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**SESTEM**  
**Supporting Equality in Science Technology and Mathematics**  
**related choices of careers**

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**COMPARATIVE REPORT ON QUALITATIVE STUDIES**

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## SUMMARY

The scope of this comparative report is to present crucial influence factors on STEM-related career choices of girls and women which derived from the results of the qualitative studies (empirical reports in the national context of each partner country) in the context of the SESTEM project. In this report the comparison of the national reports of the research conducted in Germany (UniBwM), Greece (FORTH), Poland (UITM), France (UBO), Spain (UB) and UK (UDUR) will be shown which aim at facilitating the research process and building the basis for the design of the questionnaires for the four target groups of the quantitative studies in each country. Further, aim of the research is to track down similarities and differences between countries and target groups in order to define common indicators that influence the career choices of girls and boys differently in relation to STEM. According to the findings of the qualitative studies with the four target groups a lot of similar aspects could be found: It seems that the social environment which includes parents and teachers has a crucial role in the career decision process of boys and girls in particular regarding STEM studies and careers. However, some country specific differences with respect to the assessment of the importance of pupils' career choice factors could be established after analyzing the qualitative results.

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## 1. Aim of the Comparative Report

This report is developed within the framework of the European project SESTEM and will compare the results of the qualitative studies in each SESTEM partner country (Germany, Greece, France, Poland, Spain, and UK). The four perspectives of pupils, parents, STEM-teachers, and female students in STEM-related subjects will be exposed. The research findings of SESTEM aim at enhancing the gender equality in STEM-related careers and promoting more female pupils to take a STEM-career pathway into account. The report describes the research approach and the four qualitative sub-studies in the national context. Crucial commonalities and differences between the countries will be summarized and discussed. Based on the findings implications for parents, educational institutions, and society will be deducted.

## 2. Research Approach

The methodological approach of SESTEM is divided into two parts: one qualitative and one quantitative part. The qualitative research includes the definition of variables, for the design of four interrelated qualitative studies according to the target groups of pupils (age cohort 14-20), parents, upper secondary teachers, and female university students enrolled in STEM departments in the National contexts of FR, DE, UK, ES, PL and GR under the scope of enhancing understanding into the decision making process and support requirements regarding STEM related career choices. Based on the findings of the qualitative studies the quantitative studies will be defined and will be distributed to the target groups. This empirical research report will draw the main results of the conducted qualitative studies in each of the participating countries and for each of the four target groups.

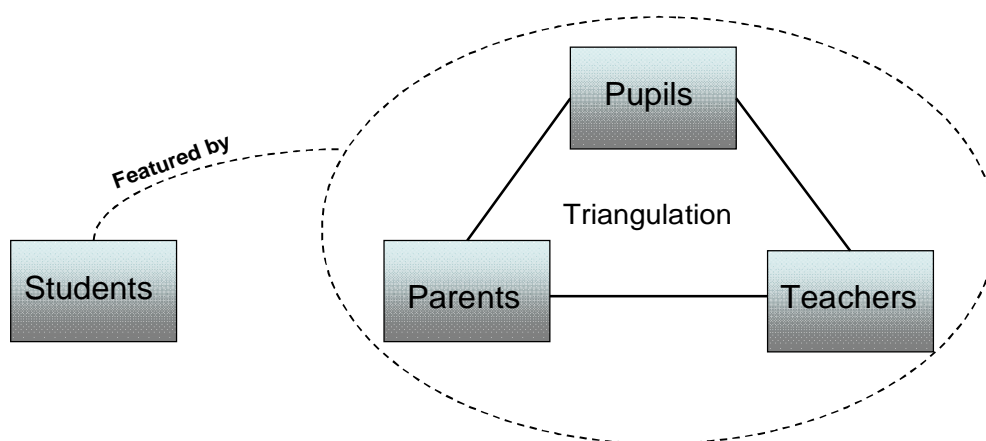


Figure 1. Research Approach of SESTEM

**Research Approach.** In the following, the research paradigm of the studies regarding the project objectives will be shortly presented. Figure 1 shows the research paradigm for the SESTEM project. It is designed by Universität der Bundeswehr München (UniBw) according to the research objectives according to the SESTEM proposal (see SESTEM Lifelong Learning Application Form, 2009). The research paradigm aims at examining the different perspectives of the target groups concerning the reasons and barriers of an uptake of a STEM career; therefore a method triangulation is foreseen that includes a method mix of different qualitative and quantitative studies for pupils, teachers, and

parents. Further, the quantitative studies will be based on the findings of the qualitative studies. According to the results of the literature review the educational biography and the socio-cultural environment (teachers and parents) are important for the career choice of pupils. To get more insights in the career choice process of pupils in particular in those of girls in STEM we will have a closer look beyond the perspectives of teachers and parents as social-cultural environment. Therefore, it is necessary with regard to the triangulation to focus more on the groups of pupils, teachers, and parents to get more insight to the career choice process concerning STEM by pupils. This triangulation means for the qualitative studies that pupils, teachers, and parents will be interviewed on the one hand and pupils and teachers will additionally take part in focus groups discussion on the other hand. The results of the qualitative analysis will be the basis for designing questionnaires for the four target groups with regard to quantitative studies. Further, the triangulation is featured by the forth target group, female students of STEM-subjects. For this target group interviews and the quantitative study will be also conducted.

### 3. Qualitative Studies

#### Description of the sample for the four sub-studies

In this section the sample with regard of the four sub-studies will be illustrated. In preparation of the qualitative studies the SESTEM partners have been contacted personal contact, schools, and institutions of previous projects which might be connected to members of target groups. In addition, interview requests via different regional schools and email distribution list which are related to pupils, parents, teachers in STEM or enrolled female students of STEM-subjects were provided. The table below shows all media which were used for the qualitative study request.

**Table 1. Used media with regard to the participation request for the qualitative study**

Study No.	Media for interview request	Target Groups
1	<ul style="list-style-type: none"> <li>○ Personal contact</li> <li>○ Recommendation of a contact person</li> <li>○ Project Flyer</li> <li>○ Deutsche Gesellschaft für begabte Kinder</li> <li>○ Girls' day</li> </ul>	<i>Female and male pupils</i>
2	<ul style="list-style-type: none"> <li>○ Personal contact</li> <li>○ Recommendation of a contact person</li> <li>○ Project Flyer</li> <li>○ Email-distribution list</li> <li>○ STEM-Initiatives for female pupils</li> </ul>	<i>Parents</i>
3	<ul style="list-style-type: none"> <li>○ Personal contact</li> <li>○ Recommendation of a contact person</li> <li>○ Project Flyer</li> <li>○ Teacher Network at Robert-Bosch FOS</li> <li>○ School contacts</li> </ul>	<i>Teachers of STEM-subjects</i>
4	<ul style="list-style-type: none"> <li>○ Personal contact</li> <li>○ Recommendation of a contact person</li> <li>○ Project Flyer</li> <li>○ Different Student councils in STEM</li> <li>○ Email-distribution list of different universities</li> <li>○ STEM-initiatives for women</li> </ul>	<i>Female Students in STEM</i>

Some minor problems occurred concerning recruiting interviewees of target group of teachers and female students because a lot of teachers had to prepare their school reports for the half-term and students were often also busy on these months because of examinations. Therefore, some of the partners had minor delays with respect to the participation in the studies.

## Main results of the qualitative studies with regard to each country

In the following section the main results of the qualitative studies for each target group (female and male pupils, parents, STEM-teachers, and females STEM-students) of the SESTEM partner countries will be illustrated and compared to each other.

### 3.1 Study 1- Interviews with Pupils

#### Germany

##### Description of the sample

In the following, the main results concerning the qualitative study with female and male pupils will be presented. In this section, the main results of the interviews with female and male pupils of secondary schools will be presented. With regard to the sample, we got 29 pupils from different schools (20 pupils from Fachoberschule (FOS), eight pupils of Gymnasium, one pupil of Realschule) who have been interviewed.

##### Main results and discussion

To sum up, regarding the **individual level** all pupils attend an *upper secondary school*. The results of the interviews with pupils show clearly that most of the pupils want to study after their graduation from school but a lot of them do not know what they will choose as subject. Most of the pupils think that *honesty* is the most important personal *value*. In addition, there are three other values which are meaningful for the interviewed pupils: *reliability, openness, and friendship*. It could be established that the majority of pupils have *no role models* or idols with regard to their career choice. However, some pupils say that their *parents or relatives, who are working in STEM field* e.g. as engineer on a building site, had influence on pupils' interests in STEM. With regard to media influences of TV-series on career choice of pupils it could be established that some *characters of STEM-related media series* or the content of the series were also a topic but have *no influences* on their own career decision. However, some pupils could imagine that STEM-related series might have impact on younger pupils' career choice. Further, it could be revealed regarding factors for career choice that *a joyful job* (first response) is even more important to the interviewees than a *high salary* (second response). With regard to gender differences, having a comfortable work environment as well as security-related factors is more important to girls than to boys. In contrast, boys are more focus on financial aspects like high salary in the first place. Girls also mentioned the salary as career choice factor but this aspect is often secondarily for most of the girls.

With respect to **STEM** careers in general, building an early *interest* for STEM seems to be the *best motivational factor* for a STEM career decision. *Being part of future developments and a high salary* are also popular incentives for choosing STEM among pupils. Asking about necessary *abilities* for STEM, the interviewees name the specific *interest for STEM, logical reasoning, and general scientific understanding* for these subjects. Most of the pupils are supported by their parents in respect of their career choice which the pupils probably will choose in the future. With regard to their preliminary choice of career pathways the major part of the pupils has got the feeling that they could *decide their career pathway by their own*. In addition, most of the friends respect their career decision.

Asking about the **consequences** of a STEM career, pupils think that the biggest *obstacles* are the *tough study in STEM* and the *male-oriented domain* for women. With regard to *facilitators* an *early development of pupils' interest for STEM* as well as *practical teaching methods in STEM* class seem to be very decisive for pupils to taking a STEM career pathway into account.



## France

### Description of the sample

During the interviews, the pupils were asked to describe what had motivated their choice of option, the studies and professions they are considering, their interest in science and technology in general, and the representations they have of jobs and careers in STEM. The sample is composed of different profiles: girls, boys of different ages at different levels (fourth year, fifth form, lower sixth and final year in a lycée); some students are enrolled in science and engineering and others not. This choice of mixing profiles follows a double aim: the first profile allows us to study the factors that can influence the students, and especially the girls, to opt for an orientation and a career in STEM, and with the second profile, which includes students who have not chosen a direction in STEM, we can try to identify factors that hinder the scientific and technical orientation.

### Main results and discussion

The pupils who responded positively to the letter, to the request for an interview, are, for the vast majority, good and good students, who did not repeat, worry-free in a high school, with good grades, accumulating many options such as Latin or being in a European class.

We interviewed young people aged from 15 to 18, we see that for younger children, the future is still unclear, they are struggling to project in a long term, they lack information on pathways that are offered to high school for students in 3<sup>rd</sup>; even for students, and the future post-bac is not yet clearly defined.

We can notice differences in how people perceive gender differences: the speech of younger pupils shows that they are not aware of gender differences, the choice of higher education is not related to gender, but they do not explain differences in tastes and interests between girls and boys. However, when we try to dig, we can see that these taste differences are directly linked to gender. For example, when we asked them to describe jobs and careers in STEM, they used many generic names (researcher, computer scientist, teacher, engineer, surgeon ...), always conjugated in the masculine, no names or adjectives were feminine a world in "masculine" was described.

The girls opt more for scientific studies regarding to the career they wish to pursue; we can note a reverse mechanism for some boys: they are gifted in STEM, so they will find a job related to their capacity STEM. The girls have an idea for a job and will therefore follow the curriculum required to achieve it.

We have discussed about STEM outside the school; we asked pupils if they read scientific magazines or journals or if they watched such television shows. The answers suggest that pupils' interest in science and technology has a weak impact outside their school life and more specifically the school day. Only a few pupils look at the scientific programs, whether girls or boys some cite "c'est pas sorcier" but they watch it from time to time, according to the theme explored. Reading scientific newspapers or articles is even less common; only one pupil says she read when she was younger the magazine "Science et Vie Junior" because her brother was subscribed. When we asked "Why do you think the girls choose less careers in STEM?" many exclaimed: "Ah I don't know!". Regarding the low presence of girls in scientific studies, many boys have no opinion on the matter. We can see that younger respondents are not aware of this issue; the more we advance in age, the more young people give answers. Their explanations are identical to those given for the target groups in general, namely, the girls have other interests ("they are moving more towards the social", "girls are more literary") and studies are difficult (hard work, long studies). Finally, if all believe that all scientific professions may be exercised by men as by women, some qualify their statement: "There are still jobs more for girls and jobs more for boys." It seems logical that girls and boys in scientific option have a greater interest in science compared to pupils who have not chosen a scientific option and also that pupils in scientific option appreciate more their science courses than others. But we find among those two groups the same stereotypes and images

about studies and jobs in STEM (see in the concept mapping). All of them think that girls and boys are similar: for them, it is more a matter of individual than a gender issue ("I do not necessarily see a difference, it depends on the person," "there is no difference; it depends on the nature of the person, his/her tastes).

It is interesting to note that we have discussed with them about the jobs they wanted to do when they were small children. Their answers refer to the issue of sexual image of the trades. For most people, these stereotypes seem natural: "of course". However, these differences have been built one time. But these gender stereotypes significantly influence educational and vocational guidance. Some examples of professions cited by girls and boys:

Trades cited by girls: Veterinary, Nurse, Professor, Air Hostess, Dresser...

Trades cited by boys: Firefighter, Chef, Professor, policeman...

Concerning the disaffection of young people in STEM, we find the same remarks among girls as among boys. Whatever their option (scientific or not), pupils respond overwhelmingly that the studies are too long and too hard. These images are probably derived partly from the fact that pupils, boys and girls, whether they had chosen a scientific option or not, experience some difficulty in citing scientific professions. They do not know the content of the variety of scientific careers to which lead graduate studies in biology, physics or chemistry for example. While having strong ambitions, the girls do mostly school choices that can be described as advisable, wise.

## Greece

### Description of the sample and the methodology

In this section, the main results of the interviews with female and male pupils of secondary schools will be presented. The target group consisted of 50 (23 boys and 27 girls) aged 15-18. The pupils were approached and interviewed through the following means: a group discussion after the end of a school visit in FORTH in one of the conference rooms was arranged where 30 pupils participated from a public school of Heraklion (Gazi Lyceum) on March 31, 2011. As the number of pupils that participated was high, we decided to use the Lyceum of Gazi as a case study. Eight more pupils were interviewed in person via personal contact and arrangement with their parents, studying in a private school (Pagkriton) and at least 9 more were interviewed through facebook (posting questions in relevant groups and receiving answers).

### Main results and discussion

Pupils in this stage of their life they seem less aware of gender differences that influence career choices more confident on their choices and they do not believe they are greatly influenced by other factors, such as family pressure or role models. The only exception was the widely reported belief that charismatic teachers can inspire them to follow one field or another. In their majority, pupils stated that they do not believe girls have less ability than boys to follow a career in STEM; however, most held stereotypical beliefs on the different roles of men and women, stating that girls might be as capable as men in STEM but they prefer other fields because it is closer to their 'nature' and aspires for the future. Pupils coming from the lower classes stated more openly their stereotypical beliefs about gender differences and concerns over the economic crisis, while students from the upper classes (mainly those studying in the private school) seemed like they lived in a different reality where they feel confident to study whatever they like without major obstacles.

## Poland

### Description of the sample

The qualitative research was conducted with focus group interview. The aim of this research technique was to recognize what are usually unconscious motives, views and opinions. Interviews were carried out according to the scenario developed for the study of problem-depth with a sequence of issues raised. Interviews were done

in groups and consisted of discussions on topics proposed by the moderator with complete freedom for participants to engage and introduce their own interests. All interviews were completed in Rzeszow, with deliberately selected pupil representatives. The only condition was that pupils were studying in the scientific or technological modules.

The research participants were pupils (13 girls and 4 boys) of the 3<sup>rd</sup> class of a 4-year technical school, specialization: technology analyst. It is a co-educational school. Graduates have the opportunity to work in analytical or medical laboratories, or in the chemical or pharmaceutical industry.

Name of school: Tadeusz Ryłski Food and Nutrition School Complex in Rzeszów (Zespół Szkół Spożywczych, im. dra Tadeusza Ryłskiego, address: Poland, Warszawska 20, 35-200 Rzeszów).

School results of students participating in the research were diversified.

**Focus group duration:** about 60 minutes

**Location:** Research was conducted in Rzeszów.

**Group size:** 17 pupils

Research was conducted in May 2011.

### **Main results and discussion**

Focus groups with pupils revealed that the future is unclear for them. They have many doubts, a clear disbelief in their own abilities and for that reason they do not plan their future because they are not sure if they will be able to handle the tasks. Apart from one boy who plans to study chemistry, and is confident in his abilities other people use the phrase 'I'll go to the university if I can/if I succeed ... ' A lot of them do not know if they will manage to "survive" at university. STEM studies are perceived by pupils as very difficult and intellectually demanding, but graduation is a great opportunity to get a high salary. They all stressed the importance of seeing and talking with professionals who have graduated STEM studies. Pupils desire examples of concrete, real life.

## Spain

### Description of the sample and methodology

We reached a total of 34 student responses:

- 14 in IES Emperador Carles (public )
- 12 in PROA school (subsidized )
- 8 in IES Eugeni d`Ors (public funding).

For both interviews and focus groups, we ensured the gender parity of respondents. Pupils were selected randomly by the coordinator of each school. The only condition was that they were studying in the scientific or technological modules. The qualitative research was based on a semi-structured conversation: pupils were guided by some questions but were also free to relate their experiences spontaneously. The result was a very positive ambience during the interviews.

### Main results and discussion

Models and cultural patterns are present: there still is a certain traditional vision of careers. Pupils don't know about new occupations and specializations that current careers offer. Contact of secondary pupils with the university and the workplace are missing: practice, outings, and talks are needed.

Pupils should know how the STEM world develops at the practical level of work. More information and communication is needed to go against stereotypes. The STEM world is more positioned, has more prestige than other fields, and, yet, it is seen to be more difficult and competitive, since these careers have better prospects and high salaries, more utility and insured future. Teachers have an essential role in this educational level: they can encourage or discourage pupils depending on their way of teaching. In relation with gender, pupils don't observe direct gender obstacles (maybe it is because they don't yet have contact with the work environment. They can't imagine their professional future). STEM abilities are common for each gender, but in general, girls tend to choose biological or health studies, because they like the contact with people and nature, to help others. When pupils were asked if this was due to cultural or genetic factors, the responses of both girls and boys were divided equally between the two choices. STEM world is not observed as more "masculine" by pupils. However, they recognize that in technology and physics there are many more boys than girls. In biology and chemistry it is the opposite with more girls than boys

In many cases, gender differences are observed as something of the past with no relevance for the current society.

## UK

### Description of the sample and methodology

The sample has a mixed composition: in all, 13 girls and 2 boys took part. Ages ranged between 15 and 19 years. All attended public secondary schools; some are following STEM subject courses and others are not. This sample allows us to study the factors that can influence the pupils (especially the girls), to opt for an orientation and a career in STEM, and also (by including students who have not chosen courses in STEM), we can try to identify factors that hinder a scientific and technical orientation.

During the interviews, the pupils responded to draft forms of questionnaires on a wide range of issues related to STEM and careers in STEM, and were asked to expand on the limited responses which a questionnaire can elicit. They were asked to describe what had motivated their choice of options at different stages, the courses and professions they are considering, their interest in science and technology in general, and the views they have of jobs and careers in STEM areas.

## Main results and discussion

Most of the pupils interviewed want to continue to study at university after they finish school, and many of them know at least what broad area they will study. However, choosing a course with good job related prospects is an increasing consideration for pupils in the light of the greatly increased debt students are likely to incur by attending university.

Many pupils expressed a desire for an intellectually challenging job, and for an enjoyable career where they can make a difference. Generally, money was not the primary objective or motivation, but job security was a consideration for many. There was no consistent pattern of pupils following established family traditions in relation to working in STEM areas, or indeed in any other area. It appears commonplace that pupils have very little idea of what most jobs and careers actually entail as their core activities (with the exception of teaching) and as a consequence, the role of work experience in shaping the direction pupils take is very important. Media influences appear modest overall; advertising and talent and ‘reality’ programmes were seen to reflect and reinforce gender stereotypes, and character parts in TV, books or movies judged to have a very minor effect on career choice.

Pupils generally feel they have made subject choices and career choices for themselves, with support from parents rather than pressure, and without significant peer pressure being brought to bear. Schools’ careers advice appears quite variable with some having fairly formal structures in place and others being more a case of being available on demand, placing the onus on pupils to seek guidance where needed. Schools generally seem to view STEM subjects as suiting bright pupils; there is some evidence of gender bias in expectations of the school as to the type of STEM boys and girls would gravitate towards. Where school uptake of STEM subjects has a relatively low gender imbalance, the perception of pupils with regards to STEM abilities and interests appears to have lower gender differences.

There were rather few negative stereotypes about STEM. However, pupils thought that STEM work environments are masculine and that girls could become isolated working in STEM jobs; that some STEM job environments are dirty; that the working day in STEM is long, and that STEM careers are hard to combine with family life. Since the general impression is that pupils are very insecure in their understanding of what most jobs and careers actually involve, it may well be that some of these negative perceptions of STEM careers could be reduced by promoting a greater understanding of the work involved in various specific careers in STEM.

## Focus groups with pupils

The qualitative research activities with pupils includes besides interview also focus group discussions. The results of the focus groups were reported by the method of Concept Mapping (see Analytical Framework SESTEM). Some of the partners had use the Concept mapping during the interview session and others divided the research into interviews and focus groups (e.g. Germany, France, and UK). In the following section the results of the focus groups with pupils of two national cases (Germany and France) will be illustrated. This method is useful to cluster the attitudes and opinions of different groups. Thus examples of attitudes regarding “women in STEM fields” were visualized (see figure 2).

