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SUMMARY

The low uptake of Science, Technology and Mathematics (STEM) constitutes a research and policy concern worldwide for some time now. SESTEM (Supporting Equality in Science Technology and Mathematics related choices of careers) is a European research project to enhancing girls' interest for STEM-related subjects and promoting their career choice regarding STEM.

A lot of initiatives already exist for promoting more girls in STEM but the under-representation of females in STEM-related career paths is still current issue. Due to this fact, the SESTEM project focuses on the analysis of facilitators and obstacles for girls and women in STEM-related subjects or studies.

This National Report aims at explaining the divided secondary school system in Germany and summarizing the statistical data of females as well as the literature review about influence factors for the career choice of female pupils and students in STEM. The important educational stages from pre-primary school to university within to STEM careers in Germany will be represented. In particular three stage in the educational pathway (after primary, lower secondary and upper secondary school) are crucial for the further career plans of pupils.

According to the results of the PISA or TIMSS studies in primary school, boys have a higher competency level in mathematics and science. With regard to the self-concept in these subjects it is a similar result. Due to these findings, girls should be enhanced more their interest and self-confidence in STEM already in primary school. This gender difference regarding the interest and performance level in STEM continues to the choice of study subjects at university. As the report shows that the uptake of studies is still related to traditional gender stereotypes. Possible factors for these phenomena could be past experiences in STEM, socialisers (peers, teachers, parents, counsellors etc.), and the aptitude according to the model of Dick & Rallis (1991).

Therefore, SESTEM is built on the premise that the study of the uptake of STEM studies by girls and their retention in the field can benefit from investigation into the triangulation of family-individual and school (secondary and tertiary) factors. Under this scope SESTEM aims to conduct four interrelated comparative studies engaging students, pupils, parents and teachers (both secondary and tertiary levels). Both qualitative (in depth interviews, conceptual mapping, tandem based dialoguing and review into existing literature) and quantitative (collection and analyses of data from across the Member States using on-line survey methods, and meta-analyses of existing statistical data) methods will be applied. The empirical result of the SESTEM project will follow in a later project stage, therefore the results will be analysed and published in a second part of the report “SESTEM Part II – Results”.

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0. Overview

The following report was written in the context of the Lifelong Learning Programme project SESTEM – Supporting Equality in Science Technology and Mathematics related choices of careers and provides an overview and information about the German structures and situation related to women's uptake of STEM-related study subjects and professional careers in the STEM sector. The following sections summarize the state of affairs on career choice regarding STEM, therefore this report could be seen as a "Part I – The state of affairs". Its main focus lies on the issue how the relation between gender and the uptake of STEM subjects develops during school, university and professional careers and which initiatives aim at supporting gender balance in these areas. The following paragraphs will describe the structure of the report in detail.

The report starts with describing the organization of the German school system in general (section 1). After four years of primary school, German pupils have to choose between three different types of school according to their grades at the end of the fourth school year.

The general situation of STEM-related subjects based on the current situation of women in Germany with regard to the educational stages career pathways could be compared to a leaking pipeline. One indicator this fact could be the high proportion of drop out by women regarding higher education and leading positions in STEM. A focus of this report is set in the description on differences between the choice of STEM-related careers by men and women. Further in this section, information in relation to STEM and gender are provided for the important stages of the educational guidance with special regard to the offer of courses and educational guidance for German pupils of lower and upper secondary education.

Section 2 describes the legislation, regulation and the national initiatives regarding gender and STEM. Several initiatives and facilitation measure are provided in Germany for promoting more girls and young women in STEM-related subjects at university and in STEM careers, which often are more attracted to boys and men.

Section 3 provides information about the teaching practices and effects on the career choice of girls and boys. In section 4, the focus is on educational practices and family strategies for promoting girls in STEM at home.

Section 5 has a focus on student's motivations regarding the orientation and career choice. According to the career choice model of Dick and Rallis, socialisers like parents, peers and teachers could have influence on perception of pupils' abilities in STEM and based on this also on their career choice.

The concluding section 6 summarises the report with a focus on the observed inequalities and the aims of the SESTEM project to improve the situation in a long-term perspective.

The empirical result of the SESTEM project will follow in a later project stage, therefore the results will be analysed and published in a second part of the report "SESTEM Part II – Results". This analysis links the findings to identification of indicators for the facilitation of an uptake of STEM by girls which aims at generating effective facilitation measures for girls and women.

It has to be noted that the information and data provided in this report only provides a selective insight in the current situation in Germany. This is mainly due to the educational autonomy of the 16 German federal states and the resulting complexity of educational issues at the national level. In addition to this, national data of the different sources in the field of STEM and gender often lack in coherence. Although several sources provided information on the related issues, they were often not up-to-date or considered the situation of men and women on a rather superficial level, not providing details that allow for a more comprehensive description of the situation.

1. Introduction: Current situation of gender in STEM

The following section is divided into two main parts. The first part will illustrate the German school system and afterwards measures for educational guidance. The second part deals with the current gender situation in relation to STEM according to the different educational stages from pre-primary school to university. The focus lies on the gender imbalance in STEM with regard to the career choice of pupils.

1.1. Organization of the German system in an overview

Historically, education is primarily a responsibility of the federal states (“Länder”), and the educational system may vary from federal state to federal state. However, it is generally divided into five different main stages (Figure 1.1):

1. pre-primary education
2. primary education
3. lower and upper secondary education
4. post-secondary and tertiary education
5. continuing education.

Figure 1.1. Five educational main stages (German Eurydice Unit, 2008)

Structural differences in German school system



Figure 1.2. Federal states of Germany

Due to the federal structure in Germany, the country is divided into 16 independent federal states (“Länder”) which make independent, political decisions with respect to educational questions. Thus, differences in educational system are presented in this report.

In the following, the characteristics of the German education system will be illustrated, starting from compulsory education at primary level up to continuing education after university or basic vocational training (Figure 1.1). Included in the figure are also the voluntary pre-school (“Kindergarten”) and further education years. Generally, compulsory education begins between the ages of six and seven and ends when the pupil reaches 16 years of age.

The ages given on the right hand side display the earliest possible entry age and account for pupils with a continuous path through the education system (e.g. not interrupted by repeating a year due to low grades).

Usually, German children start their educational pathway in primary school (“Grundschule”) in the month of September after their 6th birthday. After 4 years of primary education in most of the federal states in Germany (six years in some federal states e.g. Berlin), pupils move on to one of three types

of secondary schools (“Hauptschule, Realschule, Gymnasium”) or comprehensive school (“Gesamtschule”), depending on their grades and teachers’ recommendations (see figure 1.2). At this educational level at the age of ten or eleven, pupils will be already separated to these three different school types based on their school achievement level. At the age of 15, pupils are allowed to leave school (with the parents’ permission), but they must take some form of vocational training until they reach the age of 16. According to BMBF (2004) about 30% of the pupils who go to Hauptschule complete a 10th year at this type of school instead of leaving school.

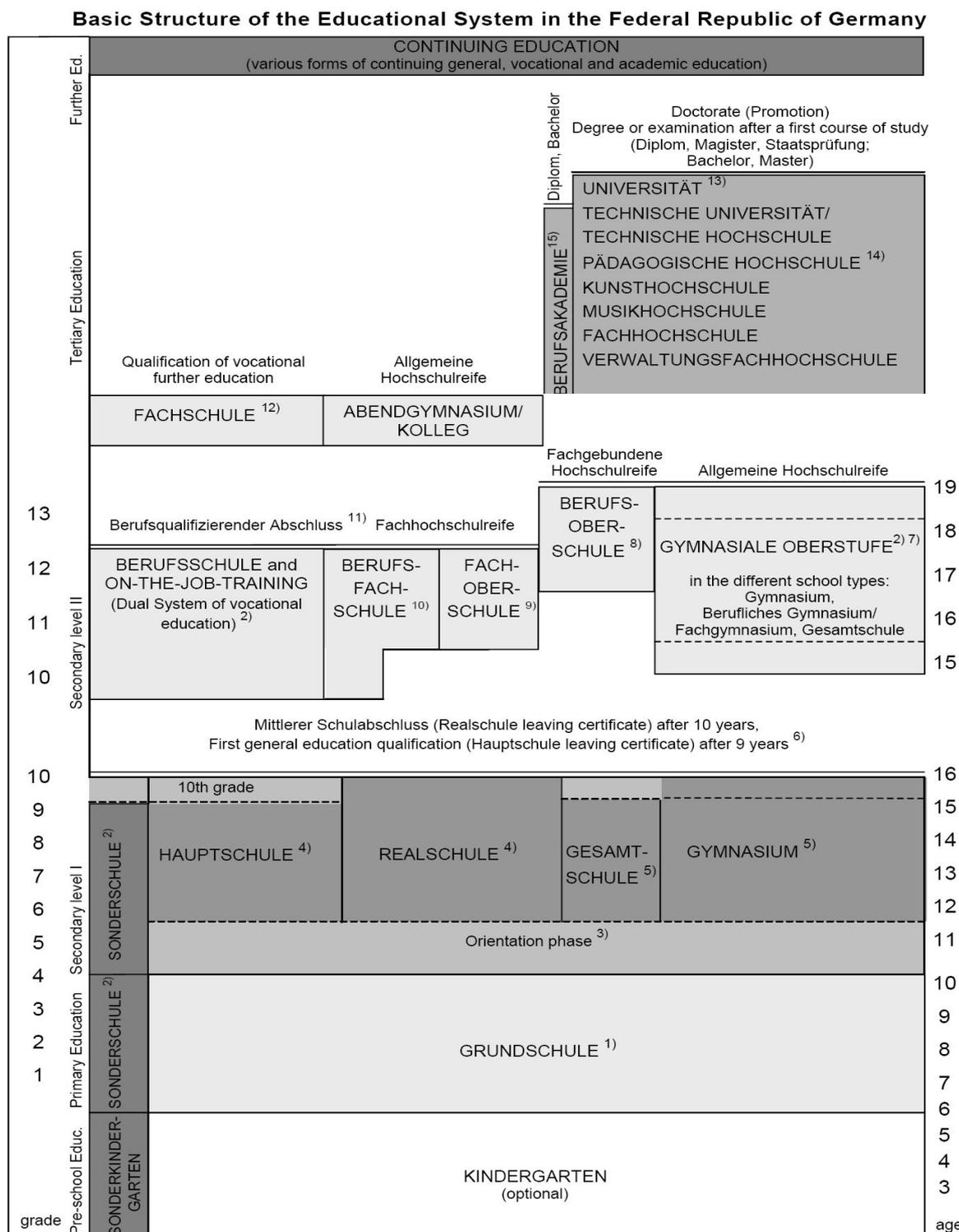


Figure 1.3. Basic structure of the educational system in the Federal Republic of Germany (KMK; 2009, p. 2). For annotations see below:

These annotations for figure 1.3 are directly cited from KMK (2009, pp. 3-6).

