WP2 D2.2 Report on stakeholders' perceptions on scientific careers

Project title: Promoting Youth Scientific Career Awareness and Its Attractiveness through Multi-stakeholder Cooperation

Project Acronym: MultiCO

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Introduction

This document has been written for the EU H2020 project titled "Promoting Youth Scientific Career Awareness and its Attractiveness through Multi-stakeholder Cooperation" (MultiCO) as the outcome of Task 2.11 for Work Package 2: Report on stakeholders' perceptions on scientific careers. Hence, the purpose of the report is to present the findings on stakeholders' awareness and perceptions of science-related careers from the individual focus group and questionnaire reports completed within the framework of the project MultiCO.

The project MultiCO focuses on the need for more scientists to tackle major societal challenges and promote scientifically literate citizens as decision makers and social actors. According to the literature, students lack interest and motivation in secondary science education, leading to a considerable decline in pursuing science-related careers. Furthermore, it has been noted that students are not sufficiently aware of the range of possible career choices related to science and technology. Consequently, the MultiCO project aspires to contribute to stimulating students' engagement in science learning through the use of motivational scenarios and at the same time raising their awareness and interest in career paths that involve science and technology.

To achieve this, the MultiCO project involves a multi-stakeholder co-operation between different stakeholders including researchers, experts from industry, teachers and parents, policy makers and counsellors. The structure of the report is based on a questionnaire, prepared by UCY with the contribution of the consortium, which was given as a protocol to organize the focus group discussion. In developing the protocol/questionnaire, where possible, the UCY team drew on (and adapted) items from available instruments that have been reported in the research literature (Venville et al., 2013; Glynn et al., 2011; Bøe et al., 2015). However, the consortium adjusted the format of the questionnaire in each country according to the school and the stakeholder group (see Appendices 1 and 2 for formats used). Therefore, interviews, either focus group interviews or individual interviews or questionnaires, depending on the schedule of the stakeholders, were conducted in each partner country. This report is a collation of the individual reports from each partner.

The focus group discussion began with a short presentation of the project giving emphasis on the problem and stakeholders' role in the project. Then, partners presented descriptions of certain science-related careers as a means to initiate and contextualize the discussion. The discussion focused on stakeholders' views of science-related careers, the factors influencing students in pursuing such careers and the ways in which the education system could enhance students' interest in learning science. Thus, the report covers the following areas:

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I. Stakeholders' views of science-related careers with regards to knowledge and skills required
II. Stakeholders' views of students' career choices and interest in pursuing science-related careers.
III. Possible factors that could influence (either impede or enhance) students in pursuing science-related careers.
IV. Ways in which the education system/learning community could contribute to problem solving regarding the lack of students' interest about science and science-related careers (information about career pathways, work experience etc.)

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Stakeholder participants

Research teams generally presented the project details to small groups of teachers, parents and scientists at focus groups or school meetings, and also conducted some interviews (see table 1 for total participants by partner). Very few parents responded to the invitation to attend, however those that did took part in focus groups to discuss the key questions about careers. The focus group discussion or interview began with a short presentation of the project giving emphasis on the problem and stakeholders' role in the project. The discussion focused on stakeholders' views of science-related careers, the factors influencing students in pursuing such careers and the ways in which the education system could enhance students' interest in learning science.

Table 1. Stakeholders by partners

	Teachers	**Parents**	**Industry experts /scientists/ NGOs**	**Students**	**Research teams**	**Career guidance/ Policy makers**
UBO	4	1	5			1
UCL	13	3	2		4	
UCY	3	1			6	3
UEF	5	3	8			3
UT	2	2	2	2	2	
totals	27	10	17	2	12	7

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I. Stakeholders' views of science-related careers with regards to knowledge and skills required

Collectively the stakeholders identified a range of careers that involve science, and skills that are science-related, as listed below. Some stakeholders added that though science is relevant to everyone, this does not necessarily translate to career choices. Some groups identified a wide range of science related careers, others focused on modern or future careers. There was also a view that science is related to all careers.

Range of Scientific careers
Research scientist, mathematical modelling, medicine, dentistry, vet science, nursing.
Conservation – government advisors, teaching science, agriculture and food production.
IT Software development, Environmental Health,
Engineers – mechanical, electronic, chemical, civil, physical, genetic.
Electrician, Fireman, Plumber, Hairdresser, Food technologist, Brewer, Farmer, Gardner, Sports scientists, Fitness trainer.
Marine biologist, Geologist, Ornithologist, Nutritionist, Astronomer/space, Chemist, Physicist, Pharmacist,
Marine biologist, Technician, Analyst, Pharmacologist, Zoologist, Occupational therapist, Pilot, Physiotherapist, Chiropracter, Astronaut, Science journalist
Computer scientist, Personal trainer, Game programmer

Careers that are more important in the future
Electro technician, plant mechanic, chemical laboratory assistant, GIS-specialist (GIS: geographic information system), agronomist and general from the food/nutrition sector and in the field of digitalization, informatics, telecommunications, nanotechnology, robotics, environmental engineering and energy engineering. Biology and medicine could be also considered modern professions specialized in specific sectors such as immunology, neuroscience, and biomedical engineering. Stakeholders pointed out that in future the careers related to environmental issues are important.

Knowledge required
The basis of science-related careers is mathematics. Knowledge in physics though is equally important. For example in engineering a combination of knowledge in physics and mathematics is required. Then biology and chemistry are fundamental to several science-related professions such as chemical engineer and environmental engineer. Specialist knowledge, general knowledge, knowledge of where scientists sit in society is also needed.