### Germany

#### Description of the sample

The Universität der Bundeswehr participated in the program of the national “Girls’ Day” on 14<sup>th</sup> of April 2011 which aims at enhancing girls’ interest for STEM subjects and career pathways. In total, 44 female pupils from different Gymnasien that are located in Munich have been involved in the Workshop “Concept Mapping

and reflection of STEM careers” for girls. The female pupils are in the age of 14 to 16. All of them attended to the Concept Mapping workshop which was developed under the scope of gender reflexion about STEM career pathway in particular STEM-related studies.

After a short introduction about the Concept Mapping method as learning strategy and structuring aid, the 44 girls built nine groups and reflected about the question “*Why should women pursue an academic study in STEM subjects?*” (yellow). Thereby, they generated a lot of concepts why women should study STEM (green) and why they will not study in these fields (red). Further, they cluster the concepts which belong together to a neutral category of concepts (blue). The arrows (or lines) illustrate the relation between to concepts and the thickness of the arrows defines the intensity of the relation that means the thicker the more intense. Moreover, dash lines could be use in order to show interactions in terms of relations between the concepts. For more details about the method of Concept Mapping see the Analytical Framework SESTEM (2010). All in all, the female pupils find various positive and negative aspects for girls in STEM study. A reflexion session by presenting two Concept Maps by the responsible groups in front of the other girls in the end of the workshop gives the girls the opportunities to think about gender stereotypes in STEM. After the Concept Mapping workshop and some of the girls might take a career choice or study in STEM into account.

### **Main results and discussion**

In the following, the results of the focus groups based on the all nine groups and their Concept Maps will be shown. For this report only the Concept Map of one group could be taken into account and will be described as an exemplary guide how to apply the Concept Mapping method.

In the following, the procedure of the Concept mapping will be shown. First of all, the girls collected positive and negative concepts which are relevant to the question “*Why should women pursue an academic study in STEM subjects?*” and write them down. They clustered the positive and negative concepts in four neutral categories which structured the different concepts (see figure 2): Academic study, family, reputation, and future. The category “Academic study” is related to “education” as well as to “often too sophisticated subjects”. The category “family” could be divided into two negative (lack of time and financial problems) and one positive concept (future for children), that means choosing a STEM study could provide on the one hand financial problems and lack of time during the study for the family, and one the other hand pupils see a good future for children by choosing STEM. The category “reputation” is divided into two positive (“esteem” and “not a day-to-day phenomenon”) and two negative concepts (“stereotypes” and “oppression”). According to the girls a high esteem could be achieved by a STEM study which is not a usual study subject for them but they consider also the stereotypes in STEM and perceived an oppression of women in these fields. The category “future” is divided into “gender-related problem upon applying for employment” on the one hand, and “employment opportunities” which is again linked to remuneration and education on the other hand that is also linked to the category “Academic study”. With regard to this category, the girls receive gender-related problems concerning the applying process for a job but they are also aware of the high employment opportunities and salary in STEM.



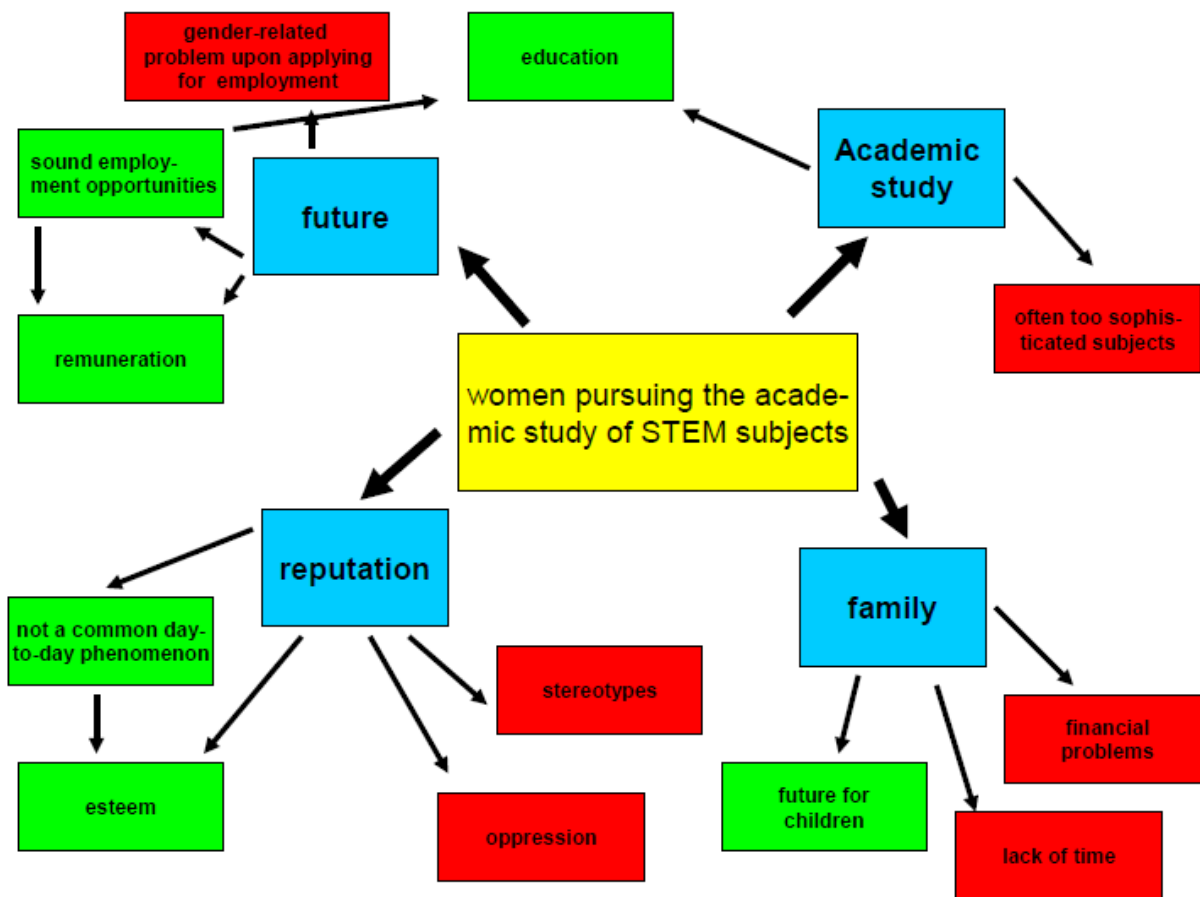


Figure 2: Concept map by German pupils

## France

### Description of the sample and methodology

Finally, the sample was smaller than expected: on 60 pupils interviewed, we had only 22 respondents in the city school Kerichen, hence our motivation to go and seek another facility. We chose to work in this second time with the city school Jean Moulin in Châteaulin. This choice was not random; this city is located between Brest and Quimper, a specific geographical location, characterized by a low mobility, and for the parents, more often a middle class or working class background. 30 of interviews have been conducted concept maps. The results of one example will be shown below (see figure 3).

### Main results and discussion

For pupils, concept maps have been made during the group interviews, girls and boys together. The girls found again more concepts than boys, they seemed to feel easier to identify with their own sex and easier to project themselves as women in STEM. The boys had more difficulties to find concepts, but many pupils (boys and girls) had no answers to give, as if, as mentioned above, the habit of coeducation had given them a representation of a universal education and knowledge, undifferentiated, with the idea that gender equality is obvious and yet realized.

Overall, in school and high school, we can note common points between girls and boys. They have the same perception and knowledge of technical and scientific professions and jobs in STEM; from a group to another, the same jobs are cited (chemist, engineer, scientist, physician, doctor, researcher ...) as if the mentioned occupations were directly related to disciplines taught in school. Science = scientist, physics = physicist, chemistry = chemist ... they have some difficulties to include other professions, they say: “we do not know

much about the professional STEM”. So we can already note, as a first result, that there is a lack of information about careers in science and technology. The pictures they have about professions are very narrow and abstract, so that it is difficult for them to identify themselves concretely to them.

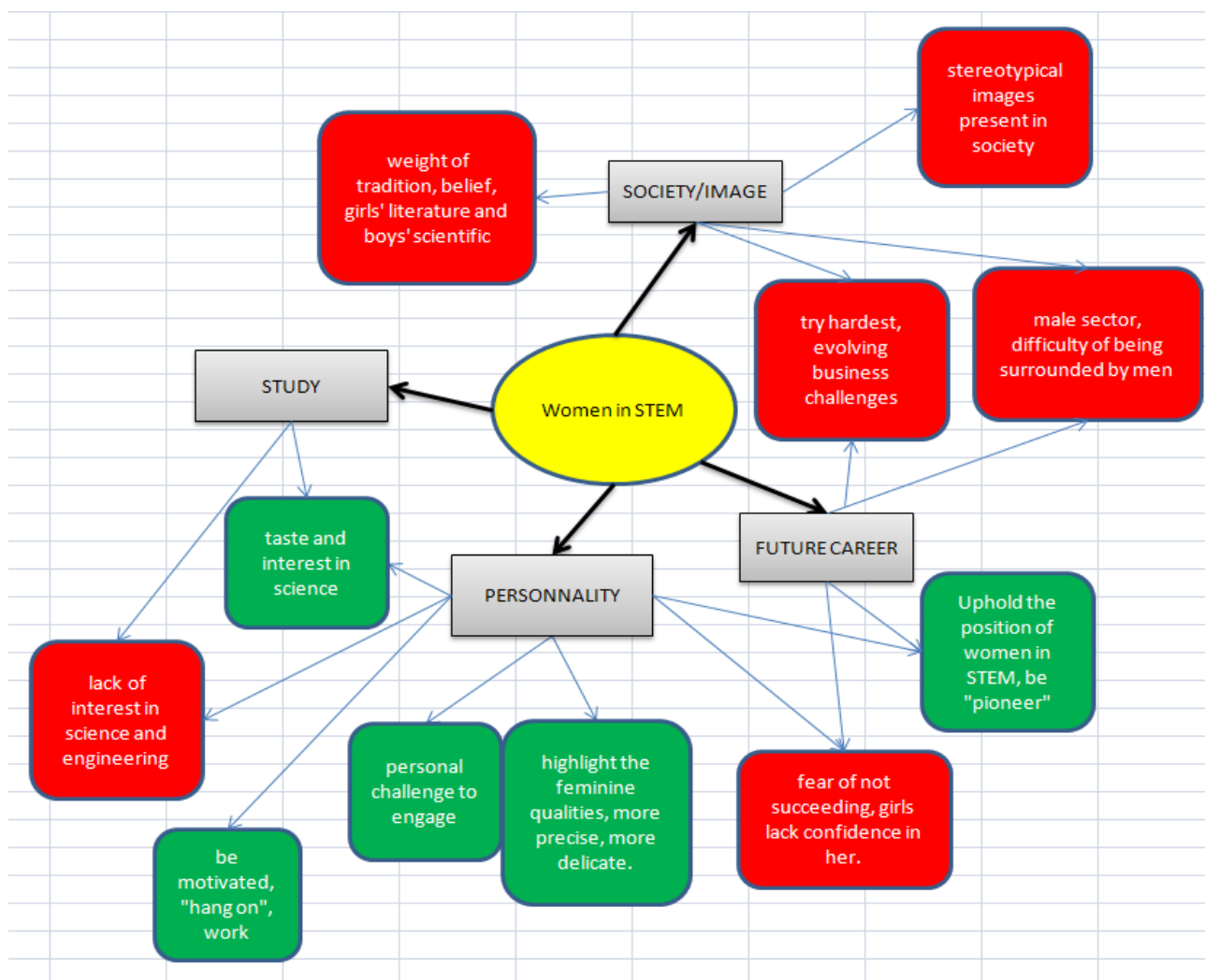


Figure 3. Concept map by French pupils

### Greece

On March 31, 2011, a focus group discussion was organized where 30 pupils (17 girls, 13 boys) participated from a public school of Heraklion (Gazi Lyceum). The focus group discussion lasted about 40 minutes and was part of a school visit in FORTH. The pupils gathered in a conference room and were engaged in a discussion initiated with questions set by the researchers. The first session (individual dimension) included questions such as ‘what is the profession of your parents’, ‘when did you first realize what you want to study’, ‘what is important in your life’, etc. The second session (STEM dimension) included questions such as ‘why would you study STEM’, ‘what kind of abilities a person needs to study STEM’, ‘how do you view the working environment in STEM fields’, etc. The final session (consequences dimension) included questions such as ‘do you think it’s more difficult for girls to follow a STEM career and why’, and ‘what would motivate you to study STEM’. All the questions aimed at opening a debate and discussion between the pupils and subquestions often araised.

### Main results of the focus groups with pupils



The majority of the pupils came from middle and working class families, as revealed by the professions of their parents. Out of the 30 pupils only one had a parent working in a STEM related field. All pupils agreed that they value free choice and taking pleasure from one's employment; however, they also claimed that the crisis intervenes with their initial aspires and dreams. Most students knew what they wanted to study relatively early, during the first years of junior high school. They chose their field of study based on what they really liked and they also considered which professions would have more job prospects.

The results revealed that there are many stereotypes on women in STEM held mainly by boys. Some openly expressed the opinion that women do not have a practical mind and should follow careers that are closer to their 'nature'. They also claimed that women would not have their career as a priority because of the family and STEM fields should only be followed by people who 'take their career seriously'. Although the girls opposed these opinions, throughout the discussion they also presented the same stereotypical view that women are better in other fields 'by nature'. It is interesting to note that almost half of the students (girls and boys) were following a STEM direction in school but only three of the girls was seriously considering following a STEM career (in informatics). Only two boys were considering following a theoretical direction of study (one wanted to study sociology and one tourist business administration). When the girls who stated they do not wish to follow a career in STEM even though they chose a STEM direction in school were asked the reasons why, they claimed that its just a personal choice and that they are more interested in other fields such as education. They also stated that having free time and a work/life balance was important to them. Most pupils argued that they are not influenced by their parents on their career choice and that their parents are not trying to direct them to any specific field of study. However, most also claimed that sometimes teachers constitute an inspirational force on the pupils and that their support can really make a difference. Pupils could not identify specific obstacles or facilitators to study STEM, although some girls did say they believe there will face 'sexism' in STEM fields because they are male dominated and both boys and girls agreed that it is difficult for a woman to combine family and a career in STEM. The major obstacle all pupils identified was the economic crisis and the uncertainty about the future. In times of crisis, they believe that university studies in STEM related fields will offer them more opportunities for employment.

## Poland

Concerning the target group of pupils (total number: 17), we arranged two focus groups in a public school in Rzeszow. The research participants were pupils (13 girls and 4 boys) of the 3<sup>rd</sup> class of a 4-year technical school, specialization: technology analyst. It is a co-educational school. Graduates have the opportunity to work in analytical or medical laboratories, or in the chemical or pharmaceutical industry.

Name of school: Tadeusz Ryłski Food and Nutrition School Complex in Rzeszów (Zespół Szkół Spożywczych, im. dra Tadeusza Ryłskiego, address: Poland, Warszawska 20, 35-200 Rzeszów).

School results of students participating in the research were diversified.

**Focus group duration:** about 60 minutes

**Location:** Research was conducted in Rzeszów.

**Group size:** 17 pupils

Research was conducted in May 2011.

### Main results and discussion

Focus groups with pupils revealed that the future is unclear for them. They have many doubts, a clear disbelief in their own abilities and for that reason they do not plan their future because they are not sure if they will be able to handle the tasks. Apart from one boy who plans to study chemistry, and is confident in his abilities other people use the phrase 'I'll go to the university if I can/if I succeed ... ". A lot of them do not know if they will manage to "survive" at university. STEM studies are perceived by pupils as very difficult and intellectually demanding, but graduation is a great opportunity to get a high salary. They all stressed the

importance of seeing and talking with professionals who have graduated STEM studies. Pupils desire examples of concrete, real life.

“I’ve never met a Ms. Engineer who has received a high remuneration. It would be great to have a meeting with such persons.”

### Spain

Thereby, from the interviews and focus groups a lot of concepts were generated. To illustrate that, the concept mapping methodology is very useful. The following scheme tries to show clearly the main associations made by the pupils, highlighting for example *why girls and boys should study STEM –positive aspects- (green), or why not –negative aspects- (red)*. Further, neutral concepts were regrouped in one category (blue) and the arrows or lines illustrate the relation between the concepts or dimensions. The thickness of the arrows defines the intensity of the relation that means the thicker the more intense. Moreover, dash lines could be used in order to show interactions in terms of relations between the concepts. The pupils discuss future projections, studies, reputation, family (traditions, values, and socio-economic position), mass media, and educational institutions in terms of encouragement or discouragement of women in STEM-studies. Highly pressured STEM-studies, financial problems, lack of scholarships, lack of information in schools about STEM-studies, and stereotypes providing by mass media could be revealed as barriers for women’s decision for a STEM-study.

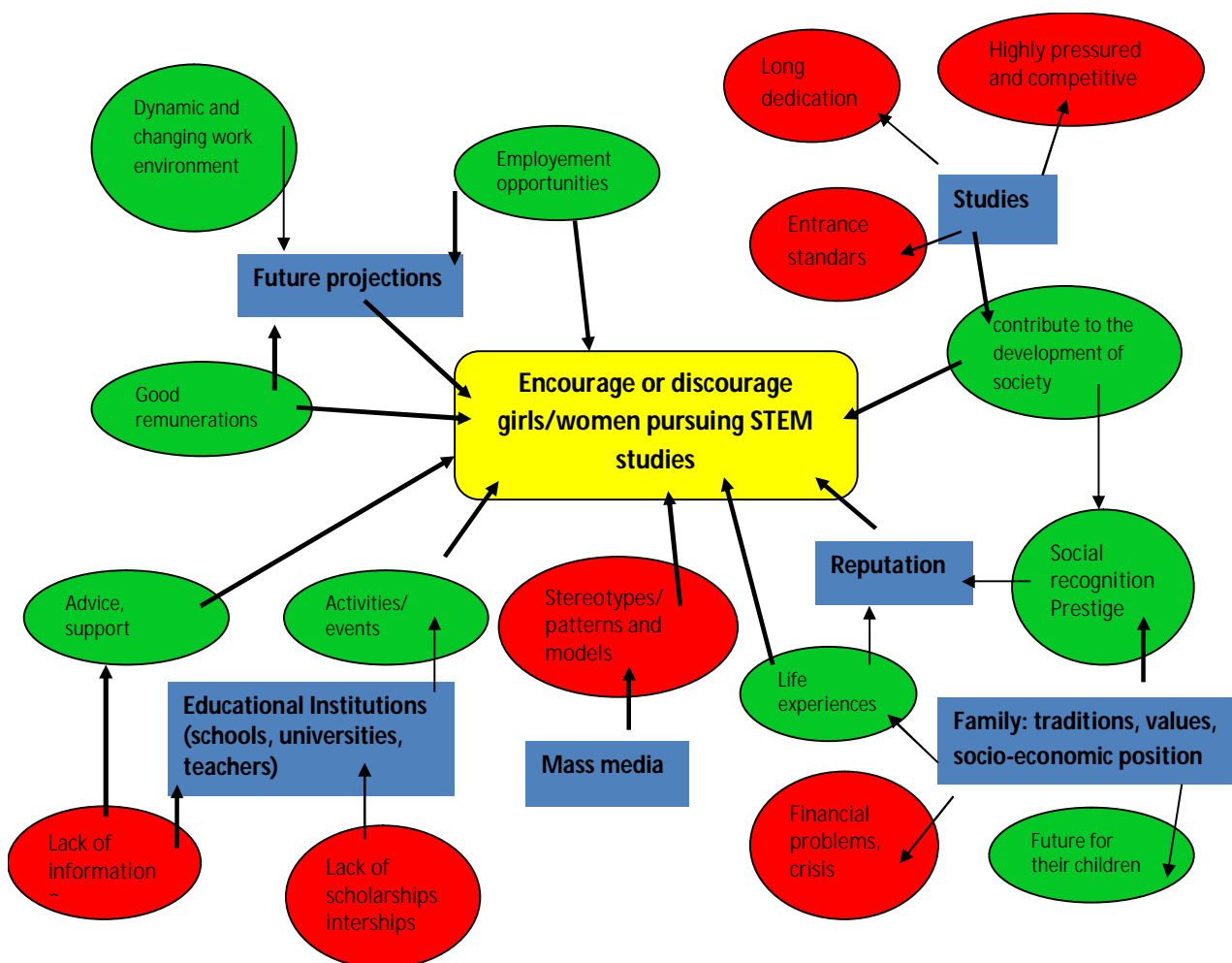


Figure 4. Concept map by Spanish pupils

## Summary of the focus groups

To sum up, stereotypes for women in STEM and insecurity about the future careers are crucial issues in the focus groups discussions with pupils.

According to German girls a high esteem could be achieved by a STEM study which is not a usual study subject for them but they consider also the stereotypes in STEM and perceived an oppression of women in these fields. In addition stereotypes in STEM careers are also important in Spain. In France it was noted that there is a lack of information about careers in science and technology. The pictures which French pupils had about professions are very narrow and abstract, so that it is difficult for them to identify themselves. In Poland the focus groups with pupils has shown that the future is unclear for them. They have many doubts, a clear disbelief in their own abilities and for that reason they do not plan their future because they are not sure if they will be able to handle the tasks. In Greece, the results revealed that there are many stereotypes on women in STEM held mainly by boys. In Poland the focus groups with pupils revealed that the future is unclear for them. They have many doubts, a clear disbelief in their own abilities and for that reason they do not plan their future. In Spain, highly pressured STEM-studies, financial problems, lack of scholarships, lack of information in schools about STEM-studies, and stereotypes providing by mass media could be revealed as barriers for women's decision for a STEM-study

## 3.2 Study 2 - Interviews with Parents

### Germany

#### Description of the sample

With regard to the sample, 22 parents with at least one or more children at the age of 14 to 19 years were interviewed. Six of the interviewees are fathers and 16 were mothers. The majority of the parents (15 of 22 parents) got an email via the LEV Bayern distribution list. Based on this email request for interview participants, parents who are interested in the SESTEM study have been contacted the project team of the Universität der Bundeswehr München and have been part of the qualitative study.