The distribution of the school population in grade 8 as per 2007 taken as a national average is as follows: *Hauptschule* 20.6 per cent, *Realschule* 26.5 per cent, *Gymnasium* 33.4 per cent, *integrierte Gesamtschule* 8.5 per cent, types of school with several courses of education 6.4 per cent, special schools 3.8 per cent. The ability of pupils to transfer between school types and the recognition of school-leaving qualifications is basically guaranteed if the preconditions agreed between the Länder are fulfilled. The duration of full-time compulsory education (compulsory general education) is nine years (10 years in four of the Länder) and the subsequent period of part-time compulsory education (compulsory vocational education) is three years.

1. In some Länder special types of transition from pre-school to primary education (*Vorklassen, Schulkindergärten*) exist. In Berlin and Brandenburg the primary school comprises six grades.
2. The disabled attend special forms of general-education and vocational school types (partially integrated with non-handicapped pupils) depending on the type of disability in question. Designation of schools varies according to the law of each Land.
3. Irrespective of school type, grades 5 and 6 constitute a phase of particular promotion, supervision and orientation with regard to the pupil's future educational path and its particular direction (*Orientierungsstufe* or *Förderstufe*).
4. The *Hauptschule* and *Realschule* courses of education are also offered at schools with several courses of education, for which the names differ from one Land to another. The *Mittelschule* (Sachsen), *Regelschule* (Thüringen), *Erweiterte Realschule* (Saarland), *Sekundarschule* (Bremen, Sachsen-Anhalt), *Integrierte Haupt- und Realschule* (Hamburg), *Verbundene oder Zusammengefasste Haupt und Realschule* (Berlin, Hessen, Mecklenburg-Vorpommern, Niedersachsen) *Regionale Schule* (Mecklenburg-Vorpommern, Rheinland-Pfalz), *Oberschule* (Brandenburg), *Duale Oberschule* (Rheinland-Pfalz), *Regionalschule* (Schleswig-Holstein) and *Gemeinschaftsschule* (Schleswig-Holstein), as well as comprehensive schools (*Gesamtschulen*) fall under this category.
5. The *Gymnasium* course of education is also offered at comprehensive schools (*Gesamtschule*). In the cooperative comprehensive schools, the three courses of education (*Hauptschule*, *Realschule* and *Gymnasium*) are brought under one educational and organisational umbrella; these form an educational and organisational whole at the integrated *Gesamtschule*. The provision of comprehensive schools (*Gesamtschulen*) varies in accordance with the respective educational laws of the Länder.
6. The general education qualifications that may be obtained after grades 9 and 10 carry particular designations in some Länder. These certificates can also be obtained in evening classes and at vocational schools.

At the end of this report a glossary provides additional information and explanations of the different terms.

7. Admission to the *Gymnasiale Oberstufe* requires a formal entrance qualification which can be obtained after grade 9 or 10. At present, in the majority of Länder the *Allgemeine Hochschulreife* can be obtained after the successful completion of 13 consecutive school years (nine years at the *Gymnasium*). Yet in almost all Länder the gradual conversion to eight years at the *Gymnasium* is currently under way, where the *Allgemeine Hochschulreife* can be obtained after a 12-year course of education.
8. The *Berufsoberschule* has so far only existed in a few Länder and offers school-leavers with the *Mittlerer Schulabschluss* who have completed vocational training or five years' working experience the opportunity to obtain the *Fachgebundene Hochschulreife*. Pupils can obtain the *Allgemeine Hochschulreife* by proving their proficiency in a second foreign language.
9. The *Fachoberschule* is a school type lasting for two years (grades 11 and 12) which admits pupils who have completed the *Mittlerer Schulabschluss* and qualifies them to study at a *Fachhochschule*. Pupils who have successfully completed the *Mittlerer Schulabschluss* and have been through initial vocational training can also enter the *Fachoberschule* directly in grade 12. The Länder may also establish a grade 13. After successful completion of grade 13, pupils can obtain the *Fachgebundene Hochschulreife* and under certain conditions the *Allgemeine Hochschulreife*.
10. *Berufsfachschulen* are full-time vocational schools differing in terms of entrance requirements, duration and leaving certificates. Basic vocational training can be obtained during one- or two-year courses at *Berufsfachschulen* and a vocational qualification is available at the end of two- or three-year courses. Under certain conditions the *Fachhochschulreife* can be acquired on completion of a course lasting a minimum of two years.
11. Extension courses are offered to enable pupils to acquire qualifications equivalent to the *Hauptschule* and *Realschule* leaving certificates.
12. *Fachschulen* cater for vocational continuing education (1-3 year duration) and as a rule require the completion of relevant vocational training in a recognised occupation and subsequent employment. In addition, the *Fachhochschulreife* can be acquired under certain conditions.
13. Including institutions of higher education offering courses in particular disciplines at university level (e.g. theology, philosophy, medicine, administrative sciences, sport).
14. *Pädagogische Hochschulen* (only in Baden-Württemberg) offer training courses for teachers at various types of schools. In specific cases, study courses leading to professions in the area of education and pedagogy outside the school sector are offered as well.
15. The *Berufsakademie* is a tertiary sector institution in some Länder offering academic training at a *Studienakademie* (study institution) combined with practical in-company professional training in keeping with the principle of the dual system. As at January 2009

1.2. Important stages of the educational and university guidance

Important educational stages of educational guidance

In the following, the important educational stages from pre-primary school to university within to STEM careers in Germany will be represented. In particular three stage in the educational pathway (after primary, lower secondary and upper secondary school) are crucial for the further career plans of pupils. According to the current educational system in Germany, reform trends could be established in the German states to different extends. The German states have been or will be made changes in the school system (ZDF, 2010). The conditions of school changes for pupils after each important educational stage and the main changes in the school system will be shortly explained in this section:

a) Change of school from primary to lower secondary school (after 4th grade)

After finishing primary school, most of the pupils are in the age of ten or eleven years; pupils reach the first educational level. At this stage, they will be separated according to their previous school achievements in the fourth grade of primary school. This might be the first starting point for pupils further career pathway. See Chapter 1.3.3 and figure 1.15 for more details.

b) Change of school from lower secondary to upper secondary school (after 10th grade)

After finishing secondary school, pupils mostly are in the age of 16 years. Due to the educational division in three school types after the fourth grade (see figure 1.3), the pupils will be separated again after finishing the 10th grade. In 9th grade of the Hauptschule, pupils graduate officially from school with a “qualifizierenden Hauptschulabschluss” which enables them to continue a vocational training and to attend the Berufsschule. Moreover, graduates of Hauptschule with good grades could also attend to another year of school class (10th grade). Thus, they will achieve higher education opportunities with respect to their career. Pupils from the Realschule will finish their 10th year of school and could continue with a Fachoberschule with the aim to study at Fachhochschule afterwards. The pupils of the Gymnasium normally attend school until 12th or 13th grade. One reform trend also can be considered with regard to the Hauptschule. The following figure shows the German state which are going to (marked) or are in discussion to abolish (hatched) the Hauptschule.



Figure 1.4. German states planning the abolishment of the Hauptschule.

(Source: <http://www.zdf.de/ZDFmediathek/beitrag/interaktiv/1074836/Die-unterschiedlichen-Bildungssysteme#/beitrag/interaktiv/1074836/Die-unterschiedlichen-Bildungssysteme>)

c) Graduation of upper secondary school (after 12th/ 13th grade)

After finishing the upper secondary school (Gymnasium), pupils mostly are in the age of 18 or 19 years. They graduate from school with Abitur and in dependence to their average of grades (Abiturdurchschnitt) they are able to choose a study subject at university in Germany. Some of the studies are limited to a “numerus clausus” which means that only pupils with a upper or excellence average of grades could begin such studies at university each semester e.g. medicine. The value of the numerus clausus depends on the state, university rules and number of study places. This selection procedure was leaded by the “Zentralstelle für die Vergabe von Studienplätzen (ZVS)” institution until 30th of April 2010 (see: <http://www.zvs.de/>). At the beginning of May 2010 the ZVS has been transmitted all responsibilities to “Stiftung für Hochschulzulassung” (see: <http://www.hochschulstart.de/>). The Stiftung für Hochschulzulassung has adopted the national selection procedure for university places which relates study subjects like medicine, pharmacy, veterinary medicine and dentistry. These subjects underlie selection procedure which distributes into 20 % of the places according to the average of the “Abiturnote” (average grade after Gymnasium), 20 % of the places according to the waiting period for a study place and 60 % of the places according to a specific university selection procedure. The other study place depending on the study subject and degree (Bachelor, Master or Diplom) will be distributed according to a university specific selection procedure e.g. the Ludwig-Maximilians-Universität (LMU) in Munich requires an aptitude test for limited study subjects e.g. Economics (Master), computer sciences (Bachelor/Master), physics (Master) etc. (see http://www.uni-muenchen.de/studium/studienangebot/studiengaenge/nach_zulassung/efv_/index.html)

Gender-sensitive vocational guidance in Europe

Statistical data of school graduates in Europe has been shown that many young people still choose gender stereotype-related careers (see Chapter 1.3.5). According to Eurydice (2010) the proportion of boys and girls enrolled in secondary education is nearly equal in many countries. However, large differences emerge regarding the types of schools or education programmes attended by male and female pupils when they have a choice. The distribution of students according to occupation in vocational schools and by subject area in secondary education reflects traditional gender roles in general. Therefore, a gender-sensitive vocational guidance is important in the process of gender equality in school. The figure below shows the vocational guidance to challenge traditional career choices available in Europe.

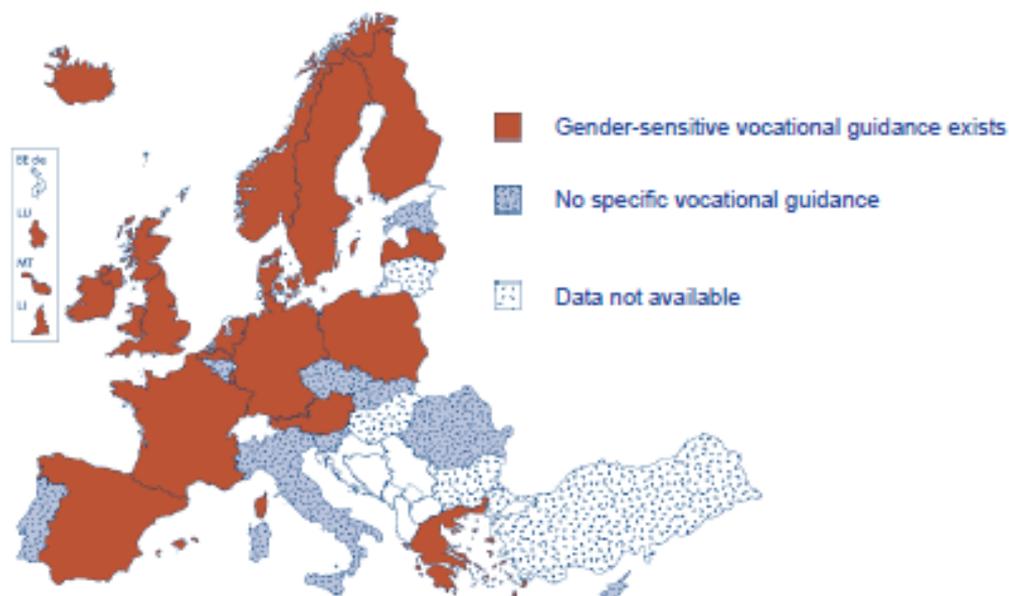


Figure 1.5. Specific vocational guidance to challenge traditional career choices available in Europe, 2008/09

According to Eurydice (2010) gender-sensitive guidance initiatives are targeted more often at girls than boys. The aim is to break traditional gender patterns and to give girls the opportunity to choose technology and natural science-oriented professions and educational pathways. Some countries Belgium, Germany, Luxembourg, Austria, and Poland organise, in this context girls' days where companies and research institutions invite female pupils and students for visits in order to introduce them to technical careers.