Research skills/tools for working
Qualitative, quantitative analysis

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Dexterity, extrapolating information
Data analysis, being methodical
Numeracy/maths skills, computer skills
Ability to use specialist equipment
Logical thinking, evaluative and higher order thinking skills, problem solving

Personal skills/ways of thinking
Creativity
Organisational
Curiosity
Will power
Self-confidence
Perseverance to complete dull/repetitive tasks
Imagination
Passion
Humility, Empathy, Patience, Ambition
Open-mindedness, Analytical, Thorough, Unbiased,
Adaptable, Approachable, Responsible, Concise
Written skills
Empathy
Life-management
Media literacy
Decision-making
Ability to draw conclusions
Patience

Social skills/ways of working
Collaboration
Team working
Communication
Presentation skills and public speaking
Persuasive – presentation and argument
Articulate
Public relations/marketing
Flexibility

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II. Stakeholders' views of students' career choices and interest in pursuing science-related careers.

Girls often choose careers which they believe are family-friendly or with a reference to environment and society. If girls choose academic careers in science/the technical sector they tend to choose medicine, veterinary medicine, psychology or study programs like environmental technology, spatial planning and environment protection ("*Science becomes interesting for young people when it is placed in the context of society and the human body (especially interesting for girls) or when the research aspect and the adventure is stressed (especially interesting for boys*", UBO stakeholder)

There is a lack of career awareness and information on where science could lead. Students have little knowledge on the possible career choices especially about science-related professions ("*Students don't know much about modern science related careers*", UCY stakeholder). Science taught in schools is not usually related to working life ("*They do not know what the working tasks are*", UEF stakeholder). According to the literature, the lack of real world experiences in learning science at school will have a negative impact on students 'identity work' and 'governmentality', which will compromise the likelihood of choosing a science-related career in the future (Holmegaard, Madsen, & Ulriksen, 2012).The knowledge is mostly gained from their experiences i.e. their family environment (e.g. parents working in science-related professions), and careers at hot topics (e.g. nanotechnology, robotics). These findings align with what have been reported by other studies in subject and career choice, namely the importance of significant other in influencing choices (Korpershoek, Kuyper, Bosker, & vad der Werf, 2012).

There is a perception that science is a very demanding and difficult subject. However, students choose mathematics and physics because careers related to these sciences are considered as being in demand ("*Students choose subjects such as mathematics, physics and economics because with this choice they can apply for more positions at the university*" UCY stakeholder). Students might think that choosing science subjects would be the best option to avoid unemployment ("*Jobs are chosen more often when they have a high popularity*", UBO stakeholder; "*Students could be interested in choosing science related career because they associate those with high incomes and good opportunities to find a job*", UT stakeholder)

Politicians perceive that students are not interested in scientific careers and interest is still decreasing. Industry representatives are more optimistic and believe that some students are interested in the scientific field, and that interest is increasing. They perceive that nowadays promoting students' interest is challenging. Scientists perceive that there are still students who are interested in sciences.

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Older students are more interested in science-related careers compared to younger students. Students perceive that science subjects are difficult, especially maths and physics for girls and therefore they cannot see the advantages of science-related careers in their future life ("*When they hear about professions related to science, they think that such jobs are very difficult and have a lot of work. Nowadays, young people tend to avoid hard work*", UCY stakeholder). Another reason why students are not interested in science-related careers is that science-related careers are not popular in society ("*Science is often associated with a negative image of scientists (being nerds, always working alone in labs), such images are difficult to overcome*", UBO stakeholder)

The link between school science and students' own lives is not clear for students' and therefore they do not relate their future profession with science ("*Careers are more interesting for both genders if they are application-oriented*", UBO stakeholder). Some stakeholders added that students are not aware of professions which are science-related.

Stakeholders don't have a common position; some focus on greater employment, bigger salaries and other incomes, the possibility to travel, to do research, to be creative and to demonstrate general capability in the profession. However, other stakeholders added that it is not possible to bring out general features of science-related careers that make them worth pursuing (or not worth pursuing), because it all depends on students' personal interests and choices ("*This depends on the access/attainment/aspiration the students has, the amount of culture/social capital, options left open" (...) This affects the perception/mindset of science careers*", UCL stakeholder)

The stakeholders' views of students' career choices and interest in pursuing science-related careers are similar to the findings reported by the literature. The reasons for the decline in students' motivation for science are not fully understood, and could change over time, but studies have pointed to a lack of practical work, a less autonomous school atmosphere, anxiety in relation to grades and careers, and perceptions of school science as difficult, decontextualized and irrelevant to students' everyday lives (Lyons, 2006).

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III. Possible factors that could influence (either impede or enhance) students in pursuing science-related careers

To explore this issue, the stakeholders were asked what features of science careers made them worth pursuing and therefore of interest to students. One focus was on job prospects and financial reward. Personal reasons included variety, enjoyment, excitement and self-fulfilment leading to a sense of pride in achievement. More social reasons included that science careers were useful, and potentially helped society. Alternatively some views on what made scientific careers not worth pursing were possible feelings of isolation. There was also a perception that science careers could be boring or repetitive and also that they could lack financial remuneration and could take a long time in formal education to qualify/get experience. The following lists some key influences/factors :