#### Main results and discussion

In the following, the main results of the interviews with parents will be shown. The first part describes the **individual level** of the interviewees. Most of the parents achieved an *average educational standard* by graduate from secondary school with a study qualification (“Abitur”). Further, some of the parents attended a university. Most of the parents of the study who have an average or high educational background are engaged to be part of the SESTEM studies. The educational background could be the reason for the parents to participate in the study in order to share their own experience. The main results regarding the individual dimension are that some of the interviewed mothers have been *successful as female STEM professionals* themselves and want to support young girls in STEM. Further, most of the parents explain that they had *no direct role models* for their career choice but for their own children’s career choice they enhance them by showing their STEM workplace. Regarding the values, parents estimate the *values honesty and reliability* the most. The most important *factors for career are a high salary, an interesting range of job content, and the joy* regarding STEM.

With respect to **STEM** in general, parents see the *positive image and job prospects* in STEM, In addition, a high salary and to *enjoy the work* seems to be important as *motivational factor* concerning career choice. Asking what are the important *abilities* in STEM the answers were *logical reasoning and persistence* regarding a STEM study. Other specific science-related abilities should be a basic STEM-related understanding. Regarding the *socio-cultural influences* of parents, there was *no direct influence from their own parents* on their career choice. Most of them were supported by their parents regarding their decision. With respect to their own children nearly all parents talk and discuss questions of career pathways or at least the job orientation at home. Besides, some of the parents suggest them to go to a STEM fairs or try practical STEM-offers for pupils.

With regard to the **consequences** of a STEM career, the main *obstacles* in STEM are *stereotypes of women in society, gender prejudices in STEM classes, and the low confidence of girls* in STEM subjects. With respect to *facilitators*, parents show a lot of effort in this context. Some parents probably *promote their children’s interest for STEM-subjects in early childhood* by e.g. by showing the children their STEM-workplace. In addition, it was mentioned a few times that the family should be a significant part with regard to support of children’s career choice. In general they would suggest more (female) role models from universities and from the field of STEM professionals which aim at clarifying the vague job profile of a STEM professional or scientist for pupils and more STEM-specific courses only for girls.

### France

#### Description of the sample and methodology

153 letters as request for the participation of parents in the study were distributed to pupils of different lycées. Only 15 parents had agreed to participate in the study. In general, parents who responded positively to

participate in the investigation also agreed that their child participates. We have globally more mothers than fathers. The interviews took place at home, in their workplace or in our office at the university. We managed to organize a big part of these talks during the school holidays.

### **Main results and discussion**

It is important to emphasize the image of the die Scientific in France: the best pupils, who are often the best in the humanities, follow the scientific path. This is the sector of excellence, for which all "doors" are open.

Many parents and pupils point out the ignorance of many trades and industries, they think they would do well to bring in professionals in schools, and more women to present their scientific careers. "Having a direct contact with students, when we see professionals, it is more humane, it's more within our reach, we can imagine." For many, we can see that the choice to opt for courses in STEM is different according to the sex; boys often continue in these fields as a logical sequence without necessarily having a career plan while the girls' decisions for the choices in high school and higher education are more thoughtful, regarding to sectors and trades considered. "Picture of a male world" is repeated in almost all interviews conducted.

The trade and professional background of the parents have a great influence on what they want for their child; for example in the importance of "reconciliation of family and professional life," for those who managed to reconcile or were seeking to do.

Girls opt more for courses and career choices not only scientific but including a social side (such as medical professions related to biology); the parents emphasize that this choice is more appropriate to the personality of their daughter, "it is her," to her loved ones, many girls are good pupils; their evaluations are good in almost all subjects, the choice of orientation is very difficult for many; they like both French and mathematics, so they hesitate between scientific and literary sector: opting for scientific studies offers more opportunities but they choose a profession that will be at the frontier of science: "she chose a profession where there are so many human relationships as science," "middle ground between science and the social side."

The parents were unanimous to say that they allow freedom of choice to their children, girls or boys. Parents of all backgrounds say that they leave or have left the "choice" of decision to their child about the course or educational options or career project. If their child has yet chosen a profession, they pay attention to the fact that this choice is consistent with the personality or the qualities of their child. Some parents (mostly mothers) have described the qualities and personality of their children. About the personal tastes, the differences are most often mentioned on the attractiveness of the social for the girls and the attractiveness of science for the boys. Boys are more often described by their parents as not knowing what they want, what they like. The girls are described as serious, hardworking, they have a specific goal.

Mothers tend to be more talkative, give more details, and tell a lot of anecdotes. Interviews with fathers tend to have been shorter as the response time to questions. If we stick to the speech of parents, it is not so clear to say today that parents have different school ambitions for their boys and their girls. One might however note that most mothers highlight the fact they don't want to see their daughter leave to study away from home, in another city, while this has been observed neither among fathers nor for boys.

We can nevertheless confirm an impact of educational level of parents, of the parents' occupation concerning the arguments related to the ambitions for their child ("career" or "do what he / she likes" or "power live well, coping "). Less educated parents or those who do not work in education seemed to have less control over the curriculum and the education of their children (most suffering failure or redirection of the child, relying more on opinions and decisions of the school, for example).

## **Greece**

### **Description of the sample and the methodology**

The target group of parents, 25 individuals in total, was interviewed via telephone and face-to-face interviews. Six of them were male researchers in FORTH and participated in a group discussion in a FORTH conference room on April 8, 2011. The rest of the parents were referred to us by parent associations and personal contacts. It was difficult to organize meetings with parents associations as the bureaucratic procedures took a long time and the interest was low. Contacting and arranging meetings with parents was the harder than other target groups as it was the examination period for their children and most of them were very busy. The total number of participants was twenty five, ten women and fifteen men. All of them except one mother who was a housewife had received higher education and were employed. All of them lived in the city of Heraklion. Twelve of them are employed in a STEM related field, but most were men (only 3 of the interviewed mothers was a STEM professional).

### **Main results and discussion**

It was interesting that most parents believed that children have their parents as role models and often choose similar careers. For instance, the STEM researchers in FORTH that had daughters and sons, all their children study in STEM except two of the daughters that studied preschool education and philology. They could not agree on which factors influence children more (they stated that parents, teachers and friends equally influence them) but agreed that many children have their parents and teachers as role models. The role model of the teacher was said to be decisive many times. Parents believe that women have more difficulties to follow a STEM career because of the family, but also because they are less self-confident as pupils.

## **Poland**

### **Description of the sample and methodology**

The qualitative research was conducted with **Individual In-depth Interviews (IDI)**.

- Qualitative research is not representative (research is not conducted on a representative sample of the population). Respondents are considered experts in a particular sphere and are not selected randomly but purposefully (due to their particular attributes, experience, etc.)
- Particular selection of respondents is done in order to gain in depth knowledge in a particular sphere. Qualitative approach focuses mainly on explanatory questions (e.g. “why”, “in what way”, etc.), on the meaning of particular issues to the respondents (“why is it important”, “how does it influence”, etc.), on expanding the information received from respondents (particularly by concentration on feelings, emotions, and eliciting issues that respondents are not fully aware of, or issues that are not fully developed), as well as on searching for needs, expectations, barriers and ways to satisfy those needs and to solve the problems experienced by respondents.
- In this case it was decided to use Individual In-depth Interviews. In each interview there was one interviewee selected in accordance with particular parameters.
- Each interview was led by an experienced interviewer previously trained on the research subject and on the specifics of the interviews with the particular groups.
- During the interview a detailed discussion guide was used as well as projective techniques. Projective techniques provide a way to reach not fully realized emotions, associations and meanings. They facilitate openness and freedom among the respondents.
- Individual meetings, due to their intimate character and possibility to concentrate on one respondent, enable:
  - Free expression of the interviewee’s opinions and views without fear of being evaluated by other participants of the meeting;
  - Accurate tracing of the individual’s perspective and further exploration of the issued being mentioned.



**Interview duration:** about 30 minutes

**Location:** Research was conducted in Rzeszów

**Number of Interviews:** 20 (IDI)

Research was conducted in May 2011.

### **Main results and discussion**

Results of the interviews with parents show that they encourage children to STEM studies by talking with them and showing positive aspects of a STEM workplace. In general, parents see the positive image and job prospects in STEM. It seems that a high chance to get a job and high salary are important factors concerning career choice. Nearly all parents discuss with children their career pathways. It is a popular conviction that a child who wants to study STEM should be gifted in these subjects.

## **Spain**

### **Description of the sample and methodology**

We reached a total of 12 parent responses:

- 6 in IES Emperador Carles (public)
- 2 in PROA school (subsidized)
- 4 in IES Eugeni d'Ors (public)

This was the most difficult target to reach. So, we had to use a flexible methodology doing an interview by letter. In each school, we delivered 30 letters with 5 key questions. Coordinators helped us deliver these letters to their “scientific-technological” pupils, to give to their parents. To get their answers the process was the reverse. Unfortunately, we only succeeded in PROA school, where we were able to interview face-to-face a mother and a father of pupils previously interviewed.

### **Main results and discussion**

In general the STEM world is economically higher positioned, has more prestige, and is considered more difficult and competitive; these careers have better prospects and high salaries, and people recognize that they are more useful and allow insured more secure future. No parent is opposed to scientific studies; in fact they would like their children to follow them but worry about the high pressure of these careers. Parents' participation or influence levels depend on socio economical and cultural factors. Family influence is stronger for immigrants than natives. In the public school we observed a higher proportion of immigrants than in the private or mixed schools. For example, for Muslims, patterns and models are more rigid. Many Latin-Americans are worried about their ability to continue their studies. Since their level in scientific subjects tends to be low; therefore, it is more difficult to encourage them to pursue STEM studies. For some, it is more important or useful to get a job first. Noting parents' statements it may realize that -in some cases- pupils' concern about job opportunities, may come from parents. In addition to pupils' personal interests, parents also believe that STEM abilities and the fact of being good at scientific studies are determinant for their children to make a career choice. Most say they support their children in what they want to do and guide them.

Regarding gender, apparently girls are more susceptible to parents' influence than boys, because they are more talkative with them; boys prefer to talk with their friends. STEM abilities are common for each gender; however there are still differences in STEM world; especially mothers think that men have better jobs and salaries than women. In general, parents don't observe gender obstacles directly. However mothers think that women have to work harder and demonstrate more their capacities because they will enter into a masculine world. For example the technology world “*still is perceived as unusual for a woman to work in this area*”.

Although our world is changing, and parents observe fewer gender differences, they still recognize historic and social stereotypes. Some parents (more fathers than mothers) think that this is due to genetic or biological reasons (innate interests, tastes); others (more mothers than fathers) say that this corresponds to socio-cultural factors and patterns (*Boys are used to playing and working with practical things and mechanisms, as assemble, set up or handle tools*).

## UK

### Description of the sample and methodology

Eight parents with at least one child between the ages of 14 and 19 years were interviewed. Five of the interviewees were fathers and three were mothers.

### Main results and discussion

At the individual level, most parents had attended university at a time when a relatively small proportion of the population did so, but there were 2 parents who had left school at 16 and gone into work immediately.

Parents are supportive of what their children want to do; examples include helping source workplace experiences for pupils to help inform career decisions. Parents viewed their influence on career choices as benignly supportive, without seeking to force them in a particular direction. All had discussed career matters with their children – even where they felt out of their depth in cases where children's career interests were at a technological level the parents could not deal with knowledgeably.

There was a general feeling that STEM careers provided more job security and stability than some other areas, so where a pupil had no clear direction already determined, it was a key area to be explored.

With respect to STEM in general, parents generally have a positive image of STEM and of job prospects in STEM. Job prospects were viewed as more stable in STEM areas than in many other career paths.

Parents view STEM as key to the future of society, including the parents of children whose talents clearly lie in other fields.

They identified practical skills, insight, perseverance, imagination, and problem solving skills as useful attributes, as well as more specific subject skills like mathematics, algebra, scientific literacy, statistics and calculus.

There was a feeling that some STEM careers are not easy environments for women to be successful in. Parents see the main obstacles in STEM as stereotypes of women in society, and in some STEM career paths in particular (rather more than is the perception of their children).

Parents generally act as a supportive influence to their children's career path via financial support, discussing options and sourcing work experience opportunities as key aspects of their role. While these aspects are not directly STEM facilitators, in instances where the pupil did not have a clear career path already in mind, parents were keen for the pupil to explore STEM areas as a possibility because of the perceived likely stability in the careers.



### 3.3 Study 3 - Interviews with Teachers

In the following section the results of the qualitative study with teachers of STEM-related subjects will be exposed for each country and noticeable similarities will be summarized.

#### Germany

##### Description of the sample and methodology

With regard to the sample, 20 STEM teachers from FOS and Gymnasien were interviewed on telephone (7 males and 13 females).

##### Main results and discussion

In this section, the main results of the interviews with STEM-teachers will be summarized. The findings concerning the **individual level** are that teachers tend to have chosen the *direct way of teaching profession*, a few exceptions only. A significant value besides *reliability and honesty* is *family* according the interviewed teachers. Family is more subject to female teachers who are thinking about child care and job prospective. Asking about role models the major part of teachers declares that at least *one parent or member of the family was already a teacher* of a STEM-related subject. With regard to *factors of career choice* three decisive reasons for the teaching profession could be revealed: *job guarantee* and opportunity of *combine family and job* which is in particular interesting for women, and the wish of three teachers to *climb up socially*.

With respect to **STEM** in general, the most popular motivational factors for STEM careers are the *high payment in STEM*, *good job prospects* for teachers in STEM, and the *passion* in these subjects according to teachers. Regarding STEM abilities, the most important ones are *logical reasoning*, a *general understanding for STEM subjects*, and *ambition*. Analysing the socio-cultural influences on the target group of teachers, there was *no direct influence of parents* but in some cases where both parents do not have academic background, they did not appreciate the choice for a teaching career because their children may inhibit to earn an adequate salary during the study phase. This might also be an indicator of a *lower socio-economic status* of the family. The influence of friends seems to play a minor role. In addition, some teachers *figured their interest and skills* for STEM out *at school*.

Taking the **consequences** of a STEM teaching career into account, difficult obstacles came up during the STEM study for most of the teachers. In particular *the demanding study in STEM* could be seen as problem for many students because the studies in STEM are very theoretical. One positive aspect of teaching STEM is the *opportunity for women to combine family and job*. The barriers in STEM industry are different to those of teaching fields e.g. women have to deal with a *lack of acceptance* in STEM field and they are confronted by *gender stereotypes*. Thus, the *barriers are established more in STEM industry* in comparison to the teaching profession according to the teachers.

*Facilitation* measures for promoting more girls in STEM could be according to teachers (*female*) *role models* from the field of STEM professionals which aim at *clarifying the vague job profile* of a STEM professional or scientist. Further, teachers *share their own study experiences* with their pupils to encourage them. One further suggestion is that specific extracurricular activities or offers for girls in STEM should be obligatory for a class during school.

#### France

##### Description of the sample and methodology

We met as many men as women, they teach in various schools in the department of Finistère. Teachers who agreed to give us a moment and that paid interest to our study are often teachers involved in the educational

world; they have already set up educational activities related to the STEM for example, exhibition titled "trades - mix ", meetings with researchers (specifically women engineers).

### **Main results and discussion**

In interviews, first, the teachers had to give their opinion on the disaffection of young people for careers in science and technology and the low participation of girls in science and, secondly, they spoke of their implementation in activities led in their school (for example scientific contests, visits or exhibitions). We also discussed about the orientation and career choices of pupils, specifically of the advice they could give to pupils.

Most teachers said they had never been aware of the problem of gender inequalities in science, neither during their initial training nor after. Only one teacher said he had been sensitized to this issue. In general, teachers are far from imagining that there are still gender differences in orientation and degrees in STEM.

According to teachers, girls and boys remain different, not in their abilities but in their aspirations and preferences: girls prefer the human relationships, the literature. For girls, there is also a desire to reconcile family and professional life, much less for boys. These responses are along the same lines for the four target groups.

In the comments of teachers, we often find the idea that scientific option is not necessarily synonymous with science vocation; it does not mean the continuation in high level studies in STEM, but is first used as a tool for academic selection ("a Bachelor of Science opens all doors "). These words are repeated very often in the different target groups.

Some teachers point out the fact that girls are less confident in their abilities in STEM or are less motivated in science; we can illustrate this by the remarks made by a teacher: "Girls are more apprehensive, they doubt their skills more; they have less confidence in themselves."

So, for most, the problem is less of motivation but of confidence (to lack self-confidence). One can draw parallels with the fact that girls are asking more questions; leave as a worse experience than boys the non-choice of orientation (cf. interviews with pupils, students and parents): "Girls are asking more questions over their grades, their orientation."

They realize that society, school and their personal choices as parents can influence the career choices of their child. One of the teachers told us that she had to stop her studies and to follow her husband (job transfer), "I have followed my husband and store my studies in a drawer." The fact that this is the woman who "follows" is not trivial; this can also be found in interviews with parents; three mothers had also experienced the decision to stop studying or working in their job in relation to their husbands' career change.

## **GR**

### **Description of the sample and the methodology**

A first focus group discussion was arranged on April 7, 2011 in the conference room of ERE group, IACM/FORTH. Ten upper secondary teachers (5 women and 5 men) from different high schools participated and six of them were also members of the Guidance & Counseling Center (KESYP) in the Prefecture of Heraklion, Crete. Most of the attendees were teaching in the fields of STEM (in the fields of informatics and mathematics), two of them were sociology teachers and one economics teacher. Only three women were teachers in the fields of mathematics, the other two were sociologists and one economist.

The rest of the teachers were referred to us by the teachers that participated in the focus group discussion and were interviewed via telephone. There were 6 women (from the fields of biology, mathematics and informatics) and 12 men (mathematics, informatics, and physics). The total number of participants was 28.

## Main results and discussion

The discussion with teachers revealed that gender stereotypes are well established in the school environment. Although the teachers were putting emphasis on the role of parents and mass media as influential forces, they themselves had stereotypical gender beliefs. These beliefs were manifested in the discussion on the reasons why girls do not tend to choose STEM studies when they are reported to be equal or even better in their performance in these courses at school. Although earlier in the discussion teachers claimed that all students should have equal opportunities to develop their personal skills and choose a career according to their talents and aspirations, at the same time, it was commonly accepted that women are less capable in STEM fields by ‘nature’.

When it comes to the students, the teachers claimed that students choose their field of study and profession based on the prospect of making easy money and at the same time maintain a high societal status. In this respect, they characterized their criteria for career choice as “shallow” or superficial, perhaps too idealistic.

There are major gender differences when it comes to the perception of STEM and it seems that gender stereotypes dominate both parents and teachers, and as a result, students as well. Girls were reported to be better students in all courses but in the end they choose a career in theoretical fields as they consider it better for them in terms of their abilities and personal life.

Although these results were common to all, teachers reported that there are major differences between rural and urban areas. Whereas in urban areas students tend to present a variety in their choices and personal skills, in rural areas it seems that choices are more prescribed and standardized and the family is reported as the decisive factor for the future career of the young people. Students in rural areas are less interested in school; boys usually finish school to take over their father’s profession or business (usually shepherds, farmers, restaurant owners, etc.). The reason for this, they claim, is that this ‘family system’ provides them economic security and certainty and as they are aware that it is the family business they will be occupied in, they do not care about school. Girls, in general, are less interested in studying for the same reason but also because they expect to be married and depend on their husband economically.

## PL

### Description of the sample and methodology

The qualitative research was conducted with **Individual In-depth Interviews (IDI)**.

- Qualitative research is not representative (research is not conducted on a representative sample of the population). Respondents are considered experts in a particular sphere and are not selected randomly but purposefully (due to their particular attributes, experience, etc.)
- Particular selection of respondents is done in order to gain in depth knowledge in a particular sphere. Qualitative approach focuses mainly on explanatory questions (e.g. “why”, “in what way”, etc.), on the meaning of particular issues to the respondents (“why is it important”, “how does it influence”, etc.), on expanding the information received from respondents (particularly by concentration on feelings, emotions, and eliciting issues that respondents are not fully aware of, or issues that are not fully realizable), as well as on searching for needs, expectations, barriers and ways to satisfy those needs and to solve the problems experienced by respondents.
- In this case it was decided to use Individual In-depth Interviews. In each interview there was one interviewee selected in accordance with particular parameters.
- Each interview was led by an experienced interviewer previously trained on the research subject and on the specifics of the interviews with the particular groups.

- During the interview a detailed discussion guide was used as well as projective techniques. Projective techniques provide a way to reach not fully realized emotions, associations and meanings. They facilitate openness and freedom among the respondents.
- Individual meetings, due to their intimate character and possibility to concentrate on one respondent, enable:
- Free expression of the interviewee's opinions and views without fear of being evaluated by other participants of the meeting;
- Accurate tracing of the individual's perspective and further exploration of the issued being mentioned.

The total number of participants was 23 from five different schools (16 women and 7 men):

- Tadeusz Rylski Food and Nutrition School Complex in Rzeszow (6)
- Technical School of Electronics in Rzeszow (5)
- II General Lyceum in Rzeszow (3)
- School Complex in Czudec (5)
- Academic General Lyceum in Rzeszow (4)

**Interview duration:** about 30 minutes

**Location:** Research was conducted in Rzeszów.

**Number of Interviews:**23 (IDI)

Research was conducted in May 2011

### **Main results and discussion**

There is a need to change the attitude of parents to arouse interest of STEM subjects among pupils. But there is also a need to increase the motivation of teachers. There should be more practical classes, based on real and current examples. For this purpose classrooms, where classes are held, should be better equipped. The cause of the problems with STEM subjects in secondary school are shortcomings in earlier education. Again, the most important career factor is a chance of finding a well-paid job.

## **ES**

### **Description of the sample and methodology**

From teachers we reached a total of 25 responses:

- 8 in IES Emperador Carles (public)
- 9 in PROA school (subsidized)
- 8 in IES Eugeni d`Ors (public)

For both interviews and focus groups, we ensured the gender parity of respondents. Teachers were selected randomly by the coordinator of each school. The only condition was that they were teaching in STEM subjects.

The qualitative research was based on a semi-structured conversation: teachers were guided by some questions but were also free to relate their experiences spontaneously. The result was a very positive ambience during the interviews.

### **Main results and discussion**

For teachers, models and cultural patterns are present: there still is a certain traditional vision of careers. Pupils don't know about new occupations and specializations that current careers offer. Contact of secondary

pupils with the university and the workplace is missing: practice, outings, and talks are needed to go against stereotypes.

Teachers observe that pupils see STEM world as economically higher positioned than other fields, with more prestige, and is considered more difficult and competitive; these careers have better prospects and high salaries for pupils.