In the following section, the educational guidance regarding STEM will be represented for Germany.

Courses and educational guidance

Throughout the school or educational pathways the question of orientation arises and has influence on the career choice of the pupils and students. At the end of the secondary school, various offers of career guidance are available for pupils at the age of 15 to 19 in Germany. In particular the career guidance offers in STEM for girls are increasing for facilitation of women's' interest in a STEM-related study and career paths in these fields. The following section will introduce the career guidance programs and initiatives in general, with special interest in career guidance for women in STEM as well as aptitude tests which aim to motivate those pupils who are unsecure regarding their study choice.

Measures taken by the public authorities (career guidance)

Career guidance is subject to different stages of the educational pathways. The public authorities have provided a lot of measures for further study and career information for pupils and students. The important stages are in particular after graduation of secondary schools like Haupt- und Realschule and Gymnasium as well as after the graduation from university. In the following, general career guidance, career guidance for women in STEM and aptitude tests for STEM-subjects at university will shortly introduced and the relevant links will be shown (Annex 1.1).

The Federal Employment Office e.g. has a special department "Berufsinformationszentrum" (BIZ) (see <http://www.arbeitsagentur.de>) for general questions about jobs and careers choices which offers general career guidance with regard to information about range of vocational

training and study subjects. For pupils who graduate from Hauptschule or Realschule could get contact several career guidances e.g. “Planet Beruf” (<http://www.planet-beruf.de/>) or “Einstieg GmbH” (www.einstieg.com) who provide further information about the different job opportunities and vocational training.

The offer of career and study guidance with respect to facilitation of women in STEM will be represented (Annex 1.2). The information is provided in German language. Different initiatives like “Girls’ day” (www.girls-day.de/), “tastMINT” (<http://www.tastemint.de/>) or “MINT Zukunft schaffen” (<http://www.mintzukunftschaefen.de/navigator/suche/show/72>) focus on girls in STEM and provide information about STEM-related studies and vocational orientation. E.g. the “Girls’ day” in Germany, where different universities, research institutes and companies take part once a year, females pupils commencing on 5th grade could get in touch with successful men and women of STEM professions and could try practical experiments in science and technology.

Furthermore, pupils have to plan their future career pathways after 10th or 12th/ 13th grade in Germany. Most of the pupils are still looking for information about appropriate career opportunities at the educational stage. Therefore, in the following different measures and initiatives with regard to career guidance taken by authorities will be represented. Different STEM-related aptitude tests (see Annex 1.3) for pupils are provided which are free of charge e.g. the initiative “think ing” (<http://www.think-ing.de/think-ing/die-qualifikationen/eignungstest>) for testing pupils’ interests and skills in engineering. Another initiative for testing IT-aptitude is “IT-Berufe.de” (<http://www.it-berufe.de/index.php?node=6>). Additionally on this homepage different IT professions will be introduced for pupils’ vocational guidance.

1.3. Girls and boys in STEM at the educational trajectories and in society

The gender differences in school performance of male and female pupils are subject still to research propositions. The term “gender gap” is often used instead of gender differences in this context (European Commission, 2008).

With regard to the educational trajectories of women in STEM fields, the phenomenon of the “leaky pipeline” during women’s educational pathways could be clearly seen (Solga & Pfahl, 2009). The higher the educational level the higher is the dropout rate of qualified women (Lee, 1998, Solga & Pfahl, 2009). Thus, the different levels at the educational stages, from primary school to STEM-related professions, will be analyzed in this section. This aims at identifying the factors that may hinder girls to pursue a career in STEM-related domains. Furthermore, the section focuses on the main statistical findings of gender differences in STEM, pupils’ interest, pupils’ self-concept, influence of parents, influence of teachers, influence of peers and the social background as far as they are related to the respective educational stage. Figure 3 shows the overview over the important data and factors according to the educational stages which are presented in this report.

<i>Educational stages¹</i>				
	<i>Primary school</i>	<i>Secondary school</i>	<i>University</i>	<i>Profession</i>
<i>Statistical Data</i>	x (After fourth grade)	x (Entrance to secondary school)	x (Enrolled student numbers)	x (Employment)
<i>Interest</i>	x	x		
<i>Self-concept mathematics</i>	x	x		
<i>Self-concept science</i>	x	x		
<i>Attribution</i>		x		
<i>Influence peers</i>		x		
<i>Social background</i>	x			
<i>Dropout</i>			x	
<i>Income</i>				x
<i>Reflection</i>	x	x	x	x

Figure 1.6. Overview educational stages

The following results of educational stages (primary and secondary school) refer to transnational studies with regard to the gender differences of pupils' school performances. These transnational studies (e.g. PISA) are based on the finding of gender research approaches which aim to

¹ The analysis of the pre-primary school context and the influence on interest for STEM (Kindergarten) has shown that there were not empirical studies which could be relevant for this National Report. Therefore, the deepened analysis of the educational stages starts at primary school level.

comparing the pupils' performances of the different nations and to analysing to which extend the school performances led back to social background-related factors (European Commission, 2008).

1.3.1. Pre-primary school

Promoting competencies of children in their early childhood was always an issue of education but since the moderate competency scores of German pupils in reading and mathematics literacy in the first PISA study in 2000 were published, the public interest for developing and facilitating the educational system has increased. Reading and mathematics competencies could be achieved already in pre-primary schools like the German "Kindergarten" (Schwarze & Wentzel, 2007). As the pre-primary education in the Kindergarten is not obligatory for all German states, it is not possible to give an elaborate overview in this report about children's performances in this report. Further, only few STEM-related results (e.g. the self-concept in mathematics) exist in this educational stage but results about the interest could be found. Thus, the interest of Kindergarten children is subject to this section.

The interest for science and technology could be promoted already in early childhood. This influence may due to gender specific socialization by parents, Kindergarten teacher and peers (Schwarze & Wentzel, 2007, Solga & Pfahl, 2009). The importance of such socialization factors on pupils' career choice were already revealed by Dick & Rallis (1991) and in other research studies.

1.3.2. Primary school

At primary school particularly after fourth grade, pupils' competence level of reading literacy and mathematics plays a decisive role in their further educational pathways. Therefore, in the following two international studies, TIMSS and IGLU, will be introduced. The first study TIMSS has its foci on mathematics and science competency of pupils and presents the differences of girls and boys. The second study focuses on the reading literacy and the correlation between the reading literacy and teachers' school preference for pupils as well as between the parents' school preference for their children.

Gender differences in mathematics and science competency in primary school (TIMSS)

The TIMSS (Trends in International Mathematics and Science Study) study in 2007 (Bos et al., 2008b) analysed the performance level of fourth grade pupils from elementary schools of 37 international countries and of seven regions².

Mathematics competency of German pupils at primary school

In comparison to the other European participants, German pupils achieved the upper third of participant nations with an average of 525 points regarding to the mathematics competency points. The average of the EU-nations and OECD nations is about 473 points. The German pupils achieved the 12th place out of 44 participants. A difference with regard to the mathematics performance between boys and girls could be established in Germany: Boys have shown a significant advantage of 531 points in comparison to the girls' achievement of 519 points. The Mean variation of performance in Germany was to a relatively low extending in comparison to

² The seven regions are Canada (Alberta), Canada (British Columbia), Canada (Ontario), Canada (Québec), USA (Massachusetts), USA (Minnesota), United Arab Emirates

the other states and regions. The standard deviation is about 68 points, which means the range from pupils of low-performance to pupils of high-performance is rather small. Bos et al. (2008b) suggested that it would be a future objective to increase the performance heterogeneity in general to a higher competency level. The highest mathematics competency level has been achieved by the pupils from Hong Kong with 607 points. From European perspective, England, Latvia (Lettland) and Netherlands (Niederlande) passed Germany (Deutschland) and achieved higher results in mathematics competency.

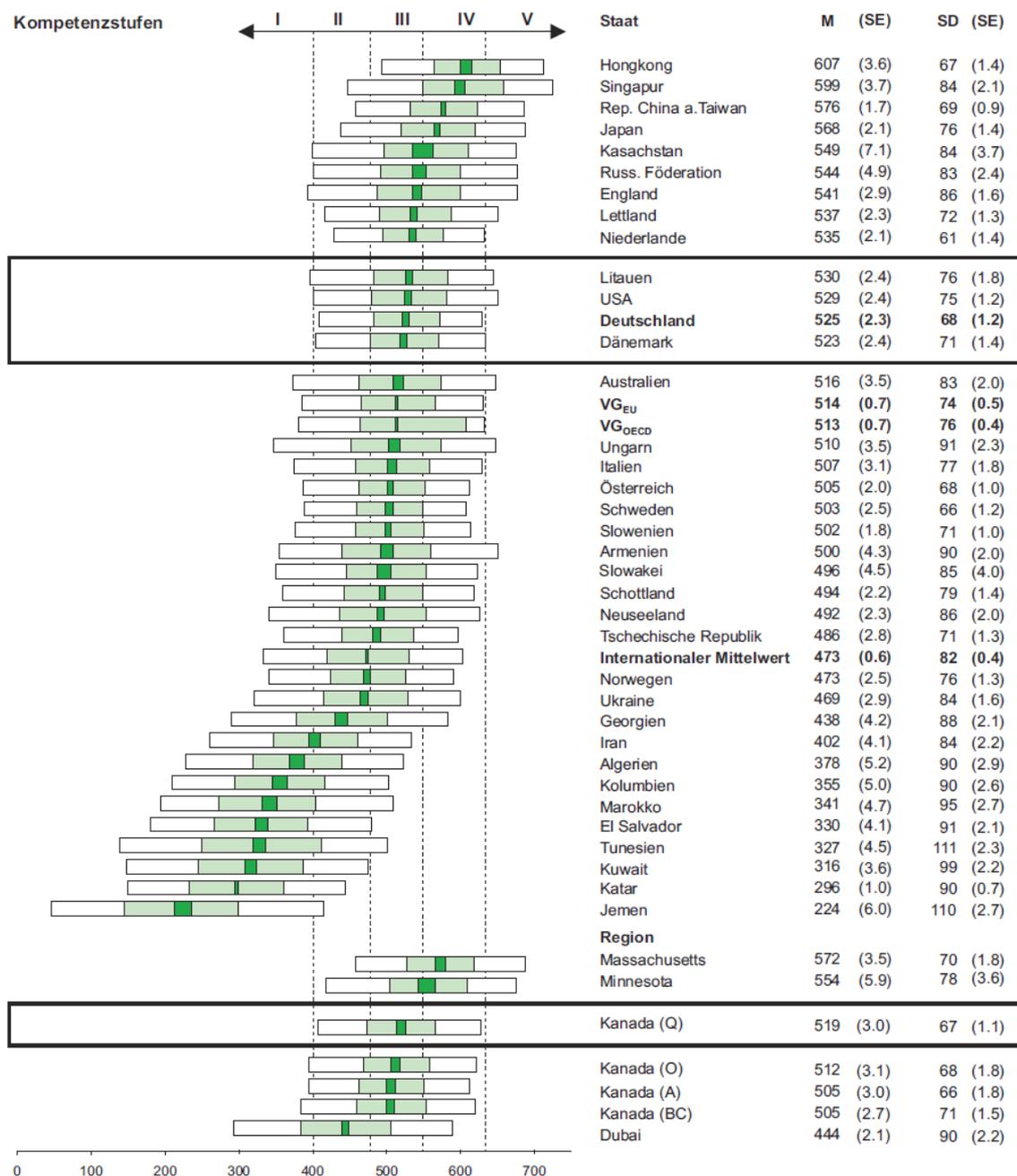


Figure 1.7. International comparison of mathematics competency scores (Source: TIMSS 2007)