- Motivation (intrinsic motivation to study science/technology, excitement about discoveries/innovations, motivation to do research/lab work, interests, talent)
  "*Some students choose to study what they love the most*", UCY stakeholder
  "*If someone gets a job in science it will benefit them and society, which some students recognize*", UCL stakeholder
- science-related activities organized by the family and out of school experiences
- School-related factors (difficulty of science-related subjects, students' performance in science, science teacher)
- excitement about discoveries/innovations
  "*Students who get excited when it comes to innovations and scientific research are usually children that are different from the rest and might feel the pressure from their fellow students and go with the flow, ignoring their interests, while few will sustain their special interests*", UC stakeholder
  "*Through doing and own observations, through the fun of discoveries and finding […] one is interested in working with future problems and big issues*", UEF stakeholder

The performance in science class is related to the experience of self-efficacy that is very important for the choice of a scientific career. If the pupils are confident enough in learning and doing science in school the probability of choosing a career in this field is higher. These perceptions are supported by empirical studies (e.g. Archer, DeWitt, & Dillon, 2014; Barmby, 2008). However, some stakeholders perceived this to be of less importance.

Less conclusive influences (participants differed greatly):

- financial prospects (more highly rated in Cyprus and Estonia)

"*The future perspectives of their career choice influence their decisions*", UCY stakeholder

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"*Students are more interested in science-related careers if they know the possibilities to find a job and they know the salary in different science-related jobs*", UT stakeholder

- employment opportunities (more important in Cyprus and Estonia)
- contribution to scientific research
- socio-economic background
- difficulty level of science-related subjects
- students' gender

Interestingly family influences were highly rated in the UK and Cyprus, but less important in Germany. Family-related factors (pressure, socio-economic background, science-related activities organized by the family) were also highly rated in Finland.

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IV. Ways in which the education system/learning community could contribute to problem solving regarding the lack of students' interest about science and science-related careers (information about career pathways, work experience etc.)

Across the partnership there were many suggestions made by stakeholders:

- Show the relevance and use of science and technology so that young people could imagine better what is behind the abstract terms, maybe by showing exemplary careers (visual and with short and simple texts) to give ideas.
- Parents should be more involved (however, it's difficult to reach all of them).
- To make scientific and technical careers more interesting and appealing for young people they should be placed in the context of society or the human body (especially interesting for girls) or research aspects and adventure should be emphasized (especially interesting for boys).
- School subjects are often too far away from careers in science or the technical field – they should be more connected to careers and should show their wide range.
- Use of role models which can come into schools and talk about their daily work in science or in the field of technology, can have a positive impact on negative stereotypes
- Negative images of scientific and technical careers have to be overcome by more adequate information.
- A wide variety of careers should be presented to allow all different types of personalities to establish an individual connection to the field
- Schools should give young people the chance to try out and participate in science/technology to be able to align their "selfs" with possible career options
- Give young people positive feedback – "You are able to do science, you are suitable for those careers, look how interesting career in science and technology are, have a look inside these fields, have a try, you are welcome".
- Short digital course units that are target group oriented and activity-oriented (e.g. a short quiz) can be recommended to deliver short career information.
- Use attractive terms, such as "team player" instead of "teamwork" because young people have positive associations with this (from the field of sport for example).
- Schools should provide work experience and direct contact with people working in a particular industry. Better access to more current technologies and IT resources was also seen as useful, for example an engineering club. Some thought that having a day in the life of a scientists would be good: a group of students could spend the day carrying out a range of different job tasks in particular science careers, for example, examining 'blood' or 'tissue' samples for a clinic.
- The idea of scientists in industry coming to school to talk about their chosen careers/experiences was seen as useful by many stakeholders, also talks from university students,

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and successful professionals from different science backgrounds sharing their experience with students in school.

- Projects on STEM topics to develop knowledge and experience, with careers fairs, visits to industry/university also featured. Projects that create really useful/exciting things could be very motivating, exposing kids to real scientific challenges .e.g. building a robot for competitions.
- Introduce industry visits in science class and promote school collaboration with industries (projects).
- Build science museums that trigger students' interest and arrange school visits.
- Science class compulsory for all grades in secondary schools.
- Need to reform the science curriculum
    - employ practical work in lessons
    - teach the evolution of science in order to develop high thinking skills and understand the nature of science (e.g. a study in Cyprus indicate that students who were taught the evolution of a scientific phenomenon scored better learning results)
    - provide links with working life; that way promoting science-related career awareness.
- Implement an interdisciplinary teaching approach of STEM subjects as to prompt students making connections between science, technology, engineering and mathematics. Fostering collaboration amongst science teachers would facilitate this process.
- Promote training programs for science teachers.
- Promote the development of inquiry skills in science-related classes.
- School counsellors should provide guidance and information on the possible career choices in science while pursuing a science field (i.e. if a student chooses to study physics at the university the school counsellor should be able to provide information on job prospects/opportunities).
- School could promote students' willingness to seek purposely in the scientific and technological fields in several ways. Activities that stakeholders pointed out are:
- tell more and in a better way about practical applications and scientific skills
- linking instruction to practical problem-solving, environmental issues, climate change
- presenting different fields and careers, current technology and its future development
- group working, games, experiences, through inquiries, using everyday issues
- LUMA clubs
- study visits (to industry and research organisations) and expert visits (to school), cooperation between schools and universities, benefitting alums of own school, TET period (students work in outside the schools), counselling.

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Many of these suggestions include collaborative work, inquiry-based learning and activities where learning science can be linked to real-life problems, and contact with role models. These aspects have shown positive links to students' motivation, interest and attitudes towards science (Potvin & Hasni, 2014).