Teachers are conscious about their essential role at upper secondary level: they know they can encourage or discourage pupils depending on their way of teaching.

In relation to gender, teachers perceive that pupils don't observe direct gender obstacles, but they recognize a strong presence of stereotypes and traditional roles (like parents' pupils). Although society has changed, there are still traditional views and associations. From the teachers' perspective, pupils need to get more informed, especially about technology and technical careers.

Teachers say that, in general, girls tend to choose biology or health studies, because they like the contact with people and nature, to help others. They say it is true that girls don't show interest in the technologies. When teachers were asked if this was due to cultural or genetic factors, the responses were divided between the two choices: more female than male teachers say that this corresponds to socio cultural factors and patterns, and more male teachers say that this responds to genetic or biologic reasons.

## UK

### **Description of the sample and methodology**

Nine STEM teachers were interviewed (4 males and 5 females) across all STEM subject areas – Mathematics, Design and Technology, ICT, Biology, Chemistry and Physics. Six of these teachers came from Belfast Royal Academy in Northern Ireland, where there is still an over-supply of teachers in all subject areas and where teaching as a profession is still held in high esteem in society. Early discussion focussed on their own motivations and the decisions underpinning career choices.

### **Main results and discussion**

Most of the teachers are direct entrants to the profession, having taken a subject specialist degree followed by a teaching qualification. One teacher worked in industry first and one took a degree in non-STEM subjects and took a STEM degree after working in market research for IBM. All of the teachers interviewed were passionate about young people and about their subject. Three of the teachers had at least one of their parents as a teacher, and two were married to teachers. Family life and being seen as fair by the pupils were important to the majority of the teachers interviewed. Job security, career prospects and flexibility in respect of family commitments were seen as important in their own career choice, as were the formal structures that allow career breaks (seen as particularly important by female teachers).

With respect to STEM in general, teachers have a positive image of, and beliefs about, job prospects in STEM, and know they could probably earn more money working directly in STEM rather than teaching, but there are other factors which make teaching attractive. Teachers generally saw engagement with STEM subjects as necessary for pupils to succeed. How well they did would then be a reflection on their intelligence and subject aptitude - but without engagement little would be achieved.

There were some perceived gender differences in work styles and in aptitude and some observations on how the assessment systems that used to be in place (high-stakes coursework) favoured girls and the changes recently (to remove or reduce coursework) favour boys. A third of the teachers came from families where a parent had been a teacher, but this does not seem to have been a major factor in their career choice. The majority of teachers had previously had experience of working with young people and this was cited as a

significant influence in career choice. The status of teaching was also seen as a positive factor in career choice.

Teachers see the main obstacles in STEM as residual stereotypes of women in society, for example in advertising aimed at the very young, and the perception that STEM subjects are difficult. Schools where the uptake of STEM subjects is already high and with lower gender imbalances seem to find that equilibrium persists without major promotional initiatives, but teachers are conscious of the need to present gender balanced materials when advertising STEM courses at subject choice time, to counteract the stereotypical attitudes which persist in society. Some teachers are very active in promoting engagement in outside STEM related activities as a way of allowing pupils a greater insight into what actually goes on in STEM careers.



## 3.4 Study 4 - Female Students Interviews

### Germany

#### Description of the sample and methodology

In the following, the main results of the interviews with the female students will be described. With regard to the sample, the interviewees were contacted by personal contact, email and via STEM-related distribution list. In total, 11 female students of STEM subjects like mathematics, physics, engineering, and STEM-related teacher training from four different universities were interviewed on telephone: Technische Universität München (TU) in Munich, Ludwig-Maximilians-Universität München (LMU) in Munich, University of Mainz, and University of Bundeswehr München (UniBw) in Munich. In addition, this sample includes three post-graduate students in mathematics and two Master-students in physics. Remarkable in this target group is the fact that three out of 11 interviewees attended to a single-sex school (Gymnasium) for girls.

#### Main results and discussion

In the following, the main results of the interviews with female students of STEM subjects will be shown. Regarding the **individual level**, the central results with regard to the individual context of the interviewees will be summarized. Most of the female students are graduates or postgraduates in STEM-subjects.

Analysing the educational biography of the students nearly all of them enjoyed mathematics or other STEM-related subjects in their childhood or in school. Some of the female students explain that they were gifted in these subjects especially mathematics.

With respect to *values and factors for career choice* of female STEM students, interesting aspects could be revealed. Regarding *role models* for career choice most of the students had no direct role models but in fact some of the *parents* do work in STEM fields and supported their children concerning homework and answer further questions. In addition, three students explained that they had some good *STEM-teachers* who gave practical exercises and impressed them. The results of the interviews with female students underline which impacts parents and teachers could have on pupils during the process of future career choices. Thus, the significance of the influence and encouragement of parents and teachers regarding the STEM interest is very important for the career choice of pupils. Even if the students explained that the parents had no direct impacts on their career choice, the interest for STEM was influenced indirectly by their parents STEM profession, thus STEM-subjects were ever-day issues at home. Therefore, the collaboration between school teachers and parents should be improved that pupils were complementary supported in the context of school and home in terms of career opportunities and decisions. Concerning *values* a lot of the interviewees underlined that self-realization aspects like e.g. identification with work, getting a meaningful work, achieving work-life-balance, and following the own ideas in life are more important than the financial aspect of a job. Further, in this group the identification and self-realization is higher than in the other target groups. With regard to these self-realization aspects, it should be mentioned that STEM-related job are well known as well-paid jobs. Maybe therefore, the graduates and postgraduates might not that worried about the salary because the STEM-jobs are anyway of an adequate amount e.g. an agreeable work environment attach more value to some students than a high salary. Asking about the important factors for the career choice are enjoying work, challenging STEM field, and the fact that STEM fields offer a range of opportunities and contents. Other factors are high salary and having time for friends and family. Further, social factors like family, friends, and work-life-balance were more important to this group.

In the following, the most important results with respect to **STEM**-subjects will be illustrated in the following. Regarding the motivation or incentives why one should pursue a career in STEM, the interviewees name in particular the interest for STEM, the joy regarding STEM, the fact that STEM are the most meaningful subjects, good job prospects, job guarantee and the significance of future STEM jobs. The salary is mentioned less often in this target group. *Logical reasoning and a certain gift for STEM* seems to be important abilities for STEM. Analysing the socio-cultural influences on students career choice, it could be seen that most of the parents support the future decisions or have positive impact on it. That means that most of parents let the children choose their own career pathway or they encourage them to take up a STEM study. In particular

parents who work as STEM professional are very encouraging with regard to an uptake of a STEM career. However, a few parents are sceptical if their child made the right decision to start a STEM subject. The meanings of the friends are different: Most of the female students report that their friends know that they are good in STEM-related subjects and accept the study or career choice. Other people could not establish an adequate understanding for the career choice in particular by women.

In this section, the results regarding the **consequences** of a STEM career will be revealed. Asking about general obstacles in STEM, nearly all the students agree that their STEM study was a difficult study subject: they have high pressure concerning the drop out-rate and miss social contacts. With regard to obstacles for women in STEM the greatest perceived problem is the lack of acceptance for females in STEM. Other possible obstacles were: lack of female role models/ contact persons e.g. female professors, prejudices against women in STEM, feeling alone under male students and lower self-confidence of female pupils in STEM.

In addition, some students reported regarding the low self-confidence of females that women think they perceived that women often think that they are not good enough in STEM. Asking about the *problems with the combination of family and STEM* career pathways which could hinder women in STEM careers most of the students think this *depends on the employer* or work field (industry versus public service). In contrast, one interviewee thinks that girls sometimes have an advantage in STEM-subject at university.

In the following, the main results regarding future facilitators and promoting measures which were helpful for students' interest and career decision will be described. The students generate a lot of suggestions e.g. more courses for girls in STEM, mentoring programs, networks, and more open days in STEM. They had some of the measures already at university. Some of the students say that they do not need a facilitation program. The main result is the support by parents who enhance the technical socialization by given STEM-related toys or tasks. Therefore, it is important to have an early encouragement by parents to increase the interest for STEM e.g. one student report that had an electronics experiments kit in her childhood.

## France

### Description of the sample and methodology

#### Main results and discussion

In addressing the question of obstacles, students thought directly about women, without this being stated in the question. Their ideas were rather ambivalent, on the first side highlighting the importance of improving themselves in the scientific disciplines, but on the other side, developing the image of the woman who has sacrificed everything for science, her craft, who looks like a man, gets masculine image, careerist. They stressed the importance of teachers to guide them, and to lead them to love or not their discipline according to their way of teaching.

They also stressed the importance of seeing and talking with professionals, people who can show them and explain the business (this from the college). Many gifted girls with good results at school in the STEM disciplines do not opt for graduate study in STEM because they meet difficulties to project themselves into a job (lack of female role models, male image in the trade). The trainings can be perceived as too theoretical and this may repel girls to opt for these subjects. For some students, the differences in tastes between men and women explain the gender imbalance in education in STEM "women do not necessarily like that."

## GR

### Description of the sample and the methodology

Twenty five Female students enrolled in the departments of Physics, Mathematics and Informatics participated in meetings and interviews that took place at the end of their class in the University classroom with the cooperation of the professors.

#### Main results and discussion

Most students feel insecurity and were concerned on the effects of the Greek crisis in their future employment. Thus, the crisis was presented as an obstacle to follow any career as a matter of fact, and in this sense students



would like to be informed on the professions that would have more employment prospects. It seems then that students agree that there are important common obstacles young people have to face, regardless of gender. However, it is interesting to note that most expect to have fewer opportunities than men to succeed in STEM careers. On the other hand, female students did not believe they were less able than their male classmates to succeed, but they receive less attention and support.

## PL

### Description of the sample and methodology

The qualitative research was conducted with Focus group interviews. The aim of this research technique was to recognize the usually unconscious motives, views and opinions of the respondents. Interviews were carried out according to the scenario developed for the study of problem-depth with a sequence of issues raised. Interviews were done in groups of ten persons and consisted of discussions on topics proposed by the moderator with complete freedom for participants to engage and introduce their own interests. All interviews were completed in Rzeszow, with deliberately selected female students representatives. Qualitative research is not representative (research is not conducted on a representative sample of the population). It is used to test hypotheses. It has led to a better understanding of the issues discussed and not to the quantitative verification of hypotheses.

During the interview a detailed discussion guide was used as well as projective techniques. Projective techniques provide a way to reach not fully realized emotions, associations and meanings. They facilitate openness and freedom among the respondents. The direction of discussion was monitored by a moderator who also had the task of mitigating the emerging potential of intra-group antagonisms, which could potentially threaten the substantive discussion. The duration of one session did not exceed 1 hour. At the beginning of the interview the moderator explained the purpose of the interview and assured participants of confidentiality and discretion and the principles of the interview. The analysis of the problem with this technique uses material from the three discussion groups. The final analysis was conducted by the research material moderator along with another investigator not participating in the discussion sessions. In order to ensure adequate capacity to analyse the focus group interviews were documented by means of audio technology. The research participants were 30 female students of technical faculties in the second year of study (three groups of 10 people) of Rzeszow University of Technology. It is a public university. Rzeszow University of Technology offers its students a wide variety of programs and courses. It also undertakes research and scientific projects in the following specialized fields of the applied sciences: engineering, mathematics, physics, economics, as well as the chemical and biological sciences.

Name of university: Ignacy Łukasiewicz Rzeszow University of Technology (Politechnika Rzeszowska im. Ignacego Łukasiewicza, address: Poland, Wincentego Pola 2, 35-959 Rzeszów).

**Focus group interview duration:** about 60 minutes

**Location:** Research was conducted in Rzeszów.

**Group size:** 3 groups of 10 female students (30 people)

Research was conducted in May 2011.

### Main results and discussion

Students believe that STEM studies have not affected their opinion about their own abilities. They indicated that there are higher requirements at the university than in a secondary school, and therefore, in order to gain a good grade, people need more effort. Students declare that in the course of study a capacity is not enough, self-study is a must.

The only difficulty with which those surveyed met while studying STEM subjects are problems resulting from their reluctance to learn. Additionally some teachers are not interested in the subject. STEM subjects are not easy to self-study; students need help and explanations in the classes.

It is interesting that those surveyed did not consider scientific work. According to them work in the STEM area is work in the office, in front of a computer or management positions in the implementation of projects. Female students are especially appreciative of the opportunity to apply knowledge of STEM disciplines. Students consider as a less pleasant aspect of working in the area of STEM the stereotypical perception of an engineer associated with "... galoshes and alcoholism ...", working under time pressure, the responsibility resting on STEM professionals, and the knowledge that women engineers with the same knowledge and experience will not be treated equally to men.

The main source of information about studies was websites of universities, open days and recommendations of students' friends.

## ES

### Description of the sample and methodology

We reached a total of 16 female student responses:

- 6 in Universidad de Barcelona (UB) (public)
- 8 in Universidad Pompeu Fabra (UPF) (private)
- 2 in Universidad Aut3noma de Barcelona (UAB) (public).

Female students were selected randomly by Division directors or coordinators. The only condition was that the students be studying in the STEM fields, especially those which with more males enrolled. Most of those interviewed were engineering or physics students.

The qualitative research was based on a semi-structured conversation: students were guided by some questions but were also free to relate their experiences spontaneously. The result was a very positive ambience during the interviews.

### Main results and discussion

While there has been improvement, stereotypes and traditional associations regarding STEM careers still prevail (students=nerds, ugly women), or types of work that they permit. Students say that this can be explained by the "shadow" of history and a lack of information regarding new studies, occupations and skills.

Engineering studies are perceived by students as difficult and intellectually demanding, but very useful in different jobs (this fields offers a wide variety of job opportunities according to respondents). By contrast, in physics, which is also recognized to require high levels of studying and dedication, future career possibilities are perceived as limited and badly paid. Even if it seems contradictory, female physics students interviewed believe that within the few work possibilities they have, being a woman could be an opportunity to be employed.

In general, we can observe that students have almost no contact with or participation in associations or scientific groups and networks. Apparently this is not perceived as necessary for succeed in careers and the general opinion is that the scientific community is very closed. Practical experience, internships, work or enterprise contacts are highly valued, but few students have had the chance to get them. To get in touch with experts in many different academic fields is much needed.

Under a gender scope, students recognize a majority of men in certain fields (mostly in technology and engineering) but many less than in previous years. The scientific community is perceived as masculine and

elitist but this is not observed as an obstacle. The obstacles are not related to gender; they correspond to difficulties and pressures of careers, or the economic crisis which has resulted in fewer job options.

All physics students say that their families and friends were surprised when they told them that they wanted to study this (either for learning challenges that it implies, or for labeling them as freaky or men's careers). However, this wasn't an obstacle to pursuing what they wanted to. Despite this perception, they recognized constant family support. Women's presence in physics or engineering, even though they feel under high pressure, for some women this constitutes a challenge and the possibility to reach their dreams and personal satisfaction.

Gender biases are seen as something of the past, especially for those students who began studies a few years ago. However, "senior students" say that at the work world or in the research field there still is male primacy. Anyway, this is not an obstacle for women; in fact it is often an incentive to demonstrate their capabilities and added value in terms of different skills between men and women (women being more responsible, methodical, creative, having social capabilities). This is perceived more by students who are closer to finishing their studies and continuing their professional development. *It is seen as an opportunity to have fewer women in Science.*

In relation with gender, pupils don't observe direct gender obstacles (maybe it is because they don't yet have contact with the work environment. Curiously in physics, astronomy studies are observed as very 'feminine'. Many facets of physics are perceived even to have a philosophical side. Another fact is that in high pressure or more difficult studies, students perceive a higher number of women. There exists a feeling that maybe this is one of the reasons to explain more men enrolled in technological or technical studies (scores are lower, so entrance is easier; women usually have better grades and academic performances).

Those students who are in the last years of their studies or who have come into contact with a research field (especially physics students) perceive difficulty in reconciling professional and personal-family life: high levels of dedication, competitiveness and usually the requirement of being willing to change city or country depending on projects' requirements.

## UK

### Description of the sample and methodology

Interviewees were recruited by personal contact and through tutor groups at a university. In total, 11 female students were interviewed, 7 whose undergraduate degrees are in STEM subjects such as mathematics, physics, engineering, and STEM-related teacher training, and 4 whose undergraduate degrees are in non-STEM subjects – History & Politics, Psychology, French and English. The students attend three different universities and were interviewed either in person or on the telephone.

### Main results and discussion

Most of the students had attended co-educational schools and were academically successful. Decisions about what subjects to study and then to study at university were generally taken from a position of strength as their grades were good enough to keep a number of options open to them. Students intending to go into teaching viewed this as a vocation as well as a career. With one exception, money was not seen as a driving force in career terms and job satisfaction in broad terms was of a higher priority.

With respect to STEM in general, a number of students felt that STEM careers offered more flexibility to adjust career trajectories than some other careers, and they make a difference to society. Those going into teaching also felt they could make a difference, as did the girl who hopes to be a clinical psychologist, so this is not a characteristic exclusive to STEM students. Students commonly reported lower numbers of girls taking STEM in sixth form and going on to university from their own school, with greater choice of options available

to girls cited as an explanation. Students studying STEM subjects were viewed as clever, and often a bit more awkward socially. Most students had support without pressure in a particular direction from family, and did not feel they had been subject to peer pressure in their choices either. Teachers and school visits or special events did sometimes influence career choices.

STEM subjects are viewed as hard, and students have a perception that gender stereotypes persist to some extent in relation to STEM, and progress for females in some STEM fields was difficult. Inspirational teachers and outside visits or visiting speakers were cited as generating interest in STEM subjects in school.

## 4. Synthesis of the four studies

In this section of the qualitative research results of all national reports will be summarized in a synthesis which includes commonalities and differences between the four sub-studies in each country.

In the following commonalities and differences between the four sub-studies and with regard to the countries specifics will be exposed and summarized.

### 4.1 Commonalities

#### Germany

In total, 82 interviews and focus groups with 44 pupils were conducted during the project (table 2).

**Table 2. Numbers of interviews and focus groups in Germany**

	Interviews	Focus groups	Total
<b>Pupils</b>	<b>29</b>	<b>44</b>	<b>73</b>
<b>Parents</b>	<b>22</b>		<b>22</b>
<b>Teachers</b>	<b>20</b>		<b>20</b>
<b>Students</b>	<b>11</b>		<b>11</b>
<b>Total</b>	<b>82</b>	<b>44</b>	<b>126</b>

#### *Individual level*

First, the main commonalities will be shown with respect to the individual level, STEM in general, and consequences of a STEM career. The educational pathways of the students, STEM-teachers, and parents are similar: they nearly all studied a STEM subject directly after the Gymnasium. The major part of the parents studied too. Nearly all interviewed pupils want to study in the future even if they do not know which subject. This could be a hint that most of the participants have a higher educational class background. With regard to values, the most important values are honesty and reliability as well as other values like ambition, work environment, family and friendship. Obvious differences are the fact that according to the age pupils are more focused on friendship and teachers and sometimes students of higher semester are more focused on questions about how to combine family and work. Most of the interviewees say that they had no direct role models for their career choice. The final factors for the career choice are different but most based on joyful work in STEM which is more subject to pupils and students. Further, opportunities of a high salary (mostly by parents) as well as the job guaranty (mostly by teachers) were also mentioned.

#### *STEM*

The perceptions on STEM careers in general were analysed. The most important incentives in STEM according to all four interview groups and the focus groups are enjoying work, interest in STEM, good job

prospects and high payment. Regarding the demanded abilities for STEM, all groups agree that a basic STEM-related knowledge or understanding and in particular logical reasoning are necessary in this field.

Analysing the socio-cultural influences, most families are supportive regarding career choice in all groups. However, the final decision was done by oneself in most of the cases. Also, pupils feel free to choose their career pathways. Other persons could have impact on the interest in STEM. Thus, teachers had an important role model function for a lot of the interviewees in particular students and STEM teachers. They impressed them by motivational and practical STEM classes and sometime they also encourage them. Friends did not play a decisive role in terms of career choice in all groups. Only some of the students mention that few of their friends valued their career choice in STEM negatively. To sum up, parents and teachers have the highest impact on pupils' career choice.

### *Consequences of a STEM career*

The main consequences of a STEM career will be summarized. In general, all groups observe obstacles especially for women in STEM like the lack of acceptance of women in STEM fields, the lack of female role models, stereotypes of STEM, the under-representation of women in STEM studies and a lower self-confidence of girls in STEM classes regarding their abilities in STEM. General obstacles are the demanding study in STEM (in particular at the beginning of the study) and the change from school level in STEM to university.

With regard to facilitators, all groups agree that schools could go more after (female) role models from the field of STEM professionals which aim at clarifying the vague job profile of a STEM professional or scientist. More specific courses for girls only in STEM at school were also requested. One important suggestion of the group of pupils is that the STEM classes should be more practical-oriented which aims at motivating pupils and increasing their interests for STEM. Especially students would appreciate more courses for girls in STEM, mentoring programs, network activities, and more open days in STEM areas. In addition, a lot of STEM initiatives for girls at school could be summarized but all groups consented that there is still a need to improve the facilitating measures for women in STEM.

## **France**

In total, 63 interviews and 30 focus groups were conducted (see table 3)

**Table 3. Numbers of interviews and focus groups in France**

	<b>Interviews</b>	<b>Focus groups</b>	<b>Total</b>
<b>Pupils</b>	<b>30</b>	<b>30</b>	<b>60</b>
<b>Parents</b>	<b>15</b>		<b>15</b>
<b>Teachers</b>	<b>6</b>		<b>6</b>
<b>Students</b>	<b>12</b>		<b>12</b>
<b>Total</b>	<b>63</b>	<b>30</b>	<b>93</b>

***Individual level***

In this first point, we will identify commonalities on the individual level, that is to say the factors affecting career choices, the educational biography and personal values.