Gender differences regarding mathematics competency

Figure 3.1 has been shown the test scores in mathematics according to the TIMSS study. With regard to test results in mathematics competency Hong Kong achieved the best mathematics competency scores. The figure below illustrates the performance difference between both genders. The difference between boys (“Jungen”) and girls (“Mädchen”) was four points but this difference between boys (609) and girls (605) was not significant. In contrast, German pupils (“Deutschland”) have shown a higher difference of 12 points between the performance of girls and boys in mathematics, this result was even significant. Further, German pupils belong to the third of the pupils who had the highest gender differences with regard to the mathematics competency. Boys had a significant advantage of 531 points in comparison to girls’ result of 519 points. In contrast, the international average of achieved mathematics scores by boys and girls of all countries has the same level with 473 points.

Staat	Mädchen		Jungen		M _j -M _m
	%	M _m (SE)	%	M _j (SE)	
Litauen	49	530 (2.8)	51	530 (3.2)	0
England	49	541 (3.2)	51	542 (3.6)	0
Japan	49	568 (2.5)	51	568 (2.7)	0
Internationaler Mittelwert	49	473 (0.7)	51	473 (0.7)	0
Neuseeland	50	492 (2.4)	50	493 (3.1)	1
Rep. China a. Taiwan	48	575 (2.0)	52	577 (2.0)	2
Lettland	48	539 (2.9)	52	536 (3.0)	-3
Ungarn	51	508 (4.6)	49	511 (3.8)	3
Hongkong	49	605 (3.2)	51	609 (4.4)	4
Slowenien	49	499 (2.4)	51	504 (2.1)	5
Australien	51	513 (4.2)	49	519 (3.6)	6
USA	51	526 (2.7)	49	532 (2.7)	6
Tschechische Republik	47	483 (3.3)	53	489 (3.0)	6
Singapur	49	603 (3.8)	51	596 (4.1)	-6
Schweden	50	499 (2.4)	50	506 (3.1)	6
Slowakei	49	493 (4.6)	51	499 (4.7)	6
VG_{EU}	49	511 (0.8)	51	517 (0.8)	6
Dänemark	51	520 (2.9)	49	526 (3.2)	7
Norwegen	50	470 (3.2)	50	477 (3.0)	7
Russ. Föderation	50	548 (5.5)	50	540 (4.9)	-7
VG_{OECD}	50	509 (0.8)	50	516 (0.8)	7
Kasachstan	51	553 (6.7)	49	545 (7.9)	-8
Schottland	51	490 (2.6)	49	499 (2.8)	9
Niederlande	48	530 (2.7)	52	540 (2.4)	10
Deutschland	49	519 (2.5)	51	531 (2.5)	12
Österreich	48	498 (2.5)	52	512 (2.3)	14
Italien	49	499 (3.2)	51	514 (3.6)	15

Figure 1.8. Gender differences with regard to mathematics competency

Science competency of German pupils at primary school

The figure below shows the international comparison of science competency scores. German pupils achieved 528 points in the test about science competency. With this result they belong to the upper third of the participating countries of the study. The average points of the EU-nations and OECD nations are lower than the Germans’ result: They only reach 476 points. Similar to the placement in the ranking of the mathematics competency, the German pupils also achieved the 12th place out of 44 participants with regard to the science competency. Singapore has the highest test result with 587 points.

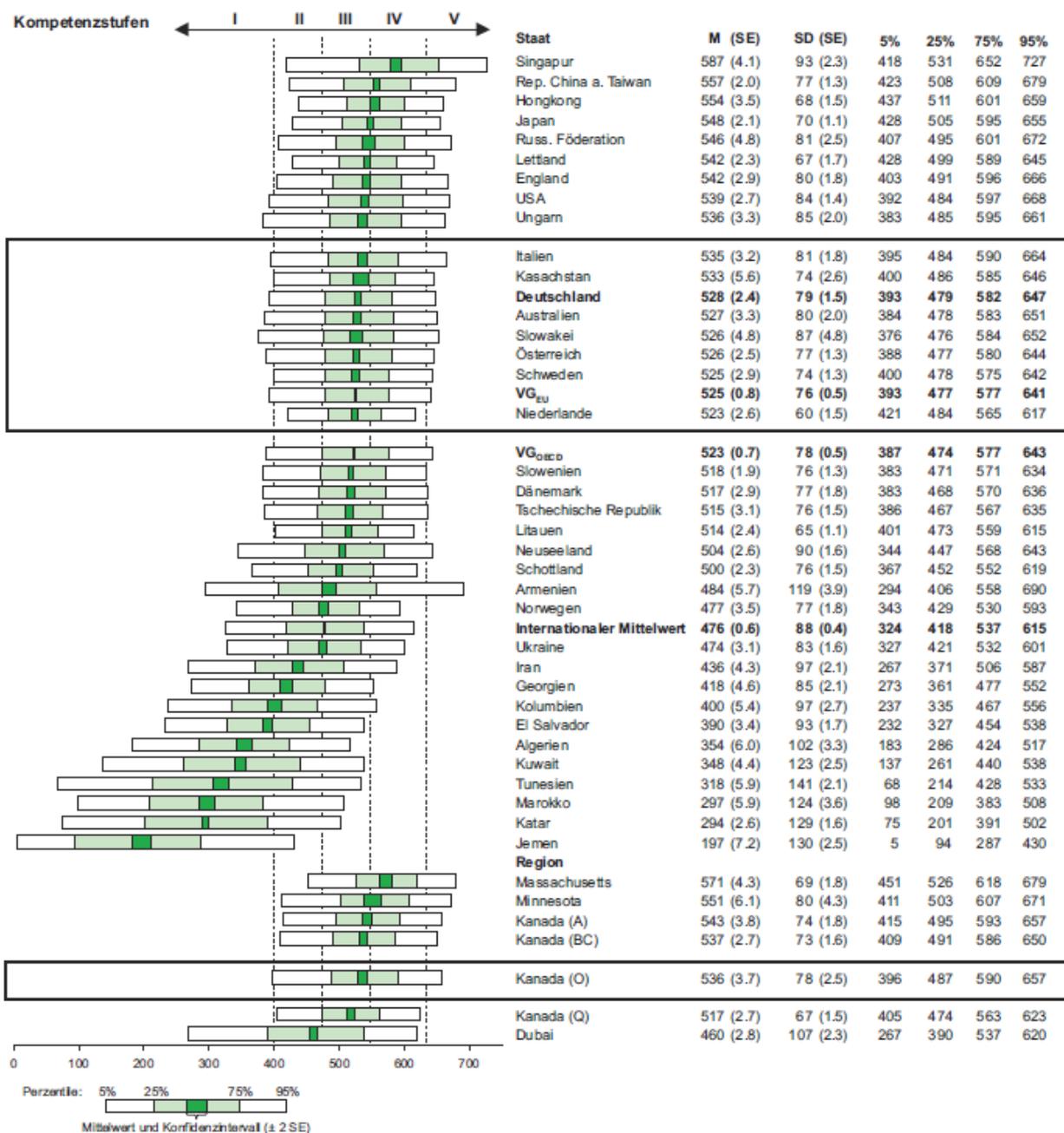


Figure 1.9. International comparison of science competency scores

Gender differences regarding science competency

The figure 3.2 illustrates the differences in achieved science competency scores of fourth grade pupils according to the TIMSS study. The scores are listed from no or small gender differences to the highest difference between the average scores of boys and girls in science (see right column below). Thus, with regard to the science competency score and gender, a clear difference of 15 points between girls' and boys' science performance is noticeable. Girls achieved 520 points in science and boys achieved 535 points. In addition, these results show that the performance gap in Germany is in comparison to the other participant countries remarkable as the country with the highest difference between female and male primary school pupils in science competency.

Staat	Mädchen			Jungen			M _j -M _m
	%	M _m	(SE)	%	M _j	(SE)	
Slowenien	49	518	(2.4)	51	518	(2.4)	0
Singapur	49	587	(4.3)	51	587	(4.4)	0
Japan	49	548	(2.5)	51	547	(2.4)	-1
Kasachstan	51	533	(5.5)	49	532	(6.3)	-1
Schottland	51	500	(3.0)	49	501	(2.4)	2
Schweden	50	526	(2.7)	50	524	(3.7)	-2
Rep. China a. Taiwan	48	556	(2.3)	52	558	(2.4)	2
Norwegen	50	475	(3.8)	50	478	(4.2)	2
Ungarn	51	535	(4.4)	49	538	(3.6)	3
Hongkong	49	553	(3.6)	51	556	(4.3)	3
England	49	543	(3.1)	51	540	(3.4)	-3
Internationaler Mittelwert	49	477	(0.7)	51	474	(0.7)	-3
Russ. Föderation	50	548	(5.1)	50	544	(5.0)	-4
Litauen	49	516	(2.7)	51	512	(2.9)	-4
Neuseeland	50	506	(2.8)	50	502	(3.5)	-4
VG_{EU}	49	523	(0.9)	51	527	(0.9)	4
USA	51	536	(3.0)	49	541	(3.1)	5
Australien	51	525	(4.0)	49	530	(3.5)	5
VG_{OECD}	50	520	(0.8)	50	525	(1.0)	5
Dänemark	51	514	(3.2)	49	520	(3.6)	6
Lettland	48	545	(2.8)	52	539	(3.0)	-6
Tschechische Republik	47	511	(3.7)	53	518	(3.4)	7
Slowakei	49	521	(5.2)	51	530	(4.8)	8
Niederlande	48	518	(3.0)	52	528	(2.8)	11
Italien	49	529	(3.2)	51	541	(3.7)	13
Österreich	48	519	(2.7)	52	532	(2.9)	13
Deutschland	49	520	(2.6)	51	535	(2.9)	15

Figure 1.10. Gender differences with regard to science competency (Source: TIMSS, 2007; Bos et al., 2008b); arrangement of the states is based on the score differences by gender

Mathematics self-concept

To be self-confident and to have a positive self-concept competency could be a good foundation for high school performances. Further findings of the TIMSS study concentrates on pupils' self-concept in mathematics. These findings revealed that German elementary school pupils have shown a positive attitude toward mathematics, whereat boys show a little more positive attitude than girls. Other gender specific differences regarding the attitude of pupils could not be established. Moreover, the German pupils assess their self-concept about their competency also positively (figure 3.3). Similar to the findings of the self-concept of the mathematics competency, German pupils belong to the third of the pupils who had the highest gender differences with regard to the self-concept about mathematics-related competency.