Conclusions

Across the partnership we were able to draw on the views of a range of stakeholders, though it was disappointing that so few parents were able to attend meetings. Feedback on outcomes of using scenarios could provide a stimulus for parental involvement if schools are able to engage parents more fully in the project. Where industry partners have been able to be involved their insights have been interesting and in some cases show a contrast to the views of teachers and parents. Their ongoing engagement in the project can provide invaluable sources for developing scenarios that stimulate students' interest and career awareness.

In identifying stakeholders' views of science-related careers there was a remarkable degree of overlap between partner countries, but with some exceptions. Many stakeholders identified careers traditionally well-known for science such as medicine, however some stakeholders mentioned more environmental careers, different kinds of engineering and 'future' careers. Some stakeholders also identified many other careers such as plumbing, brewing, farming, where there are science-related aspects. There was a view that all careers could be related to science, but this idea was not shared by all stakeholders. Further analysis could identify trends in how different stakeholders perceive science-related careers. In identifying the knowledge and skills needed in science-related careers there was again a similarity across the partnership, resulting in a long list of skills that include the professional, personal and social skills.

Stakeholders' views of students' choices and interest did show differences between partner countries. Though there were common views such as a lack of career awareness, a perception that science is difficult and there is a lack of interest, these views were not uniform and require further analysis, particularly the contrasting idea that choice could be more related to either opportunities afforded by careers such as salary, or students' personal interests.

The questionnaire evoked a range of possible factors that could influence students' choices, and here some differences between stakeholders emerged. Family influences were highly rated in the UK and Finland, and given the relatively low involvement of parents in the project this finding should provide an indicator of how to understand choice more deeply. In contrast, in Cyprus and Estonia economic influences were more prominent in stakeholders' views regarding choice, these were less highly rated in Germany. Finally, suggestions about ways in which students' could become more aware of and interested in science-related careers were wide-

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ranging and could be a useful source for action when more detailed analysis of stakeholder and student data emerges as the project progresses.

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Appendix 1

Views about science related careers

Are you a guardian/teacher/industry representative/third sector actor/scientist/administrator/ policy maker?

1. How interested students are in pursuing a career related to science?
2. In your experience, what are the most common science career paths that students show interest in?
3. What do you perceive to be important factors that could influence students selecting to pursue a science/technology related career? (answer high, medium, low)

a. Intrinsic motivation to study science/technology.
b. Financial prospects from embarking on science/technology.
c. Excitement about discoveries/innovations.
d. Pressure from parents.
e. Socio-economic background of the family.
f. Activities organized by the family (e.g., science excursions, visits to science museums/centres, science fairs/events, science competitions, science-based films/books etc.).
g. Difficulty of science-related subjects.
h. Students' performance in science.
i. Science teacher.

4. Do you think that conventional science teaching is likely to help students appreciate what is involved in science-related careers?
5. To what extent does the school provide students information to appreciate the various disciplines involved in science/technology-related careers?
6. If the school provided work experience and direct contact with people working in a particular industry, would you consider this as a useful method to provide information about career pathways?
7. Can you think of possible, even non-mainstream, activities that could be incorporated in schools to increase the likelihood that students make informed career choices (especially careers related to science and technology)?

Thank you!

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Appendix 2

Interview protocol for guiding the discussion that will unfold during the focus groups or individuals with the stakeholders.

I. Introductory questions about science-related careers.

1. Which careers do you consider as scientific?
   Which of the following careers are related to science and technology?
   Chemist, forest engineering, energy engineering, grid mechanics, car mechanics, air traffic controller, pharmacist, software designer, galvanician, master builder, geneticist, agronomist, pathologist, physiotherapist, microbiologist, Physics teacher, nurse, optician, production designer (in food industry), farmer, meteorologist, horticulturalist, zoologist, mechatronics mechanics
   Which other careers you could mention that relate to science?
   Which could be future science related careers?
   Which of the following could be science related careers in future?
   home's system designer, airship engineering, energy architect, microbe painter, vertical cultivator, well-being therapist, memory's enlarging surgeon, translator of climate change, eco police, handler of waste information, waste designer, humanizer
   Which other future science related careers could you mention?

2. In your opinion, what knowledge and skills are required in scientific careers?
   Which of the following knowledge and skills are needed in scientific careers? Why?
   Creativity, critical thinking, problem solving skill, decision making skill, learning to learn skill, communication skills, collaboration skills, information literacy, information- and communication skills, culture awareness
   Which knowledge and skills are needed in future in scientific fields?

3. Which issues increase attractiveness of scientific careers?
   How following issues impact attractiveness of scientific careers?
   job possibilities, salary level, possibility to make research, laboratory work, traveling, examinations, time consuming, challenging etc.

II. Factors influencing students in pursuing science-related careers (student characteristics, role of family and school).

4. To what extent do you believe that a majority of students could indeed become interested in pursuing a career in science?

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5. In your experience, what are the most common science career paths that students show interest in? Why?
   In future, what careers are students interested in? Why?
   Which factors influence students choices of scientific and technological fields?

The following areas are discussed at some point:

a. Intrinsic motivation to study science/technology
b. Financial prospects from embarking on science/technology
c. Excitement about discoveries/innovations
d. Pressure from parents
e. Socio-economic background of the family
f. Activities organized by the family (e.g., science excursions, visits to science museums/centres, science fairs/events, science competitions, science-based films/books etc.)
g. Difficulty of science-related subjects as a major factor in discouraging students from choosing to study such subjects
h. Students' performance in science class or a particular science teacher might be a significant predictor of their selection to pursue a science

III. Science-related careers and school.

6. Do you think that conventional science teaching is likely to help students appreciate what is involved in science-related careers?
7. To what extent does the school provide students adequate information to appreciate the various disciplines involved in science/technology-related careers?
   How school could influence students' career choices in scientific fields?
8. Wat kind of collaboration between school and working life could promote students awareness of scientific and technological career possibilities?