- For all the interviewees, the support of parents is considered as important regarding the orientation and career choices of their child. The career choices in STEM are positively perceived by the different groups even if some teachers highlight the difficulties some girls meet to integrate the labor market.
- The interest and taste for STEM are important when one comes to consider graduate studies or careers in science.
- Willingness and a desire of reconciling family and professional life is emphasized especially for girls.
- Parents are unanimous to say they allow freedom of choice to their children, girls or boys. Parents of all backgrounds say that leave or have left the "decision's choice" to their child about the course or the educational options or the career project.
- We can note that it is mainly their teacher who gave them the desire to continue in STEM. Many teachers interviewed spoke about their professor of physics, chemistry or mathematics, who motivated them to pursue in these disciplines, and to do this job. For most of them, what has really influenced their choice is simply their interest and taste for STEM. They do not mention the influence of friends, media.
- . For almost all the teachers the choice of the discipline is linked with the teachers they had when they were in school.
- We often find the idea that scientific option is not necessarily synonymous with scientific vocation; it does not mean the continuation of high level studies in STEM, but it constitutes rather a tool for academic selection (a Bachelor of Science opens Doors ")

***STEM***

In this second point, STEM has been reviewed in general. We will analyze the motivations, abilities and the influence of socio-cultural background. The explanation of the influence of parents on the process of career choice will be based on the model of Dick and Rallis<sup>1</sup> (1991). They propose a conceptual model of career choice. The model shows that the choice could be influenced by pupils' self-concept, their perception of their own abilities and the subjective value of career pathways. These beliefs of pupils are built on experiences made during school and family life, including the perceived expectations or attitudes of other people (socializers) such as peers, parents and teachers.

- The importance of science degree, such as opening all doors.
- Undeniable influence of teachers on students' preferences for the subjects taught, the friends have little or no influence on the choice of option or career. Teachers play an important role with students; it is often "thanks to" teacher that they wanted to continue.
- Many parents emphasized the important role of teachers, influencing educational outcomes; the way of teaching may have an impact on the success of the student and his/her taste for the subjects taught.
- Occupations of the father or the uncle are repeatedly highlighted as possibly having influenced the career choices of children.
- Whatever the level of parental education, they encourage their children to pursue education; parents play a significant role on the fate of school children.
- In terms of abilities, professors (men and women) use the same words; those that occur most regularly are rigor, motivation, curiosity, tenacity and organization. Words that also come back are: reasoning, logic, care and precision, and method. These capabilities are not gendered, in their discourses.

<sup>1</sup> Dick, T. P. & Rallis, S. F. (1991). "Factors and Influences on High School Students' Career Choices". Journal for Research in Mathematics Education, Vol. 22 (4), pp. 281- 292.



### ***Consequences of a STEM career***

Finally in this last part, we analyze the different consequences for the career in STEM, obstacles and facilitators for STEM (both levers and the brakes).

Concerning the brakes:

- All target groups highlight the difficulty for women to insert themselves and become integrated into the scientific and technical circles, predominantly male. "Picture of a male world", returns in almost all interviews conducted.
- When one has to project him/herself to choose an orientation, traditional representations and stereotypes, such as “girls in the humanities and boys in science”, play an important role.
- STEM studies are defined by all as long and difficult, too demanding. We can link this representation with the lack of confidence met in numerous girls’ speeches.
- Many parents as well as pupils point out the ignorance of many trades and industries, they think it would be a good thing to bring in professionals in various schools, and more women to present their scientific careers.
- Teachers also emphasize the pupils' ignorance of jobs existing in STEM; they also admit they may not have the right tools and good advice to guide and inform effectively.
- This ignorance is also reflected in the speech of pupils, boys or girls indifferently.
- Women (teachers) have stressed the fact that girls (their pupils) make reasoned if not reasonable choices about their education and careers. According to teachers, girls and boys remain different, not in their abilities but in their aspirations and preferences: girls prefer the human relationship, the literature. For girls, there is also a desire to reconcile family and professional life, much less for boys. These responses are along the same lines for the four target groups.

Concerning the facilitators:

We can notice that there is a willingness to meet and talk with professionals. These meetings with scientists and engineers in STEM seem to be considered as an ideal solution for all groups, allowing young people to know the scientific trades... especially meetings with women could facilitate and motivate girls to choose careers in STEM.

## **Greece**

In total, 128 interviews and focus groups with 30 pupils were conducted (see table 4).

The results of the qualitative studies suggest that there are many commonalities amongst the target groups. The target groups shared similar background and experiences in relation to STEM and held similar values and beliefs.

Regarding the perception of STEM in general, STEM related fields were widely reported as *prestigious*, *interesting*, *up-to-date with global developments* and with *higher employment prospects* and *salaries* in comparison with other fields in all target groups. At the same time these fields are also considered more *difficult* than other fields, *time-consuming*, *competitive* and *demanding*. In this respect, in most cases it was reported that these characteristics may present obstacles for women who are generally viewed as placing the *work-life balance* in higher priority than men.

The belief that *people should study what they really like* without influence was also presented as a dominant personal value and career choice factor in all cases and target groups. Secondary reasons for career choice were the *prospects in the job market*, *high salaries* and *high social status* with small variations on the priorities in cases.



**Table 4. Numbers of interviews and focus groups in Greece**

	Interviews	Focus groups	Total
<b>Pupils</b>	<b>50</b>	<b>30</b>	<b>80</b>
<b>Parents</b>	<b>28</b>		<b>28</b>
<b>Teachers</b>	<b>25</b>		<b>25</b>
<b>Students</b>	<b>25</b>		<b>25</b>
<b>Total</b>	<b>128</b>	<b>30</b>	<b>158</b>

The concern for the *economic crisis* was presented all target groups, but especially among the pupils and students who placed the ‘job prospects in the labor market’ high in their priorities. STEM related fields were still considered best options in these cases too, reaffirming the high regard STEM has in society in general. It seems that the higher job prospects in STEM make parents and teachers to promote it almost equally to their students and children regardless of gender. The abilities identified from all target groups as important to follow a STEM career focused on concepts such as ‘a practical mind’ and ‘hard working’.

*Social class, economic status* and the *profession of parents* seem to play a significant role in all cases. It was generally observed that the gender disparities in relation to STEM as a field study or career were wider in lower classes, while there were fewer gender differences in higher classes (in better schools) and to youngsters whose parents work in the fields of STEM.

In addition to that, it seems that although in most cases ‘role models’ were not reported as very significant, many of the people interviewed are or were actually highly influenced by *charismatic teachers* and the *profession of their parents*.

*Self-confidence* and the *use of successful women in STEM* fields as role model was reported as a great factor that disadvantages or facilitates women in STEM. The view of STEM fields as overall ‘*masculine*’ was dominant in all cases.

## PL

In total, 60 interviews and focus groups with 30 pupils and 30 students were conducted (see table 5).

**Table 5. Numbers of interviews and focus groups in Poland**

	Interviews	Focus groups	Total
<b>Pupils</b>	17	30	47
<b>Parents</b>	20		20
<b>Teachers</b>	23		23
<b>Students</b>		30	30
<b>Total</b>	60	60	120

### *Individual level*

To sum up, the four studies present similar results. The choice of career paths in STEM are made by the students themselves. Parents believe that this decision belongs to the children, they can only support them in their choices. Both parents and teachers indicate that peers play the essential factor in choosing a faculty. From pupils and female students' perspective one can not explicitly observe career choice or an external influence on gender differences. However all of those interviewed are aware of stereotypes.

According to students a bad teacher can effectively discourage and deter them from learning STEM subjects and, consequently, in that way he/she could have an influence on the choice of STEM related studies.

Careers in STEM areas are welcomed by the environment and gain their acceptance. However, parents with lower education believe that their children do not need studies and it is a better choice to try to find a job.

There is no direct role model for career choice among those interviewed. For all four groups, the most important is the chance of finding a job, it is essential to have a high remuneration, and the possibility of fulfilment and satisfaction from one's job.

### *STEM*

For all interviewed, it was important that graduation from STEM allows you to find a well-paid job, there is a big demand for students in these faculties.

The vast majority of parents encourage their children to continue learning. They talk with them in the house about a future career path, but they leave the children with the final decision. Teachers and their teaching methods play an important role too. If the school represents a low level of science education, students do not choose STEM studies because they think that they cannot cope with them. A bad teacher can effectively discourage careers in STEM areas. Peers play an essential role too, with whom the majority of pupils who are choosing a study field talk with them and ask about experiences related to the planned faculty. In addition, for studying STEM one needs to be systematic and able to think logically.

### *Consequences of a STEM career*

All of those interviewed are aware of stereotypes of women in STEM. It is more difficult to find a job in those professions, because they must prove that they are as good as men. At the same time they often receive a lower remuneration than men who work in the same positions.

It is worth indicating that it would be a very useful and successful way of promoting STEM fields to organise meetings with people who have been successful in STEM. The meetings should take place at the stage of secondary education. Much mention was made of a very small amount of practical classes in high school and at universities; in pupils' and students' opinion learning at this stage is too theoretical.

## **Spain**

In general, the four studies present very common results; no big differences are notice. However it is possible to remark that female university students perceive that, for example, in physics or engineering studies, although there are a few women enrolled, they represent a larger group than in technologic fields. They attribute this to some woman's abilities, such as being methodical, persevering and responsible.

In addition, regarding personal values' dimension, female students also stand out personal recognition of efforts and merits by others.

Female teachers and mothers perceive more gender differences in the STEM world than male teachers and fathers. That can be observed as a socio cultural influence. From pupils and female students' perspective we cannot explicitly observe on career choice an external influence or gender differences. However, teachers and parents think that stereotypes still exist. Female students also are more aware than pupils about teachers' influence or role importance, and it is the only group which distinguishes closed network and lack of shared information at the STEM world.

## **UK**

In total, 43 interviews and focus groups with 35 pupils were conducted (see table 6).

**Table 6. Numbers of interviews and focus groups in UK**

	<b>Interviews</b>	<b>Focus groups</b>	<b>Total</b>
<b>Pupils</b>	<b>15</b>	<b>25</b>	<b>40</b>
<b>Parents</b>	<b>8</b>		<b>8</b>
<b>Teachers</b>	<b>9</b>		<b>9</b>
<b>Students</b>	<b>11</b>		<b>11</b>
<b>Total</b>	<b>43</b>	<b>25</b>	<b>68</b>

***Individual level***

Most of the parents had been to university and all of the pupils interviewed hope to go to university and know broadly what area they want to study in (all students and teachers are or had been at university). In all the studies except the teachers, there were interviews with both STEM and non-STEM people. Few people in any of the groups had direct role models for their career but almost all cited parental support for whatever they chose to do and practical support both financially and in finding out more information to support decision making. Families were important supporting influences, but this was general, rather than being STEM related. Teachers of particular subjects had a big influence on some career choices but again this happened for both STEM and non-STEM subjects and careers. The Remarkable Women (RW) were different in that they commonly reported strong role models, and direct shared interests with parents.

***STEM***

STEM subjects were often seen as ‘hard’ subjects across all four groups, but also as providing greater job security than many other areas and that this was seen to be important in the current economic climate. Some people viewed STEM as being well-paid and all saw careers in STEM as being adequately paid – more important to most people was that they would be comfortable financially than receiving very high salaries. STEM was generally seen as important to society, both by those in STEM and those who are not.

***Consequences of a STEM career***

Often the nature of jobs in STEM areas was not well understood and work experience was very important for many pupils and students in making their career choices. All four groups see gender stereotypes persisting in society – in TV advertising, in anecdotal evidence of women having difficulty in making progress in STEM career environments etc., but pupils and students seemed to think this was less prevalent now than parents and teachers did. Schools seemed to view STEM subjects as being suited for clever pupils and STEM subjects are seen by all groups as ‘hard’ – which may give STEM greater prestige but also put some potential recruits off. All groups feel that work experience placements in STEM environments, and events showcasing STEM, are important ways to increase the understanding of what various careers in STEM actually involve. This was particularly marked for the RW.

**Summary of commonalities between the national contexts**

The results of the qualitative studies conducted so far suggest that there are many similarities amongst the participating countries and target groups. The hypothesis that parents and teachers greatly influence the career decisions of pupils are supported in all cases as they comprise important elements of the latter’s social environment.

Regarding the perception of STEM in general, STEM related fields are regarded as more *prestigious, interesting, and up-to-date with global developments* and with *higher employment prospects and salaries* in comparison with other fields in all national cases and target groups. At the same time these fields are also considered more *difficult* than other fields, *time-consuming, competitive* and *demanding*. In this respect, in most cases it was reported that these characteristics may present obstacles for women who are generally viewed as placing the *work-life balance* in higher priority than men.

The belief that *people should study what they really like* without influence was also presented as a dominant personal value and career choice factor in all cases and target groups. Secondary reasons for career choice were the *prospects in the job market, high salaries* and *high social status* with small variations on the priorities in all national cases and target groups.

In some cases, there were similarities between specific national reports in countries that face similar matters. For instance, the concern for the *economic crisis* was presented in Greece and Spain, placing the ‘job prospects in the labor market’ high in the priorities of the target groups. STEM related fields were still considered best options in these cases too, reaffirming the high regard STEM has in society in general. It seems that the higher job prospects in STEM make parents and teachers to promote it almost equally to their students and children regardless of gender.

*Social class, economic status* and the *profession of parents* seem to play a significant role in all cases. It was generally observed that the gender disparities in relation to STEM as a field study or career were wider in lower classes, while there were fewer gender differences in higher classes (in better schools) and to youngsters whose parents work in the fields of STEM.

It is interesting to note the case of the UK and Greece, where in both cases a specific school was used as a case study and the results can both reflect differences and similarities. In the UK case where the school used as a case study was of high standing (the Belfast Royal Academy) the gender imbalance in the uptake of STEM subjects is much lower in comparison to other schools (see the UK report, appendix 1). In the case of Greece where a public school was used as a case study, the gender imbalances and the dominance of gender stereotypes were found stronger in relation to the UK case and in relation to some other individual interviews from pupils attending a private school of high standing in the same city.

In addition to that, it seems that although in most cases ‘role models’ were not reported as very significant, many of the people interviewed are or were actually highly influenced by *charismatic teachers* and the *profession of their parents*.

*Self-confidence* and the *use of successful women in STEM* fields as role model was reported as a great factor that disadvantages or facilitates women in STEM as it was shown in most cases and more obviously in the UK case where such professionals were used to promote STEM to female pupils. This was also reported as a suggestion that would facilitate girls (Germany, France). In addition, the UK conducted a parallel study of early career women in STEM who support other women to follow STEM related fields which showed that all of these women declared their self-confidence and they seemed ‘comfortable in their skin’.

Despite the differences, the view of the STEM fields as overall ‘*masculine*’ was present in all cases. It was also reported that it is easier for girls to follow STEM than boys to follow social sciences or the humanities, an interesting point to be considered.

In most cases (France, Greece, Spain) gender bias were becoming more evident later in the course of study or career of women in STEM, as they reached more higher positions. Female pupils were generally not aware of obstacles or stereotypes where female students were more aware of them.

The role of the teacher appeared as very significant and the role of the parents were presented as being supportive no matter the choice of their children (with few exemptions coming from the lower classes). The *social dimension of science* was also stressed in most cases (Spain, UK, France) when discussing about women in STEM, where girls are reported to be promoted and to prefer fields such as medicine and biology, suggesting that the social skills of women are still considered as an important trait in their societal role and their ‘nature’. Similarly in Spain there was a ‘feminine’ view of astronomy and physics because these fields were perceived as more *philosophical*; thus, again there is a connection of femininity and the humanities in the frame of STEM in order to break the masculine view of science. It is obvious that the social and theoretical skills of women are stressed in all fields, even the scientific ones. Linking that to the responses concerning the abilities a person should have to follow a successful career in STEM, where in all cases attributes such as a “practical mind” were named, it could be assumed that these attributes are still considered to be more or less “masculine”.

Finally, the need for more *information* in relation to STEM studies and careers was stressed in most cases.

## 4.2 Differences

### Germany

#### *Individual level*

In this section, the main differences between the groups regarding the individual level will be shown. With regard to values, the impression after analysis was that the only obvious difference between the groups is that pupils are more focused on friendship which might relate to the young age (age of 14 to 20 years). In comparison, teachers and sometimes students of higher semester are more focused on questions about how to combine family and work.

#### *STEM*

In this section, the main differences between the groups regarding the STEM in general will be presented. The assessment of STEM careers in general was analysed. The priorities of the motivational factors are sometimes not similar: female students are more likely to self-realization aspects (meaningful job, joy at work) and parents and teachers are more focused on financial aspects like the payment and job prospects. This result could be interpreted that the job content and identification is more important to students than the salary. With respect to abilities in STEM, the group of female students think that if one is less gifted with regard to logical reasoning it could be difficult to persist in STEM and they would not recommend those pupils to study in STEM. Analysing the socio-cultural influences, most families are supportive regarding career choice in all groups. Some exceptions are given in the group of teachers and female students. Some parents of the teachers, who did not study, said that their children should start working instead of studying. This is a hint for a low socio-economic background which could hinder one to pursue a STEM study or career. Further, few parents of female students were sceptical if her daughter is good enough for study a STEM subject.

#### *Consequences of a STEM career*

Asking about possible obstacles in a STEM career it could be distinguished between some parents and pupils in comparison to the other groups: a few parents and male pupils think that there are no obvious obstacles if one wants to study STEM seriously, because if one has the wish to study in STEM they will find a way to make it. Female graduates, post graduates, teachers, and the major part of parents on the contrary could imagine that there could be obstacles in a STEM career in general and sometimes in particular for women in this field.

With regard to facilitators, it becomes clear that parents support their children by giving STEM specific toy or tasks could increase the interest for these subjects. Parents give their children also financial support during the study. A STEM profession of a parent could be also a facilitator by showing the workplace which aims at increasing children's interest and motivation for a STEM career choice. In addition, teachers could be a facilitator as job role model by sharing their own study experience with pupils or by making an interesting STEM-class that fascinates pupils.

### France

#### *Individual level*

- We can note differences in the speech according to the age of pupils; the more we advance in age, the more they seem aware of the issues of the labor market.

- The habit of coeducation has conducted pupils to have the representation of a universal undifferentiated education and knowledge, with the idea that gender equality is obvious, making it difficult to identify differences between the sexes.
- Concerning the conciliation between family life and professional life, this factor seems important for mothers and teachers, but appears little or not in the words of other groups (fathers, children and students).
- Many boys have no idea about the underrepresentation of girls in the scientific studies. When we asked "Why do you think the girls choose less careers in STEM? ", many exclaim: " Oh! I don't know!" We see that younger respondents are not aware of this issue, but when we advance in age, the answers are more frequent. As for their explanations, they are identical to those set for the target groups in general, namely, the girls have other interests ("they are moving more towards the social", "girls are more literary") and studies are difficult (hard work, long studies)...

### **STEM**

- There is a strong involvement of parents in children's education. Attitudes toward school differ somewhat according to the different social settings but all attach a great importance to school and expect a lot from it.
- We can nevertheless confirm an impact of the parents' educational level, the parents' occupation concerning the arguments related to the ambitions for their child ("to make a career" or "to do what he/she likes "or "to be able to get a good quality of life" or "to cope"). Less educated parents or those who do not work in education seemed to have less control on the curriculum and the education of their children (suffering more of failure or redirection of the child, relying more on opinions and decisions of the school, for example).

Among the factors for career choice, we can note that:

- For the teachers: the pleasure, the interest for STEM is very important in their choice of teaching: "To do what I love" (man), "To do something that pleases me" (woman), "doing a job I like and that interests me" (woman).
- The girls opt more for scientific studies regarding to the career they wish to pursue; we can note a reverse mechanism for some boys: they are gifted in STEM, so they will find a job related to their capacity STEM. The girls have an idea for a job and will therefore follow the curriculum required to achieve it.

### **Consequences of a STEM career**

- About the disaffection of young people in STEM, we find the same remarks among girls and boys; regardless of their option (scientific or not), students respond overwhelmingly that the studies are too long and too hard.
- While having strong ambitions the girls make mostly school choices that can be described as advisable, wise.
- Parents are also involved in a practical way in the pursuit of studies, notably by helping to find a training site. Mothers are always more active in this area than fathers.
- If we stick to the parents' speech, it doesn't appear clearly that parents have different school ambitions for their boys and for their girls. But we must note that most mothers do not want their daughter to go and study too far away from home, while this was not observed neither by fathers nor for boys.
- Women emphasize more the fact of encountering difficulties in being integrated into the professional world.
- "Feminist claims" appear in girls' words: the weight of marriage or motherhood, culture, identity, the difficulty for women to fit into a masculine world.



- Women's access to more equality goes through a greater female solidarity between generations. This can be found in the speeches of female pupils (in highlighting the importance of being a pioneer) and among students and mothers, claiming the changes and modifications yet to provide in the society and specifically on the labor market.

## Greece

The differences between target groups seem fewer in relation to the commonalities. Most of the differences that were found are connected to the social class and the economic status of the individuals and some had to do with the awareness on gender issues and obstacles for women in STEM according to age and gender.

First, the results suggest that there are differences in the perception of STEM in general and women in STEM specifically *across geographical areas and social classes*. Those coming from the upper classes (pupils studying in private schools or had parents who worked in STEM fields) tended to be less aware of the obstacles women face in STEM fields and also they expressed stereotypical beliefs less often or less openly. Those coming from lower classes held more traditional views of the societal role of men and women and expressed more often the belief that women are not meant to study or follow a STEM career by 'nature'. However, strong stereotypical beliefs were also expressed by some teachers who said that girls are naturally better in other fields and not STEM. Major differences were found between rural and urban areas, as in rural areas youngsters are less willing to study in University in general and girls are basically limited to some 'traditionally female' professions or becoming housewives and boys are usually raised to take over a family business or to follow the profession of the father.

Second, it is interesting that only the teachers identified *influences from the media* on the pupils and very strong ones as a matter of fact. Furthermore, because of their long experiences with parents, they were able to give more insight on how they influence their children and especially girls who are reported to be discouraged by the family to follow a career in STEM. These issues were not raised in the other target groups. Pupils on their majority claimed they were not influenced by their family or the media, and parents were overall agreeing that they do not and should not influence the career choice of their children. These differences may reflect first, the different backgrounds of the target groups, as teachers have more experience from a wider spectrum of social groups and geographical areas and have faced different cases; and second, that there is lack of awareness on how much each group (parents, teachers) really influence youngsters. What was happening was that, on the one hand, *teachers overemphasized the role of the parents and on the other hand parents overemphasized the role of the teachers*. When doing a self-reflection on the influences they might have on the youngsters, in the most part they claimed that *'the social environment is overpowering them'*.