State	Girls			Boys			M _b - M _g
	%	M _g	(SE)	%	M _b	(SE)	
Norway	50	3,14	0,02	50	3,17	0,02	0,03
Sweden	50	3,25	0,01	50	3,29	0,02	0,04
Scotland	51	3,09	0,02	49	3,15	0,02	0,06
Russian Federation	50	2,89	0,03	50	2,96	0,02	0,07

Kazakhstan	51	3,24	0,03	49	3,17	0,02	-0,07
Slovenia	49	3,13	0,02	51	3,21	0,03	0.08
New Zealand	50	2,87	0,02	50	2,96	0,01	0.09
International average	49	2,95	0,00	51	3,05	0,00	0.09
USA	51	3,09	0,02	49	3,21	0,02	0.12
Hungary	51	3,02	0,02	49	3,15	0,02	0.13
Italy	49	3,01	0,02	51	3,14	0,02	0.13
Lithuania	49	2,93	0,02	51	3,07	0,02	0.14
Slovakia	49	2,96	0,02	51	3,10	0,02	0.14
Czech Republic	47	2,89	0,02	53	3,04	0,02	0.15
Australia	51	3,01	0,03	49	3,16	0,03	0.15
EU	49	3,02	0,01	51	3,17	0,01	0.15
OECD	50	3,01	0,01	50	3,15	0,01	0.15
Denmark	52	3,1	0,03	48	3,26	0,02	0.16
England	49	2,99	0,02	51	3,17	0,02	0.18
Latvia	48	2,79	0,02	52	2,97	0,02	0.18
Singapore	49	2,68	0,02	51	2,87	0,02	0.19
Netherlands	48	2,92	0,02	52	3,15	0,02	0.23
Germany	50	3,06	0,02	50	3,30	0,02	0.24
Austria	48	3,11	0,02	52	3,35	0,02	0.24
Hong Kong	49	2,68	0,02	51	2,93	0,02	0.25
China and Taiwan	49	2,48	0,02	51	2,73	0,02	0.25
Japan	49	2,61	0,02	51	2,87	0,02	0.26

Figure 1.11. Gender differences in mathematics-related self-concept mathematics-related self-concept; arrangement of the countries is based on the score differences by gender. (Source: TIMSS, 2007; Bos et al., 2008b)

Competency about the science self-concept

With regard to the competency about the self-concept in science the German boys (3.33) have also an advantage (like also Singapore, Taiwan, Japan and Denmark) in comparison to the girls (3.25), but the difference is rather small (figure 3.4). The self-concept describes the perceived abilities of pupils in science.

State	Girls			Boys			$M_b - M_g$
	%	M_g	(SE)	%	M_b	(SE)	
Australia	51	3,06	0,02	49	3,06	0,03	0.00
Scotland	51	3,04	0,03	49	3,04	0,02	0.00
Sweden	50	3,26	0,01	50	3,26	0,02	0.00
Slovenia	50	3,13	0,02	50	3,12	0,02	-0.01
Hungary	51	3,15	0,03	49	3,14	0,02	-0.01

EU	49	3,13	0,01	51	3,14	0,01	0.01
International average	50	3,08	0,00	50	3,07	0,00	-0.01
Hong Kong	49	2,90	0,02	51	2,88	0,02	-0.02
Italy	49	3,12	0,01	51	3,14	0,02	0.02
New Zealand	50	2,87	0,02	50	2,90	0,02	0.03
OECD	50	3,09	0,01	50	3,12	0,01	0.03
England	49	2,91	0,02	51	2,95	0,02	0.04
Norway	50	3,14	0,02	50	3,10	0,02	-0.04
Austria	48	3,34	0,02	52	3,38	0,02	0.04
Slovakia	49	3,21	0,02	51	3,25	0,02	0.04
USA	51	3,18	0,03	49	3,23	0,02	0.05
Netherlands	48	3,01	0,02	52	3,06	0,02	0.05
Latvia	48	3,04	0,02	52	2,98	0,03	-0.06
Germany	50	3,25	0,02	50	3,33	0,02	0.08
Czech Republic	47	3,01	0,02	53	2,93	0,02	-0.08
Russian Federation	50	3,14	0,03	50	3,06	0,03	-0.08
Kazakhstan	51	3,36	0,04	49	3,27	0,03	-0.09
Denmark	52	3,08	0,03	48	3,18	0,03	0.10
Lithuania	49	3,26	0,02	51	3,15	0,02	-0.11
Japan	49	2,84	0,02	51	2,98	0,02	0.14
China and Taiwan	49	2,94	0,02	51	3,08	0,02	0.14
Singapore	49	2,63	0,02	51	2,81	0,02	0.18

Figure 1.12: Gender differences in science-related self-concept skill; arrangement of the states is based on the score differences by gender. (Source: TIMSS, 2007; Bos et al., 2008b)

Gender differences in reading literacy (IGLU)

In the following section the IGLU results will be illustrated. The special focus lies on reading literacy which aims at explaining the correlation of reading and mathematics competency on the one hand and the school preferences of teachers and parents for the pupils on the other hand. Germany was part of the **Progress in International Reading Literacy Study (PIRLS)** which has the German label IGLU (Internationale Grundschul-Lese-Untersuchung) in 2006. IGLU study deals with the school performance of forth grade pupils in primary school; the results of the study could be compared to other Nations and could give more insights in the demand of further development of primary schools (Bos, et al., 2008b).

Preferences of school career by teachers and parents according to pupils' performance

The results of the IGLU study of 2001 and 2006 (see figure 4) with regard to the general school career preference of teachers and parents have shown a change: Teachers and parents recommend their pupils or children more an attendance of higher educational school e.g. Gymnasium than an attendance of "lower" educational school e.g. Hauptschule during the years. Similar findings

were subject to the preferences of parents; the preferences indicated also a preference tendency for the Gymnasium rather than for the Hauptschule but to higher extend in comparison to the preference of teachers Arnold et al. (2007).

The figure below shows the correlation between the German language and mathematics grade of fourth grade pupils and the preference of teachers for the Gymnasium on the one hand and the preference of parents for the Gymnasium on the other hand. Preference means in this context that the teachers or parents would recommend their pupils or children to go to Gymnasium according to their school subject performance in German language or mathematics. The German language (β^*) and mathematics grade (β^{**}) illustrate pathway coefficients and they indicate different β -weights in the regression analysis. These β -weights provide information about to which extend the preference of teachers and parents could be clarified. The findings reveal that correlation for Germany between the German language grade and the preference of teachers for the pupils' pathway of the higher education (Gymnasium) is narrow to a higher extend ($\beta^*=-0.56$) than the correlation between the mathematics grade and the preference of teachers ($\beta^{**}=-0.42$). The R^2 -value describes to which extend the mean square of the preference for Gymnasium could be explained by the German language and mathematics grade. The R^2 -value for the preference of teachers ($R^2= 0.80$) is higher than the preference of parents ($R^2=0.68$), that means 80% of the variance regarding preference of teacher for Gymnasium could be clarified by the German language grade and by the mathematics grade, and 68% of the variance regarding the preference of parents for Gymnasium could be clarified by the German language grade and by the mathematics grade. Further, the correlation between the preference of parents of fourth grade pupils for Gymnasium and the German grade as well as correlation between the preference of parents and the mathematics grade were lower in comparison to the preference of teacher (see figure 1.13). To sum up, the proportion of explanation of the preference variance of teacher and parents is rather high and is an evidence for a high cohesion.

	Preferences of teachers for "Gymnasium"			Preferences of parents for "Gymnasium"		
	German language Grade (β^*)	Mathematics Grade (β^{**})	R^2	German language Grade (β^*)	Mathematics Grade (β^{**})	R^2
Bavaria	-0,62	-0,37	0,82	-0,53	-0,31	0,6
North Rhine-Westphalia	-0,59	-0,43	0,86	-0,56	-0,4	0,75
Germany	-0,56	-0,42	0,80	-0,54	-0,37	0,68

Figure 1.13. Preferences of teachers and parents for "Gymnasium". (Source: Arnold et al. (2010), S. 23)

Interest

The facilitation for the interest for STEM-related subjects by girls could occur differently in the early childhood by parents. That means it is less often in the intention of parents to introduce girls in STEM or explore activities than boys (Schwarze & Wentzel 2007). In addition, with regard to the previous experience of pupils, the finding of Hannover & Kessels (2002) showed that the girls often have less experience in the technology usage than boys in school. This could be based on the perception of children in this age is subject to the socialisation and therefore also to the social environment like e.g., parents.

Social background



The social background is still a subject to education and career paths. Pupils of a socially deprived family have fewer opportunities to get higher education than pupils of a socially privileged family with a high economic status (Bos et al., 2008a; Solga & Dombrowski, 2009). The end of the fourth grade may be a significant barrier: at this education stage, the decision of further school attendance (Hauptschule, Realschule or Gymnasium) is mostly also a decision of the career path or “biography of education”: “Hier werden die entscheidenden Weichen für die weitere Entwicklung der Bildungsbiografie gestellt“ (Solga & Dombrowski, S. 14, 2009).

The findings on the school preferences of teachers and parents lead to the suggestion that the social background has influences on the choice of school pathways. Several studies have examined that the educational background of the parents could be a crucial influence factor on pupils further school career (Mahr-George, 1999; Arnold et al., 2007). According to the TIMSS study (2007), it was found that there is a narrow correlation between social background and the achieved competency level at the end of the elementary school (Bos et al., 2008a). Other studies have taken indicators for the social backgrounds like e.g. the numbers of books in a household into account: a household with more than 100 books demonstrated a high social background and a household with less than 100 books is noticeable as low social background (Bos et al., 2008b). The findings are that the more books a family owns the higher the pupils’ performances mathematics and science are. To specify which reasons has influence on this correlation there would be a demand of further research.

Parents with a high educational background are more likely to choose a higher education according the recommendation of the preference of teachers or have even higher expectations with regard to their children’s school career, e.g. parents with a higher educational degree, will send their children more probably to Gymnasium if the teachers only recommend a lower school education e.g. Realschule (Mahr-George, 1999). In contrast, those parents with a lower educational degree are more likely to choose a lower school type (e.g. Realschule) even if the preference of the teacher recommend a higher school type (Bos & Stubbe, 2006).

Factors of school pathways preferences

Bos and Stubbe (2006) developed a prognosis-model in the connection to school pathways preferences of teachers and parents after the IGLU study 2001 and was modified to the data of the IGLU study 2006. The analysis of the data has considered the factors reading literacy, cognitive skills, effort willingness, test anxiety, gender, migration background, ISEI, and numbers of book (figure 5). The analysis of these factors could be subject to further research and could not be deepened under the scope of this report.