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Appendix 3

		UCY	UBO	UT	UCL	UEF
I. Stakeholders' views of science-related careers with regards to knowledge and skills required	quote 1	Physics Inspector and former teacher: "Everybody should start from mathematics which is the basis. All sciences and science related jobs based on mathematics. Then, of course, physics, chemistry and biology are important as well. […] For example, 'engineering' has not only to do with engines. In order to make an engine work, you need to know the law of thermodynamics, energy transfer etc. so you also need to know physics. Synthesis of knowledge from different disciplines/domains is important; many societal problems cannot be solved by exploiting knowledge merely from one science. There is a need to combine knowledge from different sciences".	Representative from "Bonn Science Shop" (promising careers): "There is no such thing like the "typical" science job. We analysed the labour market through current employment advertisements and identified some jobs which could be seen as promising careers for the future because of their high demand on the employment market: electro technician, plant mechanic and chemical laboratory assistant. Moreover, the GIS-specialist stands out as a very strong requested career in science, as well as careers in the field of ICT and nutrition in general."	Scientist: Science-related careers require good scientific (or specific) knowledge, research skills, patience, perseverance, communication skills.	Teacher: "Ability to use specialist equipment; problem-solving; ICT; communication; stats; critical thinking; evaluating; analytical skills; writing skills".	Representative of Ministry of Education and Culture: The basis is, of course strong content and methodological knowledge. […] In addition, also learning to learn and problem solving skills, skills to manage information and search information, good language skills also, because these fields are very international. Is it knowledge or skills but ethical and moral attitudes. Further, depending on the task, different communication and interaction skills. I think that the skills related to internalisation will be important in the labour market, therefore language and culture awareness and knowledge, also interaction and collaboration skills because the working environments will change to be ever various… if we think the current big problems, critical and ethical thinking are needed.

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	quote 2	Biology teacher and teacher trainer at Pedagogical Institute: "I think the most important skills for all jobs include high-order thinking skills, collaborative and intercommunication skills. There are companies abroad that help new employees to acquire these skills in order to be able to communicate their knowledge".	Representative from "Bonn Science Shop (knowledge and skills): "We experienced that the most important skills are communication skills, creativity, flexibility, team working skills including intercultural competence and scientific and technical knowledge."	Physics teacher: Science related careers require mathematical skills and critical thinking skills.	Scientist: "Research skills (qualitative, quantitative, analysis skills); Knowledge of where scientists sit in society; persuasive and influential (knowing to present an argument); introverted and focused, happy to work on your own".	*Member of Parliament*: Understanding basics of physics and its application possibilities, and laws of nature and their use. Then it comes in my mind pure mathematics, […] programming and understanding teleinformatic coding and similar. […] also understanding human physiology, because of medicine industry and development of medicine technology, understanding the function of human being is needed […] metabolism processes, how to go through cells and others. Then certainly interaction skills are needed in all fields.
	quote 3	President of Parents' Association in Nicosia: "I'm not sure whether our educational system helps the students to develop the skills mentioned here".	Parent: "High identification with the career and the specific tasks and requirements are very important."	Chemistry teacher: Communication skills, planning skills, collaboration skills and skills for practical work. Basic science knowledge is also needed.		Industry representatives: Communication skills, skills to envisage the view is in future and be able to see difficulties as challenges not as barriers. Technology develops so quickly that skills to benefit and apply technology. To connect things and make conclusions based on information from different sources; analyse knowledge and think critically; media criticism. Culture awareness, interaction and global action, flexibility and working time when living in different time zone. In principle, you interact whole time with everybody.

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	quote 4			Biology teacher: Science knowledge, mathematical knowledge and skills, skills to observe, argumentation skills.		*Representative of NGO*: I think creativity, it will be useful. That one can view the thing from new viewpoint. And then critical thinking certainly, […] problem solving, ICT skills, interaction skills, information literacy. [Another] Logical thinking, skill to organise, decision making skill, communication skill, language skills, conceptualising large entities, learning to learn skills, lateral thinking.
						Scientists: Persistence, diligence, precision, team working skills, logical thinking, curiosity, interaction skills, language skills, communication skills. In future, benefit social media, all new technology, and collaboration skills.
II. Stakeholders' views of students' career choices and interest in pursuing science-related careers.	quote 1	Mathematics Inspector and former teacher: "Students don't know much about modern science related careers. They only gain information from their experiences i.e. they listen about natural gas and they might question themselves who is the expert in this area". […] "Students choose subjects such as mathematics, physics and economics because with this choice they can apply for more positions at the university".	Representative from "Bonn Science Shop": "Jobs are chosen more often when they have a high popularity. Especially, if people have an idea of what it means to work in such a career."	Scientist: Students are not actually aware, which careers could be considered as science related careers. However, with todays' technology it should not be too difficult to introduce those careers to students if needed.	Scientist: (the majority of students is not interested in pursuing a career related to science) "no (not interested in pursuing a career related to science), but maybe only in the narrow sense of the term *scientific career*".	