Third, there were *differences between the female pupils and the female university students*. What was observed was that female pupils were less aware of the obstacles and stereotypes that women face in STEM fields and most claimed they were treated equally more or less. These beliefs seems to change as girls progress in their course of study, as female students appeared more aware and concerned of the obstacles they had to face as women. The results suggest that girls face more obstacles as they proceed in their studies and career in STEM and, in turn, become more aware of them as they gain experience and develop critical thinking.

## Poland

Female pupils are confident that they are predisposed to study science as well as boys, and it all depends on their own self-discipline and determination. Students do not have complexes because of their gender. They have the same perception and knowledge of technical and scientific professions and jobs in STEM.

Awareness of stereotypes and overcoming their problems occurs with the age of the respondents.

Parents are aware that STEM studies are difficult. After all, most of them support children in their choices and they wish to pursue these ambitions and their dreams. This is especially important for people with higher education. But there are parents who prefer their children to take a job instead of studying, or parents who have sufficient doubt in the ability of children to do STEM studies. There was a minority group of parents who regard that such studies are good for the boys, not for girls.

At the same time there is a common opinion among all four groups that the STEM studies provide employment and high remunerations. These are also the priority factors in choosing a career path.

### **Consequences of a STEM career**

Both girls and boys indicated the same obstacles in undertaking STEM studies. Answers which were repetitive are as follows: these studies are too difficult and they do not always provide knowledge which is practical. However, if someone is determined then nothing should prevent him/her from doing studies in the area of STEM. An increase of interest in STEM studies is expected because of the contracted study programmes in which students receive high scholarships.

When pupils make a decision about studies, they are guided by the opinion of parents and friends. An interesting conclusion ensues from the research and it is connected with the role of teachers in this area. Their attitude, the way of teaching and knowledge, can effectively block the motivations for the career in STEM. This is confirmed by the results of the *matura exam* in 2011. In this year every fourth pupil had not passed it because of the math exam.

## **Spain**

In general, the four studies present very common results; thus no big differences could be noticed.

## **UK**

### ***Individual level***

Most of the pupils and students interviewed had strong academic backgrounds, but some of the teachers had been late developers and two of the parents had left school at age 16 to start working. These differences did not seem to affect responses to any aspects of the study in a systematic way. The view of gender stereotyping seemed to have a fairly strong association with age - parents and teachers seeing it as more common and stronger than did pupils and students. The pupils talked more than other groups about hoping to make a difference in their careers.

### ***STEM***

There were some quite disparate views on gender differences in STEM abilities, but there were more differences within the groups than there were between groups. The one exception was that teachers generally saw girls as having a greater range of subjects to choose from because they were more thorough in their approach to studying, and this was seen as a reason why fewer girls went into STEM – they had more options than boys. Teachers also seemed to place more emphasis on the need for pupils first to be engaged with STEM otherwise they would not get anywhere with those subjects – other groups concentrated more on where they saw differences in abilities and that they thought STEM subjects are hard.

### ***Consequences of a STEM career***

There were some differences between the groups in terms of how much of an obstacle to STEM recruitment is still associated with gender stereotyping – generally the older groups (parents and teachers) thought there is more of an obstacle than do the younger groups. Teachers seemed to emphasise the need for making STEM relevant and broadening pupil experiences beyond the school curriculum, more than other groups.

## Summary of the differences between the national contexts

The differences between target groups and national cases seem fewer in relation to the similarities so far. There were some differences that are connected to the economic status of some states (Greece and Spain) and others, which appeared in most cases, had to do with social class and the economic status of the individuals. In cases where the interviewed subjects came from higher classes and/or countries that do not face serious economic depression, the issue of salaries and money was not reported as very important, such as in the case of the UK; while in other cases where the interviewed subjects came from lower classes and there is economic depression in the country (such as in the case of Greece), issues of money and employment are placed high in the career factors.

Thus, it seems that although in all cases and target groups it was supported that people should study and follow the career that they like, in some cases the good job prospects and high salaries were reported more often as a motivator.

In Spain life experiences (e.g. having to take care of a sick relative) were a main element of motivation for career choice, a trait not presented so strongly in other cases. In the UK, work experience was presented as the greater motivator for career choice, a trait not presented in other cases; probably because the Belfast Royal Academy offers this opportunity to its pupils, where this is not happening in most schools. However, as it seems that work experience is highly motivating, it should be considered as a strategy.

In the case of Spain, it was found that the influence of friends, siblings, teachers and TV characters was stronger than the influence of the parents. On the other hand, peer influence was not reported as important in other cases and TV characters were only reported as important in younger ages (Germany) and by some target groups (teachers in Greece).

Another interesting finding was that in most cases parents highlighted the role of the school and teachers as an influential force on the youngsters and the teachers highlighted the role of the parents and family environment. Overall, the studies so far suggest that parents and teachers together play the most important role on the career decisions of youngsters. Pupils and students tend to report the role of the teachers more often as an inspirational force.

Gender imbalances and stereotypes in the uptake of STEM by girls was not as present (or visible) in the UK and Germany and they were stronger in Greece, Spain and France. This may be related to the sample selection (school standing, social class, rural or urban areas), even though it is commonly accepted that Greece and Spain are considered more traditional societies.

## 5. Triangulation of the four studies within each dimension

In the following section, the triangulation of the four studies within the three main research dimensions (individual, STEM, and consequences) will be presented.

### 5.1 Individual

In this section the triangulation of the four studies on the individual level will be exposed for each national case.

#### Germany

The central findings will be illustrated with respect to the individual level for Germany. The educational pathways of the STEM-students and teachers of STEM subjects are similar: they nearly all studied a STEM subject directly after the Gymnasium. The major part of the parents also achieved an average educational level (“Abitur”); some of them achieved a high educational level (university degree). Nearly all interviewed pupils want to study in the future by tendency even if they do not know which subject yet. This could be a hint that most of the participants have a higher educational class background. With regard to values, the most important values are honesty and reliability as well as other values like ambition, work environment, family, and friendship. Obvious differences are the fact that according to the age pupils are more focused on friendship. Female teachers and sometimes students of higher semester are more concentrated on questions about work-life-balance. Most of the interviewees say that they had no direct role models for their career choice but some parents worked in STEM thus the children get in touch with STEM in their childhood. The factors for the career choice are different but most important factor is the joyful work in STEM. This is more subject to pupils and students. One remarkable gender difference between pupils is that girls prefer more social and job security factors for their career choice and some boys are more focus on financial aspects. Opportunities of a high salary are more often named by parents the job guaranty more often by teachers.

#### France

On the individual level, the pupils and students we have met are (or were for students) more often “good” pupils who have not repeated a class; the social diversity is wider among parents. In any case pupils and students as well as parents, teachers, and students consider that a STEM orientation is a promising orientation although it is a demanding one at the same time. Even if all the parents encourage their children to pursue their studies, the STEM background of the parents, uncle or other member of the family is more incentive for some. All parents underline that the career choices of their children are free but the parents whose educational level is high relate higher ambitions for their children and are less dependent of the teachers’ opinions to help their children regarding their choices.

#### Greece

The vast majority of the people interviewed shared a similar educational background and most developed a preference in their field of study from an early age (about 11-13). Very few interviewees had not completed University studies and all the pupils interviewed intended to continue studying in the University.

All target groups shared similar personal values that focused on the humanitarian side of each job or personal action, they all believed people should follow their dreams without being influenced by the opinions of others, and they also all highly valued the family and free time (women more often).

Although no major influences were reported by the interviewees themselves, it seems that most did not deviate from the expectations of their social environment. Very often individuals decided to follow a field

similar to the one of their father or mother, they reported to be inspired by their professors and teachers and girls embraced social expected roles that lead them more often to theoretical fields and not STEM.

## Poland

Most pupils and students consider which professions are more likely to have employment opportunities in the future. For boys the leading role is played by their own interests. All four groups believe that STEM is a very good and reasonable choice. Another important value is self-realization.

Regarding the factors for career choice the interviewees pointed out good job prospects, obtaining future-oriented professions, which is valued by society and a guarantee of high salary. The most important factors are: possibility of employment, skills, experiences, connections, abilities, prestige and passion. Current and projected demand for specialists in the labour market is also a consideration.

## Spain

In general, interest in STEM studies is developed in childhood regardless of sex. For girls, subjects as biology, nature sciences and chemistry seems to be the most preferred ones. At school, most of girls are in the biological-health modules. Boys like more mathematics, physics, and technology. Further, most of them are in technology modules.

More than a professional career, the perception of the four groups is that girls' and boys' value having a good job in order to earn money. This seems to be stronger for boys because social recognition is more important to them. For girls, STEM studies make it possible *to help others and take care of people*, a reason that encourages them to be involved in these areas. What is most shared in students' opinions is the value of personal dreams and personal interests.

Main factors in choosing a career are to 'study *what you like*', "*what is more attractive*", and consequently, boys and girls are 'better at' or they feel qualified. Work prospects and aspirations in terms of salaries are very significant too.

Other important elements refer to entrance standards and the difficulty of some careers. It seems that patterns or stereotypes associated with careers and jobs can be observed as an indirect cause to choose future studies. It is not something that comes directly from the speeches but that it can be derived from some arguments.

## UK

An important finding is that teachers and parents are not seen to play a direct role in influencing the subject choices or career choices for the majority of pupils. Overall, pupils have their own interests, and are supported, rather than directed, in their choices. Pupil interests can, however, be shaped by childhood experiences and by inspirational people.

## Summary

Most of the interviewees in all national contexts had a similar (high) educational background and most developed a preference in their field of study from an early age. In Germany nearly all interviewed pupils want to study in the future by tendency even if they do not know which subject yet. Most of the pupils consider good job prospects (Poland) in terms of employment and high salary (Poland and Spain). In Germany, the opportunity of a high salary seems to be more important for parents than for pupils. One important factor for career choice is the own study interest of pupils. One remarkable gender difference between pupils in Germany is that girls prefer more social and job security factors for their career choice and some boys are more focus on financial aspects. In addition, the results of career choice factors in Spain are similar: girls take STEM-studies into account because those subjects make it possible to help others and take

care of people which could be seen as social aspects for career choice. Boys in contrast take these subjects because of the social recognition of STEM domain.

This aspect is more subject to Greece and Spain. An important finding is that teachers and parents are not seen to play a direct role in influencing the subject choices or career choices for the majority of pupils but the interest for STEM subjects can be shaped indirect by childhood experiences (Germany and UK) and by inspirational people like good STEM-teachers or family members.

## 5.2 STEM

### Germany

Further, the assessment of STEM careers in general was analysed. The most important incentives in STEM are enjoying work, interest in STEM, good job prospects and high payment in all groups. With respect to the results of the focus groups with pupils, positive aspects could be revealed that these girls mostly feel confident, thus they think they will be doing well in studying STEM and they know about the career opportunities as well as high salary in this field. The priorities of the motivational factors are sometimes not similar among the interviewees: female students are more likely to self-realization aspects (e.g. meaningful job, work-life-balance, and joy at work). In contrast, parents and teachers are more focused on financial aspects like the payment and job prospects. This result could be interpreted that the job content and identification is more important to the female students than the salary in comparison to the group of parents and teachers.

Regarding the demanded abilities for STEM subjects or careers, all groups agree that a basic STEM-related knowledge or understanding and in particular logical reasoning is necessary in this field. If one is less gifted in logical reasoning it could be difficult to persist in STEM-related fields.

Analysing the socio-cultural influences, most families are supportive regarding career choice in all groups and some of them discussed job orientation at home. With respect to their own children, parents and teachers talk about job orientation and career opportunities. However, the final career decision will be done by oneself in most of the cases. Some exceptions are given in the group of teachers and female students. Some parents of the teachers, who did not study, said that their children should start working instead of studying. This is a hint that a low socio-economic background which could hinder one to pursue a STEM study or career. In addition, a few parents of female students were doubtful if her daughter is good enough for study a STEM subject. Teachers had an important role model function for a lot of the interviewees in particular students and STEM teachers. They have been impressed by motivational and practical STEM classes of their teachers and sometime these teachers also encourage them to choose STEM. Friends did not play a decisive role in terms of career choice in all groups. To sum up, parents and teachers have the highest impact on pupils' career choice and direct in questions of interest and career in a certain field. Thus, strengthening a "home-school"-collaboration between parents and teachers concerning content of STEM classes that fits pupils' needs and exchange about information and initiative regarding job orientation in STEM could enhance more pupils in STEM.

### France

A strong interest for STEM seems to be required because these disciplines are deemed to be difficult. That is why parents claim they don't oblige their children to choose this pathway but prefer for them a good motivation for the studies they will choose. The support of parents seems to be essential for the members of the four target groups, but this of the teachers is also important; several people mention the important role of a teacher in particular in their motivation to go on in STEM. At the contrary, the influence of friends or media is not mentioned.



Many people, especially boys and fathers are not sensitive to gender gap between girls and boys in STEM. A lot of them are not conscious of the problem. It seems that the coeducation hinders the gender imbalance in STEM. Feminine students and mothers are more sensitive to this problem and, with the teachers, link it more to the difficulties met by the girls on the labour market.

If we look at the concept mapping results, we can see that the image of STEM is associated to positive values such as rigor, motivation, curiosity, tenacity and method and supposes to be a good worker, to be serious, to be good and gifted in these matters. But those needed qualities are also what keep away a lot of boys and girls away from a STEM orientation. Girls feel less confident in their capabilities, even if all declare that the women are as talented as men. A difference in the attitude of girls and boys has to be mentioned: while the girls opt more for scientific studies regarding to the career they wish to pursue, boys follow their talents: they are gifted in STEM, so they will find a job related to their capacity STEM. The girls have an idea for a job and will therefore follow the curriculum required to achieve it. The girls' choices seem to be wiser, as if they had to anticipate more, regarding to the difficulties they know they will have to meet to integrate the labor market, especially if they choose a STEM pathway, seen as “a male world”.

## Greece

STEM related fields are regarded as more prestigious, interesting, up-to-date with global developments and with higher employment prospects and salaries in comparison with other fields in all target groups. At the same time these fields are also considered more difficult than other fields, time-consuming, competitive and demanding. In this respect, in most cases it was reported that these characteristics may present obstacles for women who are generally viewed as placing the work-life balance in higher priority than men.

The abilities identified from all target groups as important to follow a STEM career focused on concepts such as ‘a practical mind’, ‘discipline’, ‘ambitious’, ‘hard working’, etc. In some cases, and specifically in the pupils and teachers target groups, it was explicitly stated that these are abilities naturally found more often in men and not in women. The role of the teacher appeared as very significant and the role of the parents was presented as being supportive no matter the choice of their children (with few exemptions coming from the lower classes). It was also shown that youngsters more or less follow similar career paths as their parents.

Furthermore, although all interviewees claimed that their number one motivation factor was to follow the field they genuinely liked without influences, it seems that socio-cultural influences existed but people were not aware of them. For instance, the role of the media was undermined by all target groups when talking about themselves; however, it seems that they have adopted a social imaginary of STEM and women promoted by the media and took into consideration the ‘new trends’ in the market (teachers followed informatics because it was advertised as ‘the new trend’).

## Poland

The most important motivation which determined the choice of study was the belief of finding employment, career opportunities, developing their interests and knowledge of faculty resulting from the disclosure of opinions and experiences of older siblings (or graduate students) or friends. Opportunities of high remunerations and the job guaranty are frequently mentioned by all four groups. Moreover, technical studies are one of the contracted degree programs so a student can obtain a scholarship.

Those surveyed said that STEM professionals should have a detailed knowledge but also should be versatile because it is required for the kind of problems solved by them. It is believed that in order to study STEM, a person must be good at math, to have special abilities in this field. STEM studies are for people:

- who have a special predisposition,
- for the best pupils,



- for people who do not have any problems with STEM subjects in secondary school,
- who are not afraid of difficult challenges,
- for the ambitious and hardworking.

For young people, a large role in shaping their aspirations is played by the peer group. Over the years family influence is decreasing in favour of the peer group and school. During adolescence, young people begin to prefer their peer environment over the family. In this period a circle of friends is particularly preferred. Thus young people often just follow their colleagues in terms of study or profession. However, the most important factor is their own opinion about career choice. There is also a quite important role of the parents, but the final decision still belongs to the students. The vast majority of parents support their children in their decision to study STEM subjects.

## Spain

Life experiences and practical learning can be observed as the main elements of motivation. For example, several pupils who want to be doctors say they are motivated by these studies because in childhood they had to take care of a sick family member.

In general terms, being good at mathematics or science, the possibility to discover new and dynamic things, and the utility of science-technology given the features of our world are elements very considered. In more specific terms, boys say that they are more attracted to hands-on studies than to theory-based subjects which they perceive to require more study and dedication. On the other hand, girls are more attracted to helping or taking care of people or being in contact with nature. Technology is less attractive to girls but studies which concern the world's conception (the earth and the universe) are much more interesting for them.

Employment projections also constitute an element of motivation, especially in the current economic crisis context. Most mentioned capabilities and skills correspond to:

- Being curious and creative
- Liking to discover
- Having the capacity for abstraction/ for observation and analysis
- Being methodical/ persevering/ responsible
- Having the capacity for space dimensions (3D)
- Being good at mathematics

When it comes to this, girls tend to be associated with having this 'disciplined' ability and boys having what is related to "space vision". We can observe that friends, brothers or sisters, teachers and characters from TV and other mass media are stronger models than the influence of parents (at least explicitly). Parents' influence seems to be stronger for girls than for boys (girls are more talkative with their mothers). This can show the implicit presence of social models and cultural patterns.

Another interesting fact refers to differences between influences according to socioeconomic levels or cultural backgrounds. For lower classes working as soon as possible is a value, especially for pupils that don't perform well. For middle classes, more than having a specific career, the important thing is to continue studying. For high classes, to follow studies at university is very important and to achieve a high professional level.

## UK

STEM careers are seen to have a number of attractive features in terms of being worthwhile, prestigious, and stimulating in the UK.

## Summary

Summarizing the results it could be established for that a strong interest for STEM seems to be required in order to pass in these disciplines successfully. Thus, STEM-subjects are perceived as difficult studies.

However, according to nearly all interviews STEM careers offer good job prospects and the opportunity of a high salary. Regarding the abilities which are needed to pursue a STEM career all target groups identified concepts such as ‘a practical mind’, logical reasoning, a basic STEM-related knowledge, and discipline as important. Analysing the socio-cultural influences, most families are supportive regarding career choice in all groups and some of them discussed job orientation at home. Some exceptions are given in the group of teachers and female students in Germany: Some parents of the teachers, who did not study, said that their children should start working instead of studying. This is a hint that a low socio-economic background which could hinder one to pursue a STEM study or career. This result of the influence of social-economic aspects is also established in Spain. Teacher and parents could have crucial role regarding pupils’ career choice even if they are not aware of them sometimes. In most of the countries the influence of friends or media is not mentioned only in Poland peer groups seems to play a role among pupils and in Spain friends, brothers or sisters, teachers and characters from TV and other mass media are stronger models than the influence of parents (at least explicitly). However, parents’ influence seems to be stronger for Spanish girls than for boys (girls are more talkative with their mothers). This can show the implicit presence of social models and cultural patterns. They are strongly orientated on their friends’ career choice.

With regard to gender differences, some observations could be revealed: In France, many people especially boys and fathers are not sensitive for gender gap between girls and boys in STEM. A lot of them are not conscious of the problem. In Spain, different priorities are reported by gender: boys are more attracted to hands-on studies than to theory-based subjects which they perceive to require more study and dedication. Girls are more attracted to helping or taking care of people or being in contact with nature with regard to study or career choice. This approves the traditional gender roles.

## 5.3 Consequences

### Germany

The main consequences of choosing a STEM career will be summarized. In general, all groups observe women specific obstacles like the lack of acceptance of women in STEM fields, the lack of female role models, stereotypes of STEM, the under-representation of women in STEM studies and a lower self-confidence of girls in STEM classes regarding their abilities in STEM. General obstacles are the demanding study in STEM and the change from school level in STEM to university. A few interviewees of parents think that there are no obstacles if someone wants to study STEM seriously he or she will find a way to make it.

With regard to facilitators, it becomes clear that parents support their children’s career choice by giving STEM specific toys or tasks could. These measures could increase the long-term interest for these subjects. Parents give their children also financial support during the study period. A STEM profession of a parent could be also a facilitator by showing the workplace for children’s interest and motivation regarding a STEM career choice. Teachers could be a facilitator by sharing their own study experience with pupils and by motivating the pupils.

All groups agree that schools could go more after (female) role models from the field of STEM professionals which aims at clarifying the vague job profile of a STEM professional or scientist for pupils. Further, more specific courses for girls in STEM at school are also named. One important suggestion of the groups is that the STEM class should be more practical which aims at motivating pupils and increasing their interests for STEM-studies or jobs in this area. Especially students suggest more courses for girls in STEM in order to enhance the self-confidence of girls in STEM, mentoring programs, networks, and more open days in STEM. To sum up, a lot of STEM initiatives for girls at school (e.g. Girls’ day, mentoring for students) could be remarked but all groups agree that there is still a need to improve the facilitating measures for girls.

## Greece

The economic crisis and the high unemployment rates in the country were presented as the one most important obstacle in all cases, regardless of gender. Female students seemed to be more aware that they will have a harder time to succeed in STEM related fields than men, as they already face discrimination and even harassment in University. STEM field are regarded as male-dominated and thus it was widely stated that women will find it hard to combine family and career in these fields, as they are more demanding and time consuming. The view of women as less capable than men to succeed presented in some cases indicates that such views are common in the general socio-cultural environment and negatively influences the self-confidence and career choices of girls.

STEM fields are regarded as more prestigious and up-to-date and for this reason parents and teachers like report that they promote both boys and girls to consider studying in these fields. STEM fields are considered to offer better job prospects and opportunities in times of crisis.

Having a good teacher that inspires and supports students was found to be a major facilitator. Support from the social environment and positive role models were found to increase the interest of youngsters in STEM.

## France

Concerning the consequences of a STEM career, different obstacles have been mentioned such as the small number of girls in the STEM trainings, the lack of female models in those pathways, the persistence of gender stereotypes, the obstacles for women to integrate the labor market, the difficulty of being surrounded only by men in a competitive work environment. The ignorance of the STEM jobs is shared both by boys and girls. The difficulties to reconcile professional and family life are more often mentioned by teachers and parents for the girls than for the boys, reflecting the persistence of relatively traditional representations of gender roles.