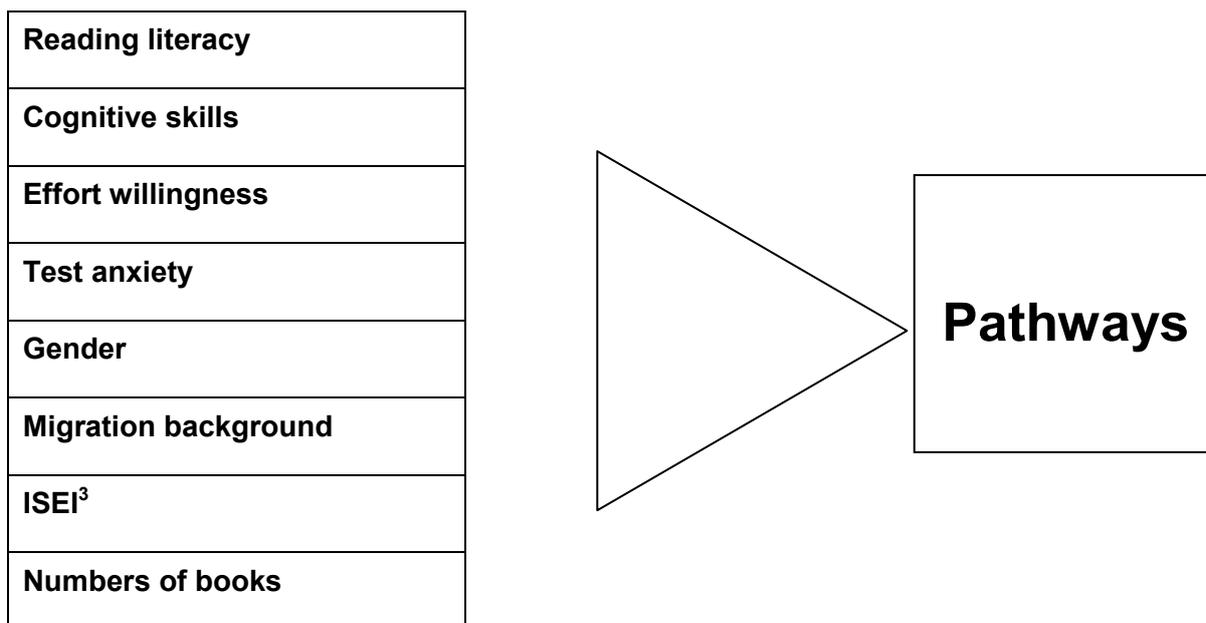


Figure 1.14. Factors for preferences of school pathways

Reflection of primary school

To sum up, the findings of the TIMSS have shown that the German pupils achieved the first third with regard to the mathematics scores after the fourth grade. Boys and girls have a positive self-concept related to their mathematics and science abilities, but boy’ self-concept is a little bit more to the advantage to male pupils. This general positive self-concept of females at the end of primary school could be strengthened by measures or by teachers who encourage girls to deal more with STEM-activities. According to the findings of IGLU, the correlation between the preference of parents of fourth grade pupils for Gymnasium and the German grade as well as correlation between the between the preference of parents and the mathematics grade were lower in comparison to the preference of teacher. Teachers are more likely to recommend their pupils to attend an educational higher type of secondary school as the Gymnasium based on the grades in German and mathematics. This recommendation for the entrance of a Gymnasium is important because only with the Abitur as upper secondary school certificate one could get the opportunity to enter a study pathway and start a career with a university degree afterwards. Further, the social background of parents and their decision, to which secondary school pupils have to go to, are linked together. The higher the social background is, the more likely the parents are to send their children to a Gymnasium, even if the pupils got the recommendation to attend Realschule.

1.3.3. Secondary school

The following section focuses on the current situation of gender and STEM in secondary school. As it was mentioned in the previous section, the educational stage after primary school is important for the further pathway. The division in three secondary school types according to the performance in primary school build an early educational selection of pupils. This selection could be influenced by teachers in some German states; therefore the primary teachers have impact on pupils’ career with respect to a long-term perspective. The teachers’ school recommendation duty in Germany will be illustrated in the next section.

³ International Socio- Economic Index

School change by recommendation of teachers after primary school

As we mentioned before Germany has different long attendance periods for primary school depending on each of the 16 federal states. For the entrance to the Gymnasium the German states have different conditions. Most of the states have four school years of primary education (e.g. Bavaria); some have discussions about rising the school years from four to six years (Saarland), and some have six school years (e.g. Berlin). The age depends on the pupil's age at the school enrolment. After the primary school, there are three options of further secondary schools for pupils: Hauptschule, Realschule and Gymnasium (sometimes Gesamtschule).



Figure 1.15. School reform trends: German states with a six-grade primary school. The states which have a six year primary school are *marked green* and those states which are planning to enlarge the primary school time are *hatched*. Most of the states are *not marked* which means that in these states only four school years are mandatory.

(Source: <http://www.zdf.de/ZDFmediathek/beitrag/interaktiv/1074836/Die-unterschiedlichen-Bildungssysteme#/beitrag/interaktiv/1074836/Die-unterschiedlichen-Bildungssysteme>)

Figure below shows those states e.g. Bavaria or Baden-Württemberg which have foreseen a recommendation of teachers for pupils who want to attend to a Gymnasium on the one hand (blue) as well as a certain average grade on the other hand which could differ from the range of 2.00 to 2.33. Some states as North Rhine-Westphalia are discussing the need of teachers' recommendation for the entrance to Gymnasium (hatched blue). Other states like Berlin or Saarland (no mark) do not have such a recommendation duty but in these states the parents are free in their school choice for the further education of their children after primary school. Most of the states still prefer the teacher's recommendation system (marked blue) and primary school average grade as qualification for the entrance in Gymnasium or Realschule. Thus teachers have a great influence on the future educational pathways of their pupils and their recommendations could determine an entrance to the further education (Gymnasium).



Figure 1.16. German states with mandatory recommendations of teachers after the primary school for further school. Federal states which have foreseen a recommendation by teachers for pupils who want to attend to a Gymnasium are *marked blue*. Some states which are discussing the need of teachers' recommendation for the entrance to Gymnasium are *hatched*. Other states which do not have such a recommendation duty are *not marked*.

(Source: <http://www.zdf.de/ZDFmediathek/beitrag/interaktiv/1074836/Die-unterschiedlichen-Bildungssysteme#/beitrag/interaktiv/1074836/Die-unterschiedlichen-Bildungssysteme>)

Numbers of secondary school pupils

According to the school system of Germany, pupils could choose between three secondary school pathways: Hauptschule, Realschule and Gymnasium. The Gesamtschule is a special school type of some Länder e.g. Berlin (see chapter 1.2). Additionally, in some Länder Gesamtschule is a kind of comprehensive school. During the School year of 2005 and 2006, 2.431.329 German pupils attended a Gymnasium (43%), 1.324.683 pupils attended a Realschule (23%), 1.023.838 pupils attended a Hauptschule (18%) and 520.684 (10%) pupils attended a Gesamtschule (Statistisches Bundesamt, 2007).

Mathematics and science competence of secondary school pupils (PISA)

In the following, the findings regarding gender and the achievements of secondary school pupils in mathematics and science are presented.

PISA is an international educational study about secondary pupils' competencies which is conducted by OECD every three years. The results of the years of 2000 to 2006 are already worked out and published. The figure shows the three different research foci and the time schedule for the further survey: Reading, mathematics and science.

Assessment year	2000	2003	2006	2009	2012	2015
Subjects assessed	Reading Mathematics Science	Reading Mathematics Science Problem solving	Reading Mathematics Science	Reading Mathematics Science	Reading Mathematics Science	Reading Mathematics Science
Students' self-assessment	Approaches to learning, engagement with reading	Approaches to learning, attitudes to mathematics	Approaches to learning, attitudes to science	To be defined + One developmental assessment per survey		

Figure 1.17. Overview over the PISA surveys (2000-2015),
 (Source: <http://www.oecd.org/dataoecd/51/27/37474503.pdf>)

Under the scope of this report, the following section concentrates on the results of the PISA study of 2006 with respect to mathematics and science competency of German pupils.

Figure 1.18 visualizes PISA 2006 results (BPB, 2008; Prenzel et al., 2008). It displays differing mathematical and science literacy mean scores for the federal states in Germany.

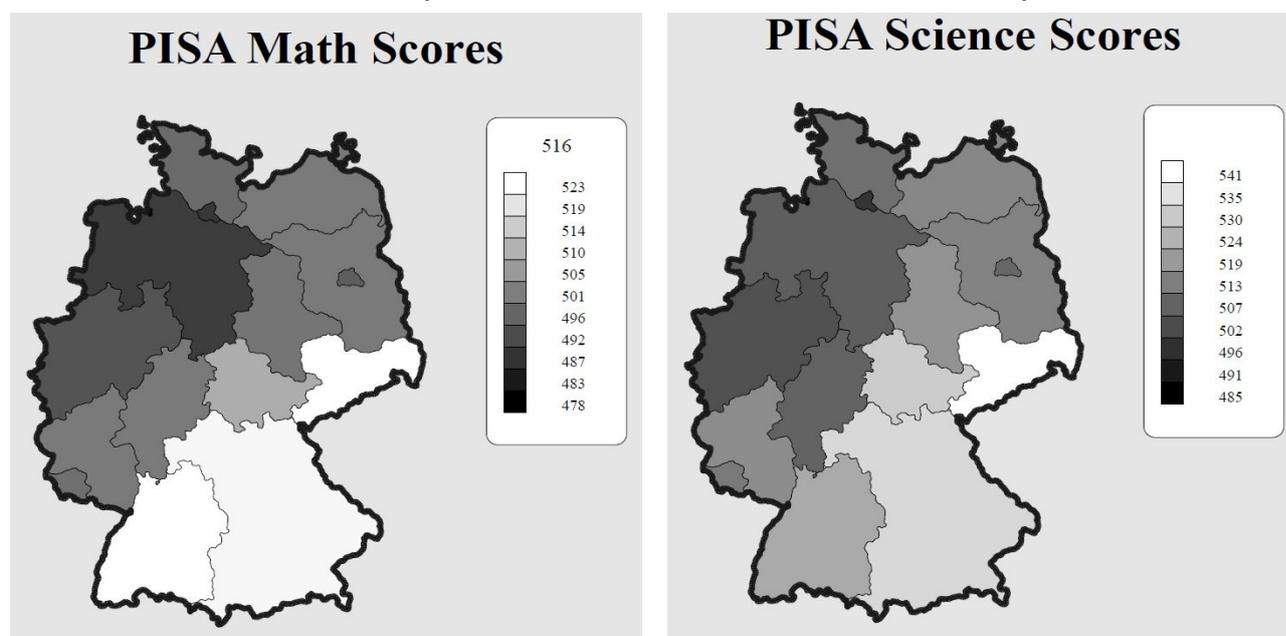


Figure 1.18. PISA 2006 mathematical and science literacy scores for the German Länder (Source: OECD PISA 2006).