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	quote 2	Career counsellor at Ministry of Education: "From my experience, students of grade 9 start questioning themselves about career choices. Those students are self-conscious and aware of what they would like to study. This depends on their family environment, their stimuli; whether their family prompts them to take the initiate and look for information. However, there are students who might know one or two professions and decide to pursue that direction. In grade 9 some students conduct an in depth research whereas some others are close to graduation and still don't know what career to pursue".	Representative from "Bonn Science Shop": "Careers are more interesting for both genders if they are application-oriented."	Science teacher: The minority of students is interested in science related careers. However, in my opinion students in higher grades are more interested in science related careers compared to students in lower grades. Students could be interested in choosing science related career because they associate those with high incomes and good opportunities to find a job.	Teacher: No, but would say a fairly high proportion one	*Industry representatives*: The first idea is that interest is nowadays inadequate towards traditional science. Maybe not now but… Interest is low, things could be better. […] Interest is in programming in game world or whatever similar, it interests. […] Media gives information that there are millionaires, it is the salary question. In some way, I think that when current young people is in our age, the value word is different for example in environmental issues. […] those fields where one can impact to reduce climate change, these fields will interest young people. Freedom to work, way to work, fields which can offer new, it interests…
	quote 3	Biology teacher and teacher trainer at Pedagogical Institute: "The average number of students knows vaguely some professions. When they hear about professions related to science, they think that such jobs are very difficult and have a lot of work. Nowadays, young people tend to avoid hard work. Hence, if we exclude last year where the majority of students chose physics and mathematics, they	Scientist: "Science is often associated with a negative image of scientists (being nerds, always working alone in labs), such images are difficult to overcome."	Chemistry teacher: In my opinion, majority of the students are not interested in science related careers. In fact, only few students in this age know, what kind of profession in the future they would like to have. At the same time, if students has decided that he or she is interested in medicine, then usually they are motivated to learn science.	Teacher: " This depends on the access/attainment/aspiration the students has, the amount of culture/social capital, options left open" (...) This affects the perception/mindset of science careers".	Representative of NGO: Awareness is not good. They do not know what the working tasks are. [Another] I think that biology for example interests but physics, chemistry only those who are good in them but not largely.

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		usually choose to pursue easier directions in order to get a higher GPA".				
	quote 4	President of Parents' Association of Nicosia: "Students are not mature enough to decide for their career choice". "Possibly the teaching approach could be a reason for not being aware of professions. Maybe the curricula need to be revised".		Biology teacher: Students are interested in science related careers if they can experience something practical in their classroom activities in science classes.	Scientist: "Relevant to everyone presumably (e.g. scientific elements in music, sport, history - it feels like there would be a side of science in everything!). It doesn´t mean this transfer to careers. When at school I thought it was irrelevant at the time. It was worksheety and methodical".	Counsellors: In my opinion, they do not like in lower secondary school, no student has said that he/she likes. [Another] Many of my students apply to the STEM class, so there are interested students.
III. Possible factors that could influence (either impede or enhance) students in pursuing science-related careers:	Intrinsic motivation	Design & Technology teacher and teacher trainer in Pedagogical Institute: "Some students choose to study what they love the most".		Scientist: Students are more interested in science-related careers if they have some level of motivation to learn science subjects, they know the salary in different science-related jobs and how good their science teacher was.	Teacher: "Wanting to help people"	Industry representatives: It is so that I have had intrinsic motivation, I have been in some way interested. [Another] Sure it has been intrinsic interest which has guided. […] If we think how people become interested in science and how young people interest in science, we need to think how to awake intrinsic interest. How it arises? With many students,

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						it can be increased through education.
		Physics Inspector and former teacher: "Students' high interest in combination with positive feelings of achievement influences students' career decisions".			Teacher: "If someone gets a job in science it will benefit them and society, which some students recognize"	*Counsellors*: Interest is the most important thing. In everything, it is like a spark coming inside, it is most important. The continuum, from kindergarten children inquiry everything naturally, they ponder and ask nice questions […] it should be kept
		Physics teacher and teacher trainer in Pedagogical Institute: "In Cyprus, for example, if someone chooses to study physics, he knows that one employment opportunity is to be a physics teacher at school. He also knows that there aren't many industries here to work as a physicist; however, he chooses to study physics because he likes physics."				*Representative of Ministry of Education and Culture*: …if one recognizes, that this is what interests me, what I then need as background knowledge

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	Employment opportunities/Financial prospects from embarking on science/technology	Mathematics Inspector and former teacher: "Students think two things: job replacement and how Cyprus can contribute in this. Thus, the level of career awareness and the future perspectives of their career choice influence their decisions".		Scientist: Students are more interested in science-related careers if they know the possibilities to find a job and they know the salary in different science-related jobs and how good their science teacher was.	Teacher: "A level Chemists feel that chemistry opens up "a lot" of varied careers - paying good money! - not just medicine and dentistry"	Representative of Ministry of Education and Culture: Employment probably, certainly the increase of the fields internationally, maybe has an impact on the salary level.
		Career counsellor at Ministry of Education: "According to psychometric tools given to students, salary is one of the career parameters that assess their work motivation. Most of the times, students report that this is the least most important factor in choosing a profession.			Teacher: "They consider them to be well paid"	Industry representative: Now when we are living economically difficult times, I feel that the employment possibilities are in young people's head. And when there are no financial concerns, when we have good economic situation and all have work, then it does not guide so much.
	Excitement about discoveries/innovations	Career counsellor at Ministry of Education: "Students who get excited when it comes to innovations and scientific research are usually children that are different from the rest and might feel the pressure from their fellow students and go with the flow, ignoring their interests, while few will sustain their special interests. This has to do with teenager's psychology at this age. Unfortunately, diversity in Cyprus is not favoured".	Parent: "Science becomes interesting for young people when it is placed in the context of society and the human body (especially interesting for girls) or when the research aspect and the adventure is stressed (especially interesting for boys)"			Representative of Ministry of Education and Culture: [Attractiveness] (…) possibility to do oneself. The possibility to experiment, the possibility to find different interesting problems in everyday life and find solutions. Through doing and own observations, through the fun of discoveries and finding. […] one is interested in working with future problems and big issues.