## Poland

The main obstacle in STEM studies is a stereotype that these faculties are very difficult and requires great knowledge of STEM subjects. Studying STEM is associated with the fact that one has to spend much time learning and there is a lack of free time. Study in STEM areas appears as more difficult than humanities faculties. Other reasons: lack of money for studying, lack of faith in their skills and abilities, or reluctance to learn. Negative aspects associated with entering STEM areas of study may also be a stereotype that STEM education is not for girls, the conviction of high demands, a large quantity of material to learn and pressures prevailing in these directions. Another obstacle is the prevailing discrimination in the profession, women engineers get paid less for equal work. For women in technical professions it is harder to succeed.

Students indicate a big transition in the material of STEM subjects in secondary school and at university, although this depends on the profile of the school and the quality of teaching.

The incentive to choose STEM studies would be a higher level of teaching STEM subjects in secondary school. It would allow people to choose STEM studies without any fear. If teachers were more involved then the situation could change. Such lessons should contain plenty of practical examples and there should be a lot of tasks to solve using a computer. The lesson should be discussed with examples from real life, or at least the issues they may face in the laboratory. It would be helpful to establish a meeting with individuals who have gained a good job after STEM studies to talk about their professional accomplishments and their STEM studies. This type of meeting should be held in schools.

## Spain

Regarding difficulties perceived it is possible to identify two kinds of obstacles. Some related to STEM studies and others to different concerns. Economic problems are identified with bad prospects for work. In

addition, there is a consensus that possibilities of studying and working in STEM areas are better in other countries, especially in the U.S. and UK, and in this sense low or no command of the English language also becomes an obstacle. Lack of scholarships or internships also represents an obstacle, especially for lower and middle classes. Otherwise, the possibility to have experiences in work environments is much valued.

About STEM studies obstacles, pressure and competition concern pupils and students, as well as dedicating many years to difficult and complex studies.

STEM careers are identified with better employment projections and better salaries than other professional areas. In relation to this some associate these studies with the possibility of working in a dynamic work environment that is less monotonous and more attractive than some other fields. Many pupils and students see STEM careers as the future and as fields which offer different job options and that are more valuable for society.

## **UK**

In the UK there is a general perception that STEM careers pose problems for work-life balance, and that working environments can be individualistic and competitive; these perceived features are disincentives for many people, notably women. With regard to facilitator measure for promoting women in STEM careers there were a lot of initiative in the UK (e.g. UKRC or STSEMNET).

## **Summary**

To sum up, STEM fields are regarded as prestigious work fields in which high salaries were expected in all countries, therefore parents and teachers like report that they promote both boys and girls to consider studying in these fields. These subjects are also perceived as difficult study subjects. According to country specific circumstances like the economic crisis (Greece and Spain), the job prospects in general were limited. A lot of different barriers could be established by the project partners which are mostly related to women in these fields: Most important obstacles are the work-life-balance in STEM careers and stereotypes. The under-representation of girls in STEM-subjects and women in STEM careers are also a reason for some girls not to choose STEM.

Most of the partners agree that different facilitators are still necessary in this field: e.g. increasing the numbers of (female) STEM-professionals as role models in schools, good STEM-teachers as well as practical STEM-classes, and an intensification of information about new job opportunities in STEM which should be provided in schools. Thus, it would be a basis which aims promoting more interest for STEM-subjects by pupils as well as improving the gender equality in STEM careers.

## 6. Summary and Discussion

### Germany

To sum up, the results of the qualitative studies with the different target groups reveal that the group of STEM-teachers and STEM graduates students had a similar educational pathway (Gymnasium and STEM study at university). Most of the pupils want to study in the future and most of the parents graduated at least with Abitur. With regard to the values and factors for career choice the answers of the groups were quite similar. However, female students in STEM are focused more on self-realization aspects (e.g. meaningful job, joy at work). In contrast, parents and teachers are more focused on financial aspects like the payment and job prospects. With respect to the socio-cultural influence, it could be shown that teachers and parents of STEM profession might play a decisive role in the career choice process of pupils. The main consequences of a STEM career will be summarized. In general, all groups observe obstacles especially for women in STEM like the lack of acceptance of women in STEM fields, the lack of female role models, stereotypes of STEM, the under-representation of women in STEM studies and a lower self-confidence of girls in STEM classes regarding their abilities in STEM. General obstacles are the demanding study in STEM. With regard to facilitators, all groups agree that schools could introduce more (female) role models from the field of STEM professionals, promote more specific courses for girls only in STEM, and improve STEM classes by increasing the practical-oriented part in STEM-subjects during the lessons. To sum up, the results showed that that the interest of pupils for STEM career could be increased by more practical STEM-lessons and by role models like teachers and parents. Therefore, good practice guidelines in STEM will be developed in this project.

### Greece

The main findings are summarized below:

- STEM fields are considered prestigious, progressive, interesting, and overall ‘masculine’.
- Abilities such as having a ‘practical mind’ and being clever and hardworking are more often listed as important to follow a career in STEM.
- Gender stereotypes are strong and evident in all cases.
- The Greek economic crisis is a major issue of concern in all cases.
- The traditional role of the woman as a mother and wife was the most important obstacle the target group named to explain why there are fewer women in STEM.
- It was also reported that girls are more scared and less confident when it comes to STEM courses.
- The role of the parents is considered more influential on the pupils by the teachers.
- The role of the teachers is considered more influential on the pupils by the students and pupils and by many parents.
- Girls are reported to be better students at all subjects but still prefer to study and follow a career in theoretical fields.
- Girls coming from the lower classes meet significantly more obstacles than boys to study and follow a career in STEM.
- Pupils in rural areas are less aware of their career options.
- Girls were more aware of gender stereotypes and discrimination than boys, and they became more aware of these issues in the course of their studies in the University.
- Discrimination based on gender was reported to be far less evident in the high school classroom in comparison to the University classroom, where women reported that they are often ignored by the professors.
- Cases of sexual harassment in the University were also reported.

- Most teachers and parents seemed to agree that gender inequalities and stereotypes exist everywhere in society and efforts to eliminate them go beyond their capacity.
- Parents and teachers were less aware that they are actually part of the socio-cultural environment and in some cases undermined the power of their influence on youngsters.

## France

Even if the majority of the pupils and students interviewed have good results, we can point out some differences between girls and boys. First, we can highlight the mechanisms of "self-censorship," "self selection" of girls who make "reasonable expectations" and choose the trades that seem most compatible with family life (this concern is not often found among boys). In the same idea, some teachers point out the fact that girls are less confident in their abilities in STEM or are less motivated in science. But for most, the problem is less motivation than confidence (girls lack self-confidence). One can draw parallels with the fact that girls are asking more questions; leave as a worse experience than boys their doubts about their orientation (interviews with pupils, students and parents).

Gendered logics can be observed in educational guidance. The girls opt more for scientific studies regarding to the career they wish to pursue; we can note a reverse mechanism for some boys: they are gifted in STEM, so they will find a job related to their capacity in STEM. The girls have an idea for a job and will therefore follow the curriculum required to achieve it. Boys are more guided by their taste and ability in a discipline, girls by the projects of career they have defined. Many gifted girls with good results at school in the STEM disciplines do not opt further for graduate study in STEM because they meet difficulties to project themselves into a job (lack of female role models, male image in the trade).

## Poland

Pupils have many doubts, a clear disbelief in their own abilities and for that reason they do not plan their future because they are not sure if they will be able to handle the tasks. STEM studies are perceived by pupils as very difficult and intellectually demanding, but graduation is a great opportunity to get a high salary. They all stressed the importance of seeing and talking with professionals who have graduated STEM studies. Pupils desire examples of concrete, real life. In addition, classes should be more practical. It could have an influence on increasing interests for STEM.

The decision of young people in choosing a field of study often affects the closest environment. They go for STEM faculties, because most of his/her classmates chose them, and what's connected with this, they could study in the group of good friends. A future prestige of the profession is also significant. By choosing such studies young people hope that money will follow prestige. In selecting studies other criteria than the student's abilities often determine a decision. Sometimes it happens that the candidates choose the faculty that is the easiest to study or to satisfy the ambition of their parents. They are often driven by "fashion" created by media. Candidates for the study are interested in scholarships, but an important role is also played by access to university facilities (location, availability of places in dormitories). Modern and well-equipped laboratories will encourage the choice of studies in these faculties and it is an important issue for students. Currently, very often they are equipped with outdated equipment.

In general, parents see the positive image and job prospects in STEM. It seems that a high chance to get a job and high salary are important factors concerning career choice. Nearly all parents discuss with children their career pathways. It is a popular conviction that a child who wants to study STEM should be gifted in these subjects. The main sources of information about studies were websites of universities, open days and recommendations of students' friends. As a conclusion it should be noted that all four groups are aware of the positive and negative aspects with regard to females in STEM.

## Spain





It seems that models and cultural patterns are present: there still is a certain traditional vision of fields of study and work. Pupils don't know about new occupations and specializations that current careers offer. Contact of secondary pupils with the university and the workplace are missing: practice, outings, and talks are needed.

Pupils and students should know how the STEM world develops at the practical level of work. More information and communication is needed to go against stereotypes. In general the STEM world is economically higher positioned, has more prestige, and is considered more difficult and competitive than other fields; these fields have better prospects and high salaries, and most people believe that these careers are more valuable for society and allow a more secure future. Even though this sense of future security is variable in the current economic context, most of interviewed consider that STEM studies permit more stability than other fields.

Although the STEM world is seen as an environment with many possibilities and different applications or projections, there is no concrete knowledge about this. This reflection rather corresponds to tradition and prestige factors. This may be revealing the influence of socio-cultural elements, which in fact change with time. Teachers have an essential role at upper secondary level: they can strongly encourage or discourage pupils depending on their way of teaching (*“he /she can inspire you or make you seriously doubt yourself”*).

STEM abilities are common for each gender, and in general pupils and students don't observe direct gender obstacles. Maybe this could be explain by the fact that they don't have yet contact with the work environment (they can't imagine their professional future).

In general, girls tend to choose biology or health studies, because –according to the responses- they like the contact with people and nature, to help others, and they also show little interest in technologies. When subjects were asked if this was due to cultural or genetic factors, the responses in general were divided between the two choices, and in fact mostly men were those who tend to remark genetic or biologic elements to explain this reflection. The STEM world is not observed to be more “masculine”. However, pupils recognize that in technology and physics more boys are present, and in biology and chemistry it is the opposite (boys are more attracted to hands-on studies than to theory based subjects which they perceive to require more study and dedication).

In many cases, gender differences are observed as something of the past with no relevance for the current society. However, in fact when contact with work environment happens, most of people notice a real difference.

### Summary of all national contexts - Similarities

The results of the qualitative studies conducted so far suggest that there are many similarities amongst the participating countries and target groups. The hypothesis that parents and teachers greatly influence the career decisions of pupils is supported in all national cases.

Regarding the perception of STEM in general, STEM related fields are regarded as more *prestigious, interesting, up-to-date with global developments* and with *higher employment prospects and salaries* in comparison with other fields in all national cases and target groups. At the same time these fields are also considered more *difficult* than other fields, *time-consuming, competitive* and *demanding*. In this respect, in most cases it was reported that these characteristics may present obstacles for women who are generally viewed as placing the *work-life balance* in higher priority than men.

The belief that *people should study what they really like* without influence was also presented as a dominant personal value and career choice factor in all cases and target groups. Secondary reasons for career choice were the *prospects in the job market, high salaries* and *high social status* with small variations on the priorities in all national cases and target groups.



In some cases, there were similarities between specific national reports in countries that face similar matters. For instance, the concern for the *economic crisis* was presented in Greece and Spain, placing the ‘job prospects in the labor market’ high in the priorities of the target groups. STEM related fields were still considered best options in these cases too, reaffirming the high regard STEM has in society in general. It seems that the higher job prospects in STEM make parents and teachers to promote it almost equally to their students and children regardless of gender.

*Social class, economic status* and the *profession of parents* seem to play a significant role in all cases. It was generally observed that the gender disparities in relation to STEM as a field study or career were wider in lower classes, while there were fewer gender differences in higher classes (in better schools) and to youngsters whose parents work in the fields of STEM.

It is interesting to note the case of the UK and Greece, where in both cases a specific school was used as a case study and the results can both reflect differences and similarities. In the UK case where the school used as a case study was of high standing (the Belfast Royal Academy) the gender imbalance in the uptake of STEM subjects is much lower in comparison to other schools (see the UK report, appendix 1). In the case of Greece where a public school was used as a case study, the gender imbalances and the dominance of gender stereotypes were found stronger in relation to the UK case and in relation to some other individual interviews from pupils attending a private school of high standing in the same city.

In addition to that, it seems that although in most cases ‘role models’ were not reported as very significant, many of the people interviewed are or were actually highly influenced by *charismatic teachers* and the *profession of their parents*. In Spain friends, brothers or sisters, teachers and characters from TV and other mass media are stronger models than the influence of parents (at least explicitly) on the one hand but parents’ influence seems to be stronger for girls than for boys (girls are more talkative with their mothers) on the other hand. This can show the implicit presence of social models and cultural patterns. The peer groups have impacts on career decisions by Polish pupils.

*Self confidence* and the *use of successful women in STEM* fields as role model was reported as a great factor that disadvantages or facilitates women in STEM as it was shown in most cases and more obviously in the UK case where such professionals were used to promote STEM to female pupils. This was also reported as a suggestion that would facilitate girls (Germany, France). In addition, the UK conducted a parallel study of early career women in STEM who support other women to follow STEM related fields which showed that all of these women declared their self-confidence and they seemed ‘comfortable in their skin’.

Despite the differences, the view of the STEM fields as overall ‘*masculine*’ was present in all cases. It was also reported that it is easier for girls to follow STEM than boys to follow social sciences or the humanities, an interesting point to be considered.

In most cases (France, Greece, Spain) gender bias were becoming more evident later in the course of study or career of women in STEM, as they reached more higher positions. Female pupils were generally not aware of obstacles or stereotypes where female students were more aware of them.

The role of the teacher appeared as very significant and the role of the parents was presented as being supportive no matter the choice of their children (with few exemptions coming from the lower classes).

The *social dimension of science* was also stressed in most cases (Spain, UK, France) when discussing about women in STEM, where girls are reported to be promoted and to prefer fields such as medicine and biology, suggesting that the social skills of women are still considered as an important trait in their societal role and their ‘nature’. Similarly in Spain there was a ‘feminine’ view of astronomy and physics because these fields were perceived as more *philosophical*; thus, again there is a connection of femininity and the humanities in the frame of STEM in order to break the masculine view of science. It is obvious that the social and

theoretical skills of women are stressed in all fields, even the scientific ones. Linking that to the responses concerning the abilities a person should have to follow a successful career in STEM, where in all cases attributes such as a “practical mind” were named, it could be assumed that these attributes are still considered to be more or less “masculine”. Finally, the need for more *information* in relation to STEM studies and careers was stressed in most cases.

## Summary of all national contexts – Differences

The differences between target groups and national cases seem fewer in relation to the similarities so far. There were some differences that are connected to the economic status of some states (Greece and Spain) and others, which appeared in most cases, had to do with social class and the economic status of the individuals. In cases where the interviewed subjects came from higher classes and/or countries that do not face serious economic depression, the issue of salaries and money was not reported as very important, such as in the case of the UK; while in other cases where the interviewed subjects came from lower classes and there is economic depression in the country (such as in the case of Greece), issues of money and employment are placed high in the career factors. Thus, it seems that although in all cases and target groups it was supported that people should study and follow the career that they like, in some cases the good job prospects and high salaries were reported more often as a motivator. In Spain life experiences (e.g. having to take care of a sick relative) were a main element of motivation for career choice, a trait not presented so strongly in other cases. In the UK, work experience was presented as the greater motivator for career choice, a trait not presented in other cases; probably because the Belfast Royal Academy offers this opportunity to its pupils, where this is not happening in most schools. However, as it seems that work experience is highly motivating, it should be considered as a strategy. In the case of Spain, it was found that the influence of friends, siblings, teachers and TV characters was stronger than the influence of the parents. On the other hand, peer influence was not reported as important in other cases and TV characters were only reported as important in younger ages (Germany) and by some target groups (teachers in Greece). Another interesting finding was that in most cases parents highlighted the role of the school and teachers as an influential force on the youngsters and the teachers highlighted the role of the parents and family environment. Overall, the studies so far suggest that parents and teachers together play the most important role on the career decisions of youngsters. Pupils and students tend to report the role of the teachers more often as an inspirational force.

Gender imbalances and stereotypes in the uptake of STEM by girls was not as present (or visible) in the UK and Germany and they were stronger in Greece, Spain and France. This may be related to the sample selection (school standing, social class, rural or urban areas), even though it is commonly accepted that Greece and Spain are considered more traditional societies.

## Synthesis

According the findings of the qualitative studies in SESTEM the presence of gender imbalances and stereotypes in STEM studies and careers has become clear more or less in all participating countries. Further, social environment of pupils in particular parents and STEM teachers are crucial influence factors with respect to pupils’ career choice in STEM fields. A lot of parents are STEM professionals, thus they could reveal as indirect role models for their children. In addition, the socio-economic status of the families as well as the economic situation of the country could have impacts on career choice e.g. the economic crisis in Greece.

## 7. Implications

In the following, consequences for family, educational institutes and for stakeholders of politics and industry will be exposed. This aims at developing new implications for promoting more equality regarding a career choice in STEM.

### 7.1 Consequences for the family (parents)

In this section, consequences for the families and in particular parents will be shown with regard to support pupils' career choices in STEM.

#### Germany

With regard to implications for family in Germany, the tendency could be established that parents of lower socio-economic background prefer that their children work as soon as possible. With respect to this, more financial support measures like scholarships or grants for gifted pupils in STEM should be offered by the government or STEM-related companies to encourage more young people of lower socio-economic family background to take a STEM-related study into account.

In general, most of parents support their children following STEM-related career or study subjects because they think that jobs in STEM offer a high salary and job prospects. This attraction of girls and boys for STEM studies may be a consequence of family influences and sometimes as consequence of positive role models in the family (e.g. parents as STEM-teachers or STEM-professionals). A lot of the female students were getting in touch with STEM and “sciences”-oriented toys or special mathematics tasks in early childhood. Thus, it is essential for children to get the opportunity to explore elementary STEM-related activities and toys at home that parents provided their children. This built the basis for an interest for STEM-subjects in school and finally also for a career pathway. Based on these findings it is important that parents support the early development of their children's interest for STEM.

With respect to information about STEM-studies and job, only few parents know about new specializations and careers opportunities or current associations to useful careers. Some of the parents criticized that the schools did not provide enough information for pupils about career opportunities in particular in STEM. However, most of the pupils' parents reported that they discuss the future career pathways or wishes with their children under the scope if the future plans fit to the person or not. The collaboration between schools and parents regarding information regarding new career pathways (in STEM) is necessary but the involvement of parents at public school is of rather low with respect to information about career pathways.

#### France

Generally, we can observe strong involvement of parents in children's education. Attitudes toward school differ somewhat according to the different social settings, but all attach a great importance to school and expect a lot from it. For all, the STEM pathways represent “the royal road” because it allows all the orientations but in the same time, STEM appear to a lot of people as austere and difficult; their school memories about those subjects are not often positive so it seems necessary to develop another image of the sciences, mathematics, and technology perhaps by associating parents from the early age of the children in playful scientific activities with their children. It seems important to reduce the contradiction between a positive aim but so austere that it seems too difficult to achieve.

#### Greece

The role of the parents was found influential as they indirectly act as role models. It was observed that youngsters tend to follow similar fields of studies and careers as the ones of their parents. Most parents argued

that they equally promote their children (regardless of gender) to study whatever they really like, taking into consideration of the job prospects. Parents that came from the lower classes were reported as acting more negatively to their daughter's choice of studying STEM.

However, most parents were feeling that the wider social environment is often overpowering them as their children are frequently influenced by the school environment and the societal expectations. Therefore, there should be a focus on raising awareness on how parents might influence the choices of their children even without realizing it, by carrying the same socio-cultural norms that they place 'elsewhere' in society. Awareness raising events and/or training courses designed for this target group could be a realistic option to address this issue.

## Poland

The family is the basic and chronologically the first environment for shaping the personality of a young person, often decisive for its entire life. Certainly in the choice of further education and work, an important role is played by such factors as: financial situation, social origin, family tradition, the opportunity to learn and work in the area. Family is essential for the formation of aspirations. The factors influencing the aspirations are formulated in the presence of a young person and assimilated by him/her in the behaviour patterns, criteria for evaluating other people, the career patterns and the associated views and opinions from the family circle. Among impact factors is also the direct, intentional actions of parents who want to raise the desired aspirations of a young person. Youth, however, regardless of the suggestions or pressure from the parents can express their interest in continuing the work done professionally by parents. Family connections will influence, whether the way of life starts easily, or with effort and what are the chances that objectively can be expected by a young person in achieving desires and aspirations. Therefore an important role is played by social origin. Still, in different social groups, professional aspirations are clearly differentiated. In some, there is a clear trend to continue in the family education tradition, for example the children choose professions of the parents. Often this phenomenon concerns the professions which enjoy high social prestige. In other social groups, a low level of educational aspirations can be observed, due to the lack of tradition in this regard. There are however also such families, where despite the fact that parents did not shape their children's educational aspirations for a professional - long education track, their children overcome numerous barriers such as those environmental and often receive higher education and acquire interesting work.

In addition to the environmental conditions of development prospects in life, there are also inner family conditions, such as personality patterns of parents, their personal attitudes and expectations, aspirations, attitudes toward children, lifestyle, etc. Although there is a tendency that parents of a lower socio-economic level prefer that their children work as soon as possible, in general results of the interviews with parents show that they encourage children to STEM studies by talking with them and showing positive aspects of the STEM workplace. In general, parents see the positive image and job prospects in STEM. It seems that a high chance to get a job and high remuneration are important factors concerning career choice. Nearly all parents discuss with children their career pathways. Therefore it is important that they have knowledge of new specializations and career opportunities.