The figure shows clear differences between the Länder. For example, the math and science scores of the two largest Länder Bavaria (population: >12.519.300) and North Rhine-Westphalia (NRW, population: >17.968.100) differ about 30 points in both subjects. The competences of pupils in Bavaria in math (519 points) and science (535 points) are above OECD average (math 489; science 500) and above the average of Germany (maths 504; science 516). This is not the case in NRW where the pupils' maths score (487 points) is below OECD average and the average of Germany; and the science score (507 points) is below the average score of Germany but above the OECD average.

The following link provides a video example of science learning in Germany produced in the context of the OECD PISA 2006 study (Duration: 4:17min):

www.viewontv.com/oecd/031207_pisa2006/index.php?lang=ge

PISA 2006 – Science Learning: Germany



The differences in the pupils’ mean scores of mathematical, science and reading literacy are established in Germany also between school types and by sex. Figure 7.3 presents the performance differences of girls and boys for schools on secondary level.

The crucial gender difference in girls’ and boys’ reading competence is reflected in their distribution to the PISA 2006 proficiency levels: at proficiency level V (expert level) two-thirds of the pupils are female, and on the contrary at competence level I (basic level) only one-third are female. This distribution is different for the mathematics and natural sciences competences: at the basic level the proportion of girls and boys is nearly equal whereas at competence level IV and V about 60% of the high achievers are boys (Frey, et al., Frenzel et al. as cited in Blossfeld et al., 2009).

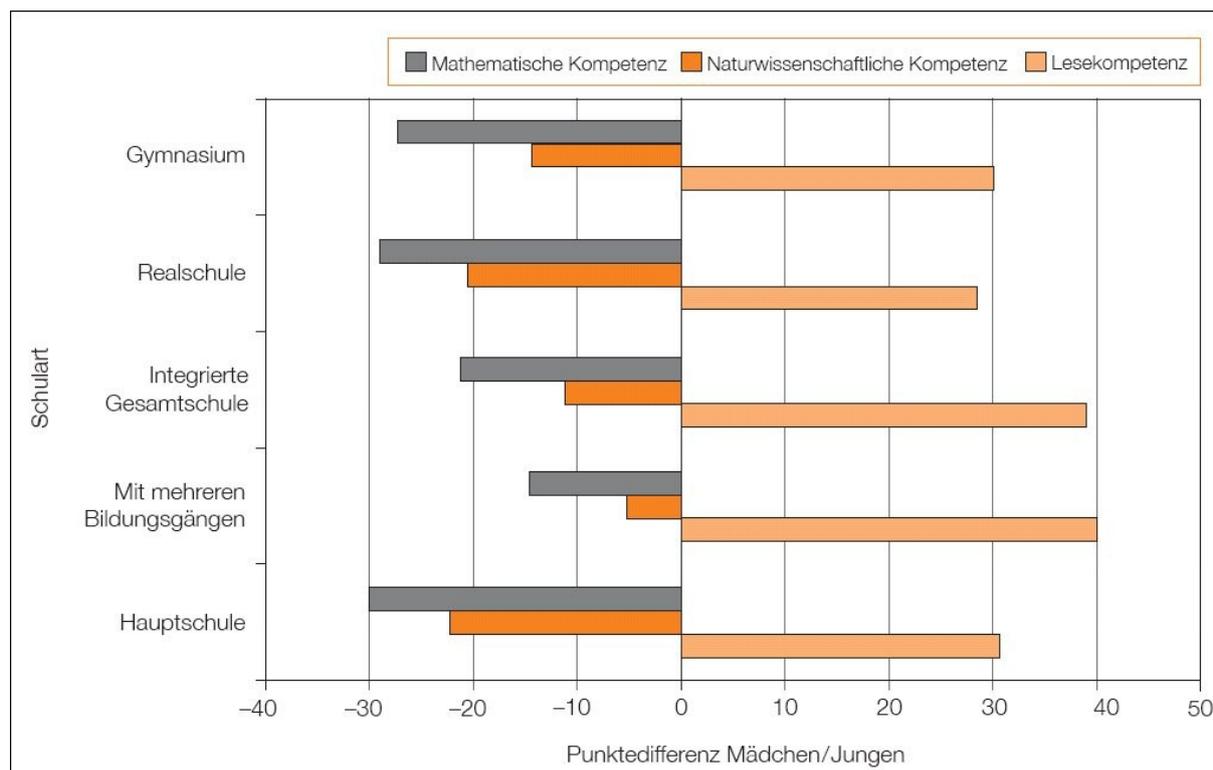


Figure 1.19. Differences in the mathematical, sciences and reading literacy PISA scores by school type and by sex. (Source: PISA, 2006; Blossfeld et al., 2009). Translation of figure 7.3 – Schulart: type of school; Gymnasium: grammar school; Realschule, Hauptschule: lower secondary schools; Integrierte Gesamtschule: integrated comprehensive school; mit mehreren Bildungsgängen: including several courses of education; Punktedifferenz Mädchen/Jungen: difference in the score of girls/boys; Mathematische Kompetenz: mathematical literacy; Naturwissenschaftliche Kompetenz: science literacy; Lesekompetenz: reading literacy.

Interest

In secondary school the interest for STEM-related subjects changes by boys and girls in particular when they reach puberty (Solga & Pfahl, 2009). A smaller share of girls shows interest in mathematics and physics subjects and the girls rather prefer typical subjects like foreign languages and German. Interest in school subjects may determine the choice of the majors in school and further the career choice.

Self-concept

The self-concept of girls in secondary school is important issue for girls' development of STEM-related competencies in school. In this connection, the self-assessment by pupils is the most important issue to the performance of pupils in particular in STEM-related subjects, besides the other influence factors like interest and joy for the subject as well as the profit belief. This self assessment includes the performance rating in general (self-concept) on the one hand and the coping with difficult subject tasks (self-efficacy) on the other hand (Jahnke-Klein, 2006). In addition, the anxiety perception could have also influence on the school performance. According to the findings of the PISA-study in 2003, higher gender differences in Germany with regard to the attitudes of performance in comparison to the effective performance could be established particularly in mathematics (Zimmer, Burba & Rost, 2004). Further, female pupils attribute their success in STEM-related subjects to other reasons than males (Dickhäuser & Meyer, 2004): Girls assess their successful performances in STEM more often as fortune and ascribe their failure more often to their own abilities. These unfavourable attribution patterns could have negative impact on the interest and motivation of girls for STEM (Menacher, 1994).

These findings could be also approved by Dickhäuser and Meyer (2006), they found that although girls and boys did not differ in their general ability and grades, but girls attributed their mathematics performance less to high ability and math failure more to their own low ability.

Influence by peers

According to Leslie et al. (1998) the crucial reason for the increasing gender gap regarding the school performance and interests in school for STEM during the adolescence are the peer group impacts on the self-confidence of girls. Girls and boys choose more and more stereotypical subjects. Further, the wish of girls' aspires for popularity among the boys leads to strengthening of "doing gender" phenomena.

Due to the findings of a study by Hannover & Kessels (2004) the perceived (negative) image of a prototypical student in science may causes the dislike of choosing the science subjects or even a science career. Furthermore, the negative perception of the image of a science student could be described as person who is "socially incompetent isolated and not creative" (Hannover & Kessels, 2004, p. 65). This perception is supported by the scripts of instruction which guides mathematics and science lessons on the one hand, and by science related prototypes which are taught by older peers or shown by the media.

Reflection on secondary school

Taken together, the PISA findings (2006) have shown clear gender differences in secondary school with regard to literacy and mathematics and science performance (Blossfeld et al., 2009). Two-thirds of the literacy levels V (proficiency level V) are girls. In contrast, boys were better in mathematics and science performance: 60% of literacy level IV and V are boys Similar gender

differences could be established with respect to pupils' interest in STEM-subjects: with the beginning of puberty, less girls show interest in mathematics or science-related subjects, they are more concentrated on other subjects like e.g. foreign languages (Solga & Pfahl, 2009). Regarding the self-concept of pupils, it was noticeable that particularly the negative perception of science or the profession in sciences are common among pupils of secondary school and have influence on their stereotypical beliefs. These stereotypes of females and males pupils could be one of the reasons for the low uptake of STEM careers (Hannover and Kessels, 2004). According to Hannover and Kessels (2004) stereotype beliefs are not fixed, thus the beliefs of pupils are changeable e.g. such changing could be enhanced by contacting members of a stereotypical group. In addition, several research findings with regard to the differences of girls and boys concerning the attribution (see Zimmer, Burba & Rost, 2004, Dickhäuser & Meyer, 2006) have shown that girls are more likely to unfavourable attribution patterns with regard to their abilities in STEM in particular in science and mathematics in school. Further, other socialisers like peers could have impact in particular on girls' self-confident and girls' aspire after popularity among the boy during the adolescence (Leslie et al., 1998).

To sum up, the gender differences of female and male pupils in STEM-related subject become more distinctive in secondary school in comparison to those in primary school. The interest and self-concept about the competencies in mathematics and science are strongly to the advantage of boys (see Blossfeld et al., 2009). In addition to that, self-concept in STEM-related subjects has changed by girls: in primary school they had almost the same positive attitude regarding e.g. mathematics; in contrast in secondary school the girls have shown negative attribution patterns with regard to their abilities in STEM.

1.3.4. Higher education

With regard to the higher education level of women in STEM-related subjects, it is noticeable in mostly all European countries that women rather chose a humanities or social science subject at university than a STEM-related subject. These statistical data goes along with traditional stereotypes (Eurydice, 2008) which are still one of the biggest challenges for the gender equality in the educational field.

In general, a degree of higher education could improve the job prospects in comparison to vocational trainings after graduation of secondary school according to the OECD (2010): http://www.kmk.org/fileadmin/pdf/PresseUndAktuelles/2010/2010-09-06_PM-LangFinal.pdf

The following figure 8.1 illustrates the percentage of female students who enrolled in different fields of study in the year of 2006. In Germany and in the other European countries, the share of women in the science, mathematics, computing (D) and in particular in engineering, manufacturing, construction (E) is rather low. The development to a small share of women in comparison to the beginning of their school career at elementary school could be established in 2006. Germany has the lowest proportion of 18.2 % of women who enrolled for engineering, manufacturing or construction subject at university among the European project partners, the EU average is 24.4 %. Poland and Spain, in contrast, declare a higher share for this study subjects: 27.1 % of the Polish women enrolled and 28 % of Spanish women enrolled for these subjects. The share of 34.8% of women in science, mathematics and computing is a little higher than the one of engineering field. Most of the women still prefer a study in the field of humanities, social science, education and health sector.

