- Foreign Languages
- Language Arts ([National language(s)], Literature, Journalism, etc.)
- Visual and Performing Arts (Drawing, Photography, Choir, Band, Orchestra, etc.)
- Sports (Physical education)
- None of the above
- Not sure or have not thought about it yet
- Other (Please specify)

TRANSITION SCREEN: Great! Now that we know more about your school and classes, we’d like to find out about your career interests in general.

CAREER ASPIRATIONS

C1. How interested are you in pursuing a career related to science? [SINGLE CHOICE]

- Extremely interested [if this option is selected -> C1a]
- Somewhat interested [if this option is selected -> C1a]
- Neither interested nor uninterested [if this option is selected -> C2]
- Somewhat uninterested [if this option is selected -> C2]
- Extremely uninterested [if this option is selected -> C2]
C1a. Which science subject area(s) are you considering for your future career? [MULTIPLE CHOICE - RANDOMISED; next question -> C2]
   o Biology
   o Chemistry
   o Physics
   o Other (Please specify)

C2. How interested are you in pursuing a career related to computing, technology or engineering? [SINGLE CHOICE]
   o Extremely interested [if this option is selected -> C2a]
   o Somewhat interested [if this option is selected -> C2a]
   o Neither interested nor uninterested [if this option is selected -> C3]
   o Somewhat uninterested [if this option is selected -> C3]
   o Extremely uninterested [if this option is selected -> C3]

C2a. Which subject(s) are you considering for your future career? [MULTIPLE CHOICE - RANDOMISED; next question -> C3]
   o Engineering
   o Design and technology
   o Maths
   o Computing
   o Other (Please specify)

C3. Do you personally know someone with a STEM-related job?
   o Yes [if this option is selected -> C3a]
   o No [if this option is selected -> C4]
   o Not sure [if this option is selected -> C4]

C3a. What is your relationship to the person(s) with a job in STEM? [MULTIPLE CHOICE -> C4]
   o Close family member
   o Other relative(s)
   o Family friend
   o Guest speaker in school
   o Group leader for a club or activity I am involved in
   o Someone else (Please write in)

C4. Thinking about careers that are not related to STEM, which of the following areas of work are you interested in? If you are considering more than one career path, select all relevant subject areas. [MULTIPLE CHOICE]
   o Social Studies (e.g. History, Geography, Politics, Philosophy)
   o Medicine and Health Studies
   o Language Arts (e.g. literature, foreign languages)
   o Visual and Performing Arts (e.g. painting, drama, playing an instrument)
   o Economics
   o Sports
   o I haven’t thought about it yet
   o None of the above
   o Other (Please specify)
C5. Below is a list of opportunities that may help young people get information about careers and career pathways. Which of these opportunities have you experienced and how helpful did you find them? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Not helpful at all</th>
<th>Somewhat unhelpful</th>
<th>Somewhat helpful</th>
<th>Very helpful</th>
<th>I haven't experienced this opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talking to a career counsellor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talking to a teacher</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>An organisation for pupils who are interested in this career</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning about relevant careers in lessons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attending an after-school club</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C6. Here is another list of options that may help young people get information about careers and career pathways. Which of these opportunities have you experienced and how helpful did you find them? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Not helpful at all</th>
<th>Somewhat unhelpful</th>
<th>Somewhat helpful</th>
<th>Very helpful</th>
<th>I haven’t experienced this opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volunteering related to your career</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job shadowing or work experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visiting relevant work places or universities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meeting people who work in this job</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mentoring programme supported by people who work in this job</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Career aptitude testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mock interviews</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simulation (imitation) of job tasks virtually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C7. Do you know what particular career(s) you want to pursue? [SINGLE CHOICE]

- Yes, I definitely know what career I want to pursue [if this option is selected -> C8]
- Yes, I have a couple in mind that are really interesting to me but I haven’t picked one yet [if this option is selected -> C8]
- Yes, I’ve thought about a few that I think I might like but I’m not sure yet [if this option is selected -> C11]
- No, but I’ve thought about it a little [if this option is selected -> C11]
- No, I’ve not thought about it at all [if this option is selected -> C11]
C8. When did you decide on what career(s) you want to pursue? [SINGLE CHOICE - RANDOMISED]