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	Contribution to scientific research	Physics Inspector and former teacher: "If we are talking about 13-14 year-old students, at this age they don't know much about scientific research, although there is an effort to teach the students how researchers work".		Science teacher: Possibility to do scientific research. In basic school, students are not aware what scientific research actually means.		
	Work overload and pressure	Biology teacher and teacher trainer at Pedagogical Institute: "Many students say that they will not choose to study medicine because they will spend many years at the university". "The average student wants to have very good grades and finish school but without putting any effort and then find a great job with a high income but again effortlessly".		Science teacher: In my opinion, students are not aware, what is scientist workload, how much work they have to do and the pressure they have in their work.		Representative of Ministry of Education and Culture: If the challenge is interpreted in a way that it is something very difficult […] Time consuming, experimental work is time consuming, it is the nature of science […] in a way if we think the challenge and time consuming, ok, it is in these sciences, you can do nothing with that
		Career counsellor at Ministry of Education: "Students link workload in a job to the workload in their school courses. This happen particular in grade 10 when students have to choose major courses".				Industry representative: …I am not sure what is difficult and what not […] everything is ok when one applies him/herself in it

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	Student's gender	Biology teacher and teacher trainer at Pedagogical Institute: "I think gender is not an influencing factor now. The personal identity is".	Representative from "Bonn Science Shop": "Girls often pick jobs in a smaller range of careers even if they have much more options because of their good grades. Moreover, girls often choose careers that they consider as family friendly - but often such jobs are not really family friendly in practice, like nurse for example. We should communicate advantages (of science careers) more strongly."			Representative of NGO: I would claim that young people at least boys may think more the engineering education than the field
		Physics Inspector and former teacher: "Boys tend to choose engineering, I don't know why but I think gender plays a role. However, we have many girls who choose to study medicine. (…) Compared to other countries there many girls who choose to study science nowadays". "Nevertheless, when I was a teacher, girls used to stay out from lab work, they didn't want to participate compared to boys".	Teacher: "Nature and environment in the title/name of a career seems to be interesting for girls"; careers with a reference to environment and society			
		Technology teacher and teacher trainer in Pedagogical Institute: "In my class, although girls seem to perform much better than boys; in the way they work and handle machines; few will choose to pursue a career in technology".				

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	Pressure from parents/family on students' career choices	President of Parents' Association in Nicosia: "There is a consensus that family plays a vital role when it comes to students' career choices (…) now with the new system [not choosing school subjects but domains e.g. economics, classic studies, sciences etc.] the majority of students chose sciences because of their parents' pressure".	Scientist: "I don't think that the parents push them in direction of science studies."	Biology teacher: Science related activities with family could also influence students interest towards science related careers.		Representative of Ministry of Education and Culture: Nowadays the mates influence most in particular age than home […] Parents are no more enough in influence.
		Career counsellor at Ministry of Education: "We usually hear parents saying that studying medicine takes many years and they don't recommend it for girls".				Policy maker: If there has been in the circle of acquaintance some adult who is a good example or maybe has used time to discuss these issues with the child or young people. […] And in some way, it is one of the challenges how to assure those young people who do not have in their circle of acquaintances any representative of scientific fields, no one in the family.

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	Teacher's role/teaching approach/education system	Biology teacher and teacher trainer at Pedagogical Institute: "In low secondary school, particularly in grades 7 and 8, teacher's role determines students' career decisions. He/she could even influence parents if he/she does a good job". "There is an issue with teacher's perspective and teaching approach. For instance, the new curricula in Biology for grade 7 introduce some doctor specialists as part of a script in the teaching unit of human body. Almost all teachers felt that this activity might be excluded from the curriculum because it's not useful. They said that teacher's mission is not to teach students this kind of knowledge."	Teacher: "The performance in science class is related to the experience of self-efficacy which is very important for the choice of a scientific career, if the pupils are confident enough in learning and doing science in school the probability of choosing a career in this field is higher."	Chemistry teacher: Science subjects' teachers are important for creating the career awareness among the students. Science teacher is the one who should motivate students to learn science and choose science related career in future. This is for example something that is not covered in science textbooks		Industry representative: …the personal interest of teacher influences. The schools must be aware about the development and current situation.
		Mathematics Inspector and former teacher: "We should be willing to relate our science with other relevant sciences without being afraid to do this". We are hiding behind our little finger and we cannot see the connections between different sciences".	Representative from "Bonn Science Club": "The science teacher can be an important role model – especially related to the pupils' perceptions of their self-efficacy. Teachers who are themselves self-confident in science and communicate scientific knowledge with enthusiasm can have a very positive impact on pupils."	Chemistry teacher: It is also important to recognise, how well students think they can do in science subjects. If something looks difficult, then maybe they are not interested in doing this anymore. And this is also the point students lose their interest towards science subjects.		Scientists: It is the inspiring teacher, it has the crucial role even the methods are good the teacher is not successful if she/he is not inspiring.