## Spain

Although there is a tendency that parents of lower socio-economic level prefer that their children work as soon as possible, in general all parents support their children following scientific studies because of prestige, social recognition and employment projections. This attraction of girls and boys for STEM studies may be then a consequence of mass media and family influences. In addition, neither parent know about new specializations or careers possibilities; current associations to useful careers usually correspond to traditional studies in which women's and men's roles are more classically defined. It is then important to involve families in this process and provide them with information, especially mothers and girls, where communication has been seen to be

closer. Moreover, teachers have report parents have low participation in schools. Information about these new careers and trainings must be disseminated to parents, especially at public schools where there is less parents' involvement.

## UK

With regard to implications for family, early experiences of practical activities (e.g. with machines or resistive materials) seem to be important in stimulating an interest in STEM. Parents should encourage and engage in such activities with children. Clearly, the family has a role in the development of the identities of their children. The development of 'confident femininity' – where there are few conflicts between the identity of 'girl / woman' and any area of competence (in particular in STEM) should be a parental goal. Activities which offer narrow gender roles should be avoided or tempered with activities which offer broad gender roles. In terms of careers advice, many parents are unaware of emerging STEM fields, and possibilities for employment. Better school-parent communication should be encouraged. Conversely, where parents are working in STEM-related fields, they can provide assistance to schools in terms of parent-school collaborations by providing relevant work experience to pupils. In general, parents should be advised to look for ways for children their children to have direct experience of careers they are considering.

## Summary

In general, parents are the first socialization instance and thus an important environment for pupils with regard to questions about career choice. Most of parents in all countries support their children to choose the career which they personally like to pursue. The results in Germany and UK showed that early experiences in STEM and technical toys had positive impact in terms of stimulating an interest in STEM. In addition, the parents who are working in STEM fields often occurred as indirect role models for their children's career decision In all countries STEM-related careers or study subjects are assessed as jobs which offer a high salary and good job prospects by the parents but many parents are still unaware of new professions and study opportunities emerging of STEM fields. Therefore, the school-parent communication regarding information about new STEM-related employment opportunities and career pathways should be in improved in terms of career advice. Further, Information about these new careers and trainings should be disseminated to parents, especially at public schools where the percentage of parents' involvement is rather small. However, some parents in particular of lower socio-economic background rather prefer their children to begin a job instead of studying (STEM). With respect to this, more financial support measures like scholarships or grants for gifted pupils in STEM should be offered by the government or STEM-related companies to encourage more young people of lower socio-economic family background to take a STEM-related study into account.

## 7.2 Consequences for educational institutions (teachers/schools/universities)

In the following, consequences for educational institutes will be exposed. This aims at developing new implications for promoting more equality regarding a career choice in STEM.

### Germany

Schools as educational institutions could play an important role regarding the career decision and the interest development in STEM of pupils in two respects: First, as educational institution, information about new STEM-studies or opportunities could be offered for pupils. Therefore, it is appropriate for schools to collaborate more with (local) universities to provide more information about current study subjects in STEM and to let pupils get in touch with students of these subjects which aim at sharing their study experiences with pupils. Second, it is a good habit that STEM-teachers have impact on the interest of pupils by making the STEM-lessons of more practical use for pupils and by encouraging them to choose STEM by sharing experiences during their own STEM study. In addition, the some interviewees perceive the low self-confidence of girls in STEM-classes, so that it is subject to teachers to enhance the self-confidence of girls in STEM-classes. To sum up, a stronger involvement of schools and teachers regarding the career choice process and of the arousing the interest for STEM of pupils is still crucial and should be implement in concrete practices and action plans by educational institutions.

Regarding the situation of female STEM-students at universities, the following consequences could be revealed: Some students perceived a high pressure concerning the drop-out-rate in STEM, they missed social contacts sometimes, and they observed still a lack of acceptance for females in STEM and a lack of female role models/ contact persons e.g. female professors. It is a crucial practice to implement measures against these obstacles in STEM by building networks for women in STEM-related studies and female tutors at university in STEM as contact persons for question concerning the study contents, requirements, and career pathways after university graduation.

### France

The role of the educational institutions appears as central in the implementation of measures favorable to gender equity in STEM. First, a significant lack of information and knowledge on the trades existing in STEM has been noticed. To address this gap, it would be desirable to set up meetings in the classroom with professionals, especially women (such as scientists, engineers ...). This need has been raised by all the target groups. Secondly, the problem of gender inequalities in STEM is ignored or considered as not important by a lot of parents, pupils and teachers. So it would be important to implement actions to sensitize all these actors to this issue. Thirdly, to break the austere image of STEM, it would be necessary to think about modifications in the way of teaching STEM, perhaps by reducing the theoretical side of teaching STEM and by underlining their practical applications.

### Greece

Educational institutions are important carriers and transmitters of societal norms and culture. What was found in the research is that Greek educational institutions lack behind in providing positive role models for girls who consider studying STEM and in providing useful information about career options and opportunities in times when unemployment rates are high and young people are pessimistic about the future. Furthermore, it was found that many teachers are carriers of negative stereotypes when it comes to women in STEM and even though they might not explicitly express them in the classroom they might be demonstrated indirectly, for example when advising pupils or in classroom behaviour. Schools and teachers should take their role more



seriously as it was also found that they can be a real inspirational force on the pupils. Therefore, training on gender equality issues and strategies to encourage girls to follow studies in STEM fields should be seriously considered, especially in schools based in rural areas where the problem was found to be more established. The obstacles met by pupils coming from lower classes should also be addressed by providing specialized support; in the same manner, career counseling and guidance should be provided to all students taking into consideration their special needs, obstacles they meet, providing concrete solutions and realistic employment options.

## Spain

There is a lack of information on opportunities for future employment, such as available scholarships, internship opportunities, vocational training and new and emergent jobs. As a consequence they miss many options that are available for them. It is crucial that pupils, students, parents and teachers have information of new studies and job possibilities; otherwise, young people will miss important opportunities for their future, including options that break occupational stereotypes.

In conclusion, it is necessary to promote awareness of the realities of today's academic and work environment; for example, through lectures, outings, academic fairs etc. In this way girls and boys can become informed about academic, professional and labor market opportunities and the competencies required. Moreover, it is important to explain new careers and vocational training possibilities in order to go against stereotypes. To exemplify this, development of a topic of interest through the upper secondary research project has been for many students and pupils interviewed a key moment of motivation to determine their future studies and career path. Today there are training possibilities that young people don't know about, even at the university level, not because they don't want them it but because information is not easy available. In fact, girls and boys are very interested in outings, field work and internships. Some teachers mentioned, that although there are lectures by university students, in some case ex-pupils, it would be good to have these events more frequently with both men and women professionals participating, in order that pupils see that there are specializations possible without a gender bias.

In general, for both students and pupils, the teachers' role is perceived as crucial for academic and career motivation. Teachers have the unique opportunity to encourage or discourage a student to pursue their subjects. For example, many physics students interviewed said that they have had teachers that were physicists who positively influenced them to continue these studies. This allowed them to have more information and to be encouraged and supported.

## Poland

School is the second institution (in addition to the family) which has a principal influence on the career aspirations of young people. In some way, it dominates the family environment, thanks to special preparation for educational work. Regarding the system of orientation and career guidance, the school, next to the professional bodies, should occupy a central place. The effect of school should be aimed both at students, as well as on their environment and parents who have an earlier influence on the development of the interests, attitudes and career aspirations of children. Therefore, students choosing a university, or a future profession, as well as their principal advisers - parents should know what type of competition is demanded in labour market, which occupations will develop or decrease. The school should prepare pupils for the rational choice of profession and schools and, consequently, to work in accordance with their interests, predispositions, and the needs of the socio - economics of the country.

It is worth mentioning that young people in their choice of profession are often guided by the "fashion" of the faculty of studies, they do not think about later perspective and chance to find an employment in their profession. To plan a career, pupils and students need a particular orientation in the



economy, in politics. Unfortunately, it is very common to forget about this. There is a lack of awareness that such things in general must be taken into account. Perhaps it is the fault of the education system - the school does not teach creativity and activity. School focuses only on the transition of knowledge.

Pupils generally agreed that the incentive to choose STEM studies would be a higher level of teaching STEM subjects in secondary school. It would allow pupils to choose STEM studies without any fear. Most of them believe that they are taught in a diagrammatic way, and therefore do not choose STEM study. If teachers were more involved then the situation could change. The pupils had a clear idea of how STEM subjects should be taught. Such lessons should contain plenty of practical examples and there should be a lot of tasks to solve using a computer. It would be helpful to establish a meeting with individuals who have gained a good job after STEM studies to talk about their professional accomplishments and their STEM studies. This type of meeting should be held in schools. Obstacles to choosing careers in STEM and existing stereotypes may be overcome by establishing a network of women who have had success in STEM, and who would be willing to share their experiences in this area, answer the questions and identify possible career paths after graduating university. There should be more practical classes, based on real and current examples. For this purpose classrooms, where classes are held, should be better equipped. The cause of the problems with STEM subjects in secondary school are shortcomings in earlier education.

In conclusion, the greater involvement of schools and teachers in the process of choosing a career and raising interest of STEM are still important and should be identified and substantiated in further action plans for education.

## UK

Inspirational people (e.g. teachers or mentors) can be important in career choice. Work experience in areas where pupils are considering careers should be provided. Careers advice should be broadly based (and not gendered); STEM careers should be emphasised for students of high academic ability. Further, the development of 'confident femininity' should be a goal for all educational institutions. This theme should pervade all educational experiences. Before points where decisions are made about academic specialisms, pupils should be exposed to examples of successful women in STEM (and other professions) who are confident with their multiple identities – as engineer, lover, parent (that is *not* to advocate a procession of people who are exclusively heterosexual or able bodied or middle class or white). Discussions about careers should focus on values and long-term goals. For many students, factors such as 'making a difference' and a career which provides intellectual challenges will be attractive. Consequences of different career choices should be discussed. At school level (and presumably at university and in industry too), success is likely to lead to success; where gender imbalances are reduced, it is easier to recruit girls into STEM.

## Summary of consequences of educational institutions

School could be established as the second instance (in addition to the family) which has a principal influence on the career aspirations of young people. In this regard schools as educational institutions and teachers in STEM as crucial contact person for pupils with respect to career advice in general as well as enhancing the interest for STEM. Teachers had the opportunities to encourage and discourage pupils to pursue their subjects after school. In Greece, educational institutions are lack behind in providing positive role models for girls who consider studying STEM and in providing useful information about career options. Furthermore, it was found that many teachers provided negative stereotypes when it comes to women in STEM and even though they might not explicitly express them in the classroom they might be demonstrated indirectly, for example when advising pupils or in classroom behaviour. Therefore, training on gender equality issues and strategies to encourage girls to follow studies in STEM fields should be seriously considered, especially in schools based

in rural areas where the problem was found to be more established. Teachers in Germany and Poland could strengthen the self-confidence and interest of girls in their STEM lessons by containing practical examples and by solving tasks by means of the use of computer. In general all project partners reported that there is a lack of information about employment opportunities, scholarships, internships, and new job professions (also in STEM fields). Successful women (and men) in STEM should be exposed and they could collaborate with school by visiting STEM classes and answering questions about their career pathway and current work tasks. With this regard a STEM professional network could be founded for interested pupils in STEM. In UK, discussions about careers which focus on values and long-term goals and consequences of different careers are important. To sum up, the involvement of schools and teachers in the process of choosing a career and raising interest of STEM should be increased and should be taken into account in further action plans for education.

## 7.3 Consequences for society (policy makers/industry/etc.)

In this section, consequences for society which includes policy makers and stakeholders of the industry will be exposed. This aims at developing new implications for promoting more equality regarding a career choice in STEM.

### Germany

In schools there seems to be a lack of information regarding careers and future professional options intended to reduce classic gender associations. Most of the pupils do not have an idea about STEM job profiles or what does a study in STEM mean exactly. Therefore, it is necessary to give more information about current STEM-job profiles to pupils by different companies.

Most of the interviewees, still perceived stereotypes against women in STEM fields (at school, at university, and at work): for women it is difficult to achieve higher positions or jobs, such as managers or directors, or they receive less remuneration. Most of the interviewees are concerned that a STEM professional has to be flexible regarding working hours, he or she has to handle prejudices against women in these fields. In addition, he or she might have problems to combine family and work in STEM which is clearly more an obstacle that refers to women in STEM. For that reason, it is crucial to continue with policies that encourage gender equity at occupational and labour levels.

While some interviewed parents and teachers say that the situation has changed, they recognize that some stereotypes still remain at the career level but the share of women in STEM studies increased a lot in the last years. According to the findings of this study it is essential to reveal the urgent needs for industries, enterprises, and professional associations in order to develop information about possibilities and jobs specializations to young people in order to facilitate more women in STEM.

### France

If the educational institutions have to implement actions favorable to gender equity in STEM, the frame of these future actions is a political one. So it is important that the political level encourages the schools to apply the existing rules on gender equity and if necessary, adds new ones to improve the existing legal framework.

The study underlines the lack of information regarding the trades existing in the STEM field. A narrower cooperation between schools and the industries, laboratories and associations working in the STEM fields has to be undertaken to address this issue. Further, those partners have also to be sensitized to the inequalities that women meet in the labor market, the problems to reconcile professional and family life, the lower salaries and the persistence of gender stereotypes so that they become involved in the research of solutions.

### Greece

The socio-cultural environment where each society is strongly defined by practices and ideologies that are cultivated and transmitted through the family and the educational system. In relation to promoting equal opportunities women and men, it was observed that the Greek society still needs to address the issue of providing equal opportunities for men and women in all sections of society, including STEM sectors. Therefore, policy makers and institutions dealing with the family and education should carefully reflect on the findings of the research and ensure that the main findings will be efficiently addressed by making recommendations in cooperation with experts and employ monitoring processes.

### Poland

The most popular actions which aim at helping pupils and students in choosing a profession or in further education are meetings with representatives of higher education or participation in events organized by

universities but also through less often discussions with a teacher or school pedagogue, or cooperation with the employment office, career workshops, or organization of the school career offices. Based on the results of research it can be stated that schools are making efforts to introduce their students an offer of higher education, but they care in much smaller scale and probably insufficiently about the quality of information on the labour market and vocational counseling.

According to pupils the main source of information about studies are websites of universities, open days and recommendations of students' friends. The problem of an insufficient number of applicants to study in STEM fields is due to weaknesses in the earlier stages of education. Schools do not stimulate an interest about the world through the knowledge of STEM sciences. Teaching in schools is focused on the *matura exam*, and not on the formation of interests and meeting the needs of cognition. Vocational guidance for students should be organized to a greater extent than at present. The same activities should be done by universities within their own promotional activities. They could invite potential students to take advantage of free counseling to identify particular faculties with competitions, which can be held upon graduation. Pupils from secondary school, as very young people, must decide about studies, but they usually have a very poor idea about it. They do not have a sufficient knowledge about subjects and what they will do after graduation - when choosing universities they are guided by the prevailing fashion, the expectations of parents or the opinions of colleagues. As a result, a significant portion of people who get to universities do not know what they will do in the future. In schools there seems to be a lack of information regarding careers and future professional options intended to reduce classic gender associations. Most of the pupils do not have an idea about STEM job profiles or what a study in STEM means exactly. It is important to continue the policy of promoting gender equality and not forget about the fight against stereotypes that affect the decision to study in the area of STEM.

There are still barriers on the educational way and professional development. To attract highly trained workers with a variety of skills it is necessary to address programmes of studies to the need of business and industry. Technical education gives women not only great opportunities that facilitate job finding, but also economical independence and social prestige. It is also a chance to have influence on the development of a science, creation of new technology, controlling the industry and economic strategies. It is worth to mention that in Poland on the 14th of April 2011 sixteen public technical universities and four faculties of physics and mathematics invited to take part in an "Open Day" for Girls Only. Through a great variety of events young women are able to gain an insight into academic life of Polish technical universities and make useful connections. For this purpose, the participating universities opened their laboratories, workshops and offices as well as organised meetings with women professors to give concrete examples that showed girls how interesting and exciting studying at a university of technology can be.<sup>2</sup>

Undoubtedly, it is worth drawing experience from the activities such as: "Girls As Engineers!" and increase the frequency of such projects. The results of research show the urgent need to organize meetings with people who have achieved success in STEM, during which students would learn about the potential place of employment and areas where they could specialize.

## Spain

Some interviewed perceive gender bias, especially those who have had work experiences: for women it is difficult to achieve higher positions or jobs, such as managers or directors, or they receive less remuneration. Therefore it is crucial to continue with policies that encourage gender equity at occupational and labor levels.

While most interviewed say that the situation has changed, they recognize that some stereotypes still remain at the career level. Although most of interviewed have not directly perceived that, because only a few students

<sup>2</sup> <http://www.dziewczynynapolitechniki.pl>

have had chances for professional contact, they have a general perception that differences between men and women still exist, at least in jobs. This is perceived as unfair or unreasonable because the training and degrees of women has grown increasingly and their academic performance is in general better than men. In relation to this, in demanding careers, there are many women, which may be due to the better grades of women in the university selection process. There is a significant lack of information regarding careers and future professional options intended to reduce classic gender associations. For example, there are now many engineering specializations outside the typical stereotype that may be considered more "feminine" or multidisciplinary; however few people know about these. We are left with classic images and stereotypes by a lack of information.

The findings of this study point to the urgent need for industries, enterprises, and professional associations to communicate possibilities and jobs specializations to young people and academic and training institutions.

## UK

All imbalances in access to positions of influence (in politics, law, and business) should be made public and challenged. The number of men and women employed at different levels (and salary levels) should be publicised and discussed. Policies that promote gender equality should be developed. In industry, there are some issues of work culture that need to be explored on a site-by-site basis, such as: hours worked and flexibility; prospects for promotion; patterns of working (collaborative versus competitive); work-family balance. There should be an active exploration of culture and the implications for *all* employees. Mentoring systems and systems providing general social support (especially for women) should be considered.

In the UK, changes in university funding will require most students to pay tuition fees of 10,000 euro a year. This is likely to encourage students to take courses which lead to remunerative careers. A policy decision where STEM courses attracted lower fees (despite higher costs of provision) could encourage more students to take up STEM courses.

## Summary of the consequences for society

The society as socio-cultural environment is defined by practices and ideologies that are cultivated and transmitted through the family and the educational system. Greek society has to provide more equal opportunities for both gender in all section of society and also in STEM fields. Gender stereotypes could be perceived strongly in Greece and Spain and but also in the other countries. Further, female students and parents who are employed in STEM fields are more aware of the stereotypes and gender bias at employment level. According to the results in Poland it can be stated that schools are making efforts to introduce their students an offer of higher education, but they care in much smaller scale and probably insufficiently about the quality of information on the labour market and vocational counseling. However, barriers on the educational way and professional development still exist. E.g. For the attraction of highly trained workers with a variety of skills it is necessary to address programmes of studies to the need of business and industry (particulaty in Germany and Poland). A variety of STEM-related events yould give young women more insights into academic life of STEM scientics and provide the opportunity to make new connections. In UK mentoring system and measures that provide scial support should be considered. With respect to the high tuition fees of 10.000 Euro a year for studying a policy decision where STEM courses attracted lower fees (despite higher costs of provision) could encourage more students to take up STEM courses. In general more information about STEM employment numbers and salary at different levels could be useful for a basis of policies that promote gender equality. Furthermore, work-life-balance issues in STEM are more difficult for women with regard to combine family and career. Thus it is crucial to continue with policies that encourage gender equity at occupational and labour levels.

## 8. Conclusion

The national reports present differences and similarities between the four groups of the qualitative studies as it was expected. So far the differences do not seem as important as the similarities. The results of the qualitative research has revealed that there are still unresolved issues to be addressed in order to promote more women in science and to ensure that boys and girls are given equal opportunities and support to study and follow a career in STEM. The hypothesis that parents and teachers have strong influence on career decisions of pupils is supported in all national cases.

The reports present some common patterns that should be further investigated in the research process. For instance, the role of the (charismatic) teacher and the family as a role model was found more influential. Stereotypes that influence the social imaginary and characterize STEM as masculine and social sciences and the humanities as feminine are still visible. Further, schools do not have much relation with the outside or the professional world in general; Pupils have almost no contact with associations or scientific groups or networks. Thus, institutions should strengthen ties with and build a network among pupils, ex-pupils, professionals and educational institutions. In addition to this, professional insecurity is common: unemployment is a widespread fear as a result of the crisis and this many times conditions career choices. Finally, as the results so far suggest, the issue of enhancing the self-confidence of girls, reversing stereotypes (especially in the lower classes), and using successful women in STEM as role models should be in the center of our considerations for the design of best practices and guidelines.

The results of the SESTEM studies and consequences for family, educational instituts, and policy makers as well as STEM industries emphasis the current needs for industries, enterprises, and professional associations to communicate possibilities and jobs specializations to young people and academic and training institutions (see Chapter 7).

To sum up, for further educational policies for gender equality in STEM across EU parents, educational institutions, policy and industries should take the following research findings of the project and suggestions of promoting measures into account:

- Considering the issue of social class that could probably disadvantage the uptake of STEM by girls of lower classes
- Supporting pupils from lower social class in STEM regarding an the uptake of STEM studies or careers (by universities or scholarship of STEM industrial companies)
- Early support of pupils interest for STEM subjects by parents who work in STEM fields (STEM-related toys and tasks)
- Promoting equal values to boys and girls and supporting their talents and abilities. That also means attracting more boys to social sciences; or in other words, de-feminizing social sciences and the humanities in the process of dismantling the male dominance in STEM
- Considering the mostly lower self-confidence of girls in STEM and promoting female role models in STEM to attract more women in STEM
- Enhancing the self-confidence of girls in STEM (by female role models in STEM)
- Gender-sensitive training for STEM teachers which aims ate promoting girls' interest for STEM
- Using more practical examples in STEM lesson to increase the interest for STEM
- Training for parents and teachers regarding the career advises and career choice

- Collaboration of parents and teachers regarding pupils’ need of information about STEM studies and professions
- Improving a “woman-friendly” STEM work environment

These suggestions could be seen as basic approaches in terms of promoting higher gender equality in STEM-related study subjects and careers. More details about good practices guidelines that comprise instructions for families, teachers, and policy makers will be provided in a further project report “Indicators and Guidelines”.