- For as long as I can remember
- Before I went to primary school
- Sometime in primary school
- Sometime in secondary school
- I’m not sure

C9. Who or what was influential in helping you decide on the career(s) you want to pursue? [MULTIPLE CHOICE - RANDOMISED]

- Family members or relatives
- Family friend(s)
- Teacher(s)
- Friend(s) or peers
- An adult who is not a parent, relative, or family friend
- A book you read or a film watched
- A volunteer opportunity or a job you had
- A class you took
- An after-school programme
- A summer programme or internship
- A field trip
- A job-shadowing opportunity
- A mentoring programme

C10. Do you know what steps you need to take in school and beyond (e.g. what university course you need to take) to pursue your chosen career(s)? [SINGLE CHOICE - RANDOMISED]

- Yes, I know what steps I need to take
- Yes, sort of but I still have some questions
- No, but I don’t have any questions
- No, I don’t know where to begin

C11. How much do you agree or disagree that the following statements describe you? [MATRIX - RANDOMISED]

<table>
<thead>
<tr>
<th>Statement</th>
<th>Disagree completely</th>
<th>Somewhat disagree</th>
<th>Somewhat agree</th>
<th>Agree completely</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like to take risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I love understanding how things work</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have plenty of time to figure out what I want to do with my life</td>
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</tr>
</tbody>
</table>

TRANSITION SCREEN: Thanks for telling us about your science classes. Let’s now talk a little bit about your activities outside the classroom.

STEM-RELATED EXTRACURRICULARS

E1. At present, is there an active club(s) in your school or community that provides science- and technology-related activities (like a robotics club)? [SINGLE CHOICE]

- Yes [if this option is selected -> E2]
- No [if this option is selected -> E3]
- Don’t know [if this option is selected -> E3]
E2. Have you participated in these club activities in the last 12 months? [SINGLE CHOICE]
   o Yes [if this option is selected -> E4]
   o No [if this option is selected -> E5]

E3. If there were a club in your school or community that provides science- and technology-related activities, would you be interested in joining it? [SINGLE CHOICE; next question -> E5]
   o Yes
   o No
   o Don’t know

E4. How frequently did your school club or community group meet? [SINGLE CHOICE - RANDOMISED]
   o Two or more times a week
   o Once a week
   o Once in two weeks
   o Once a month or less

E4a. What was the focus of your club? [OPEN RESPONSE]

E4b. What was your favourite club or group activity? [OPEN RESPONSE]

E5. Thinking about STEM-related activities that you do outside school, which things from the list below did you do in the last 12 months? Please select all applicable options. [MULTIPLE CHOICE - RANDOMISED]
   o Visited museum or exhibition (e.g. science fair)
   o Visited a zoo or botanical garden
   o Read an article or watched a film or listened to a podcast
   o Attended a public talk or discussion
   o Discussed science news with family or friends
   o Went on a field trip
   o None of the above [if this option is selected -> EXIT SCREEN]
   o Other (please specify)

E6. Who did you do these activities with? [MULTIPLE CHOICE - RANDOMISED]
   o Close family members
   o Other relative(s)
   o Friends
   o My school
   o Other (please specify)
This report has been developed in the framework of STEM Alliance, with support from Amgen Europe. It can be accessed online at the following link: http://bit.ly/Attractiveness-of-STEM-2019-pdf

STEM Alliance - inGenious Education and industry, is a Europe-wide initiative that brings together Industries, Ministries of Education and education stakeholders to promote STEM education and careers to young Europeans and address anticipated skills gaps within the European Union. Building on the success of the inGenious initiative (2011-2014) STEM Alliance works towards bridging the gap between the education sector and the industry world by facilitating STEM career education in schools and helping them to develop relevant STEM skills and competencies for students.