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IV. Ways in which the education system/learning community could contribute to problem solving regarding the lack of students' interest about science and science-related careers	quote 1	Design & Technology teacher and teacher trainer in Pedagogical Institute: "In Germany for example, in Design & Technology subject, students make projects in collaboration with industries."	Teacher: "The term "Naturwissenschaften" (German for natural sciences) is a very abstract word for a lot of pupils – it would be useful to show them the relevance and use of science and technology so that young people could imagine better what is behind the abstract terms, maybe by showing exemplary careers (visual and with short and simple texts) to give ideas." "Role models which can come into schools and talk about their daily work in science or in the field of technology, can have a positive impact on negative stereotypes"	Scientist: Everything starts from the teacher and it could be also useful if science related professions are more than today introduced in science classes. Students could also go and visit some industries.	Teacher: "*The doors it can open approach* - use specialists from various fields, that are engaged to promote awareness, trips. *The science behind it approach* - using everyday objects like smartphones and (...) the science behind it"	Representative of Ministry of Education and Culture: Understanding that they [sciences] are the basis of our life. Children and young people should understand that we are speaking about fundamental issues, if we speak about climate or water or food. […] This should be point out more clearly. The possibility to experiment, find different interesting problems in everyday life and solve them […] through doing and observing and discovering
	quote 2	Physics teacher and teacher trainer in Pedagogical Institute: "I would recommend building science museums that relate to science curriculums and interesting topics for students, linked to science careers such as how a crane works […] and realise the application of physics in real life".	Teacher: "Parents should be more involved but it's difficult to reach all of them."	Science teacher: Visits to industry and possibility for students to observe someone's activities in the industry for all day and then make some conclusions from career aspects.	Teacher: "Talks from university students. Projects on STEM topics to develop knowledge and experience.	Policy maker: Environmental education is important […] familiarising with nature and nature phenomena, for example in clubs in schools. Knowledge suitable for the age, own participation and wondering. Work-based learning. It should be told about different skills what is needed in everyday life. And co-operation that awareness on career possibilities raises. It should be done systematically then it is better. Visits; role plays; contexts; godfather (sponsor) school

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	quote 3	Physics Inspector and former teacher: "There is a need to enrich our national curriculum with science applications but this is not enough. Proper teaching and teacher training need to follow up".	Representative from "Bonn Science Shop": "You have to address your target groups specifically (sex, age, type of school,…)." "There is a need of gender-sensitive lessons and mediations in schools."	Chemistry teacher: It could be useful, if people who work in industries come to science classes and introduce their everyday work to students. This could be really interesting for students. Students then have also opportunity to ask from those people what they learned in universities and what kind of knowledge and skills are actually needed to work in this area.	Teacher: "Talks from university students. Projects on STEM topics to develop knowledge and experience."	Representative of NGO: the class should go outside and observe how ice smelts and what happens when there are changes in the nature. Representatives of working life could visit more schools. Sponsor classes. Presenting careers.
	quote 4	President of Parents' Association in Nicosia: "Probably, references to important people in this area might trigger students' interest".	Representative from "Bonn Science Shop": "School subjects are often too far away from careers in science or the technical field – they should be more connected to careers and should show their wide range."	Biology teacher: Collaboration with industry could be useful for raising the career awareness among basic school students.	Teacher: "Careers fairs, visits to industry/university"	Scientists: Group work, collaboration, experiments, doing, thinking, co-operation with stakeholders, work-based learning
	quote 5	Mathematics Inspector and former teacher: "Developing inquiry skills, information literacy skills […] and skills in connecting knowledge from different sciences; for example we could introduce the concept of inversely proportional in mathematics providing an example from physics; try to close the door by pushing in the middle and very close to the edge. Students might not know physics in grade 7, but if I introduce a	Teacher: "Careers should be presented without discrimination – there should be the focus on the pupils' strengths, not on their weaknesses (like: "Because you are all bad in science we want to help you"). Especially girls want to be treated as normal and not be put down by saying: "In general you are not good in this kind of work or knowledge and that's why we have to support you."		Teacher: "Successful professionals sharing their experience with students in school"	

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		science concept in mathematics, he will be ready to welcome the new knowledge about Newtonian mechanics in grade 9". [...]"We should give emphasis on the interdisciplinary approach of the national curriculum". [...] We, educators, have a problem to accept this. We live in a 'micro world' and we say I teach physics not mathematics. It's not like this. We teach science. There must be a link between sciences." [...] "Students choose major subjects at school based on the required school education in order to apply for a position in the faculty of their choice [graduates take entrance university exams]." Universities could expand their range in academic domains – e.g. combined degrees - so that students will get the chance to know the modern science-related jobs".				

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	quote 6	Biology teacher and teacher trainer at Pedagogical Institute: "Teaching the history of science evolution. There was a biology research project in grade 9 where in one class there was an implementation of the history of biology evolution and applications in all teaching units for one whole year compared to the other class who had merely some references to important people but none particular emphasis in biology evolution. Results indicated that students who were taught in first way had significant results in conceptualization and better results in thinking skills, attitudes, and understanding the nature of science. There was an excellent difference compared to the other class".	Representative from "Bonn Science Shop: "Give young people positive feedback – "You are able to do science, you are suitable for those careers, look how interesting careers in science and technology are, have a look inside these fields, have a try, you are welcome".		Teacher and scientist: "Work experience. Guest speakers from a variety of science related careers. We usually get the odd doctor or some very high up people in their field. Maybe have a careers aspect to the curriculum"	

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