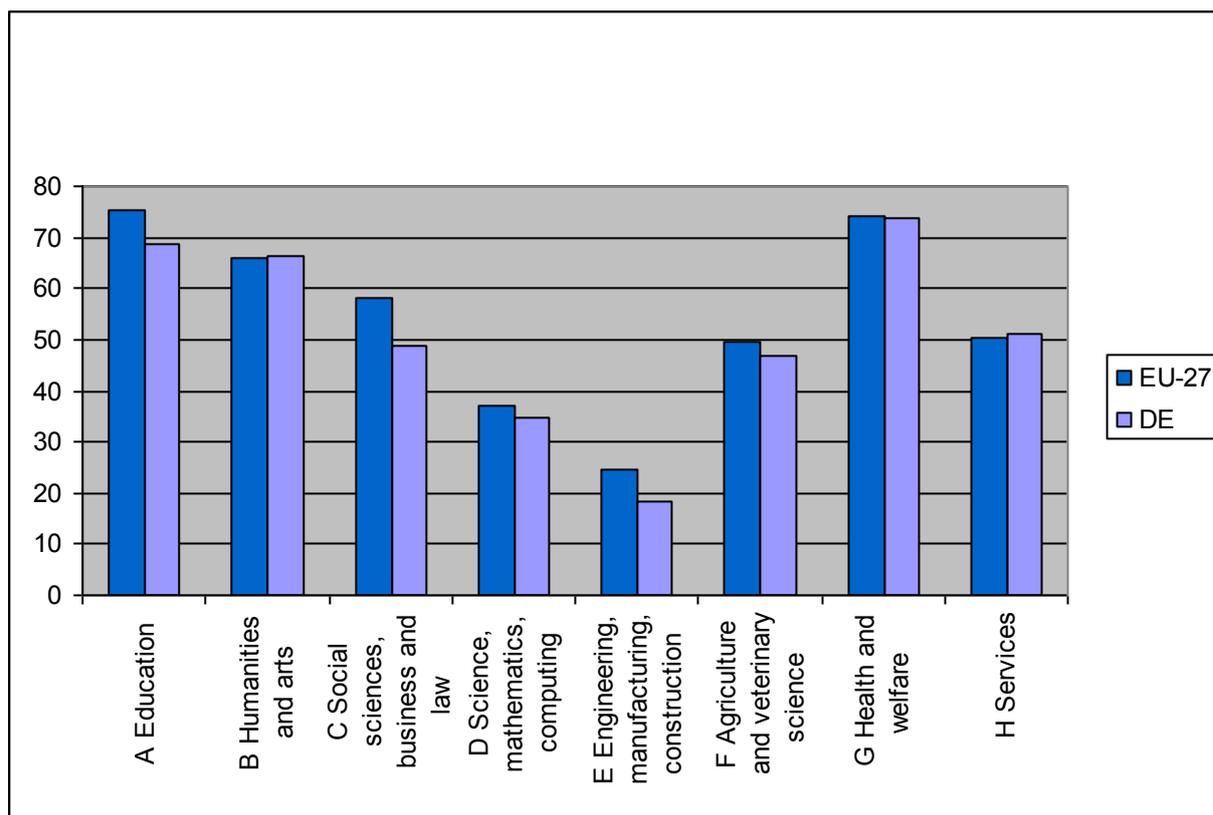


Figure 1.20. Proportion of enrolled female students in Germany

Low share of women in STEM (HIS)

To get more insights to the situation of women in STEM with special regard to STEM subjects at university the Hochschul-Informationen-System (HIS) (2006) study reveals further findings. The results of the HIS survey (2006) have shown the low share of women in STEM-related subjects in relation to the year 2002 in particular study subjects like computer science are unpopular among women. The proportion of female students is about 17 %. In physics there are a similar proportion of women. In comparison to these rather technical oriented subjects, the share of women is higher and lays about 36% in other STEM subjects like mathematics. Other science subjects like biology and chemistry (“life sciences”) are rather popular among women.

PhD graduates

The PhD-graduates data reflect these findings: The share of female PhD graduates varies considerably across the different fields of study. In 2006, on average throughout the EU-27, female PhD holders accounted for 64% of all PhD graduates in education. However, in 2006, on average in the EU-27, 45% of all PhD graduates were women. In the field of science, mathematics and computing the share of female PhD graduates is only 35%, in engineering, manufacturing, construction the share of 14% of women is even lower. Women are still more likely to choose their PhD in stereotype-related subjects like agriculture (60%) or education (53%), which seems more attractive women’s career paths.

Growth rate of PhD

The following figure shows the compound annual growth rate of PhD graduates in the field of natural science and engineering in the year of 2002 to 2006. Mostly in all countries the growth rate is rather moderate, except Greece. Germany has a rather high growth rate for women in particular in the field of life science (7%), physics (4%), mathematics & statistics (6%), engineering (6%) and architecture (9%) in comparison to men (figure). Furthermore, the growth rate of PhD doing by women (13%) exceeds that of men (7%). But in manufacturing both show a significant decrease of the growth rate for PhD. To put it together, this increasing PhD rate by women in particular in fields of STEM could be found and seen as a positive tendency that women trust themselves to take higher tertiary education into account.

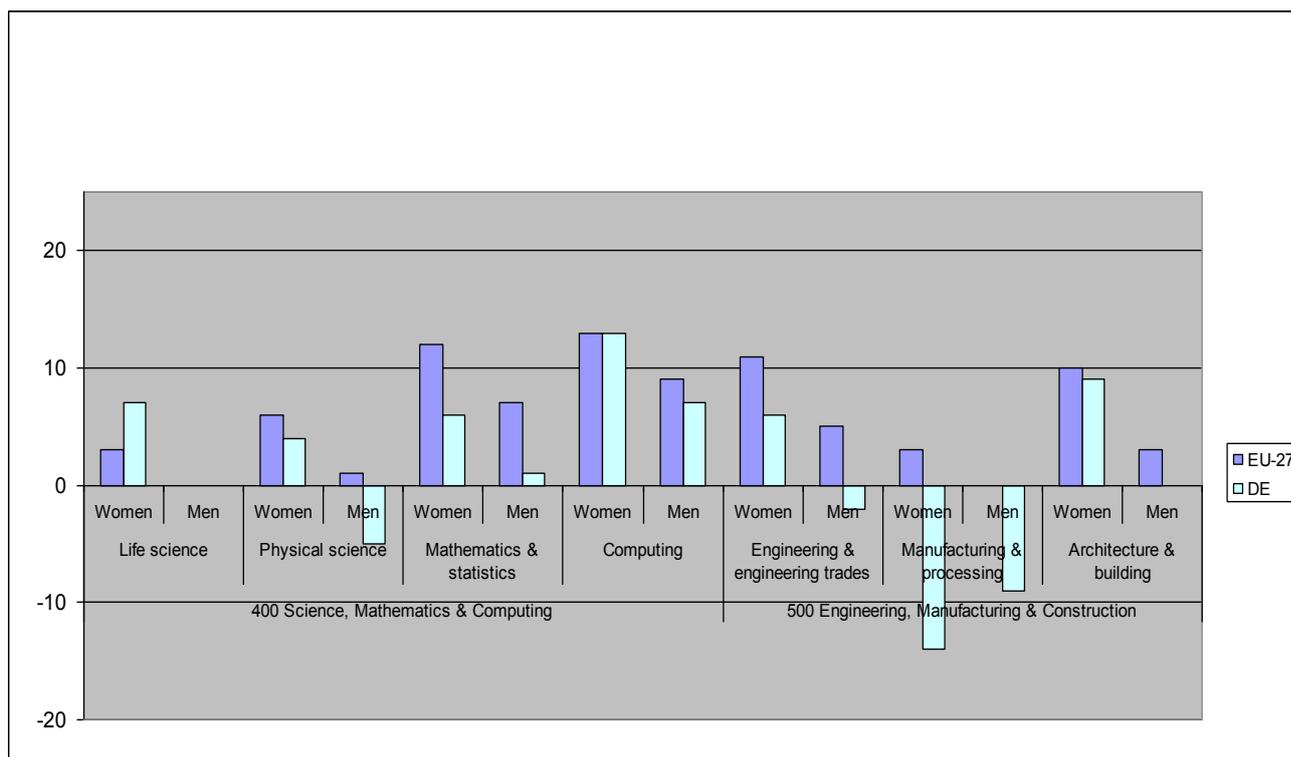


Figure 1.21: Compound annual growth rates of PhD (Source: Eurostat, 2008)

Dropout of STEM-related studies

In the following, reasons for a high proportion of dropouts of students in STEM will be presented. In comparison to humanities or social sciences, the tendency of dropouts by female and male students of STEM-related subjects is relatively strong (Heine et al., 2006): the dropout proportion in computer science is 38%, the proportion in mechanical engineering is 34%, the proportion in physics is 30%, but in mathematics and biology the proportion of dropouts is rather small (26% and 16%). According to the results of the study by Fellenberg and Hannover (2006) the high rate of dropouts or the fact of changing study subjects by women in STEM-studies could be led back to the demand of social support by minorities. Women are often a minority in STEM study context and they perceive stereotype assessment of study tasks e.g. male connoted task are assessed as difficult in contrast to the female connoted tasks. In addition, the findings have shown that the self-efficacy-expectation was a subject to women regarding the tendency of dropout. Further reasons for a dropout of STEM for both genders could be the heavy workload, different course expectations, exam failure or course change (The Womeng Consortium, 2005).

Reflection on higher education

Regarding the current study situation of women in STEM, females students are still underrepresented in these study fields: In Germany the share of women in the science, mathematics, computing and in particular in engineering, manufacturing, construction is rather low (Eurostat, 2008). These findings could be supported by the results of the HIS survey. They found that a smaller share of women chose STEM studies and especially subjects like computer science are unpopular among women. In contrast to these findings, the PhD growth rate of women concerning the year of 2002 to 2006 has shown that more and more women take the PhD as high educational qualification into account. Thus, the share of women who will do their PhD at universities in stereotype-related subjects exceeded the share of women in STEM-related subjects.

To sum up, a lot of female students still prefer to study stereotypical study subjects like education or social sciences, but the growth rate for PhD by women increases slightly in STEM. A rather difficult study context and the conditions for STEM-related subjects could be possible reasons for the low uptake of STEM studies by women (Heine et al., 2006).

1.3.5. Women in scientific and technological careers

Solga & Pfahl (2009) describe the successive dropout of women in science and technology; they ascribe the interest problem of girls in STEM not only to the educational system but to the labour market.

In Germany the lack of specialised workforce particularly in science and technology field is given. For a better understanding of the current STEM career situation, the following section describes the progress of employment of students after the graduation at university during the first 12 months. Different data will be presented for the employment situation of STEM professions in Germany and gender as well as the gender imbalance regarding the income in STEM domains.

Employment of students after the graduation at university

Leuze & Rusconi (2009) reveal that after graduation no sex differences exist as regards obtaining professional employment in general. The first job placement, however, already shows clear horizontal gender segregation patterns among professionals in the public and private sector. Women are predominantly attracted by professions in public sector women, particularly women with young dependent children, but are also attractive for men with female dominated fields of study.

The above mentioned HIS survey (Briedis et al., 2008) provided additional data about the progress of employment of students after the graduation at university. Figure 9.1 displays this progress for the subjects mathematics (Mathematik), teacher education for the subject mathematics (Lehramt Mathematik), information technologies (Informatik), electrical engineering (Elektrotechnik), humanities (Geisteswissenschaften), and in comparison to the average progress of employment for all graduates in the related period (Uni insgesamt) in the first 12 months following graduation at university. It can be concluded from the data, that in general graduating in mathematics, and even more in information technologies and electrical engineering, is associated with clearly better chances for a swift job entry after university than graduating in mathematics teacher training or humanities. However, after completing teacher education (for mathematics) at university the students have to continue their education during practical phases in schools. This accounts for the relatively low number of employed mathematics teachers during the first 12 month after graduation at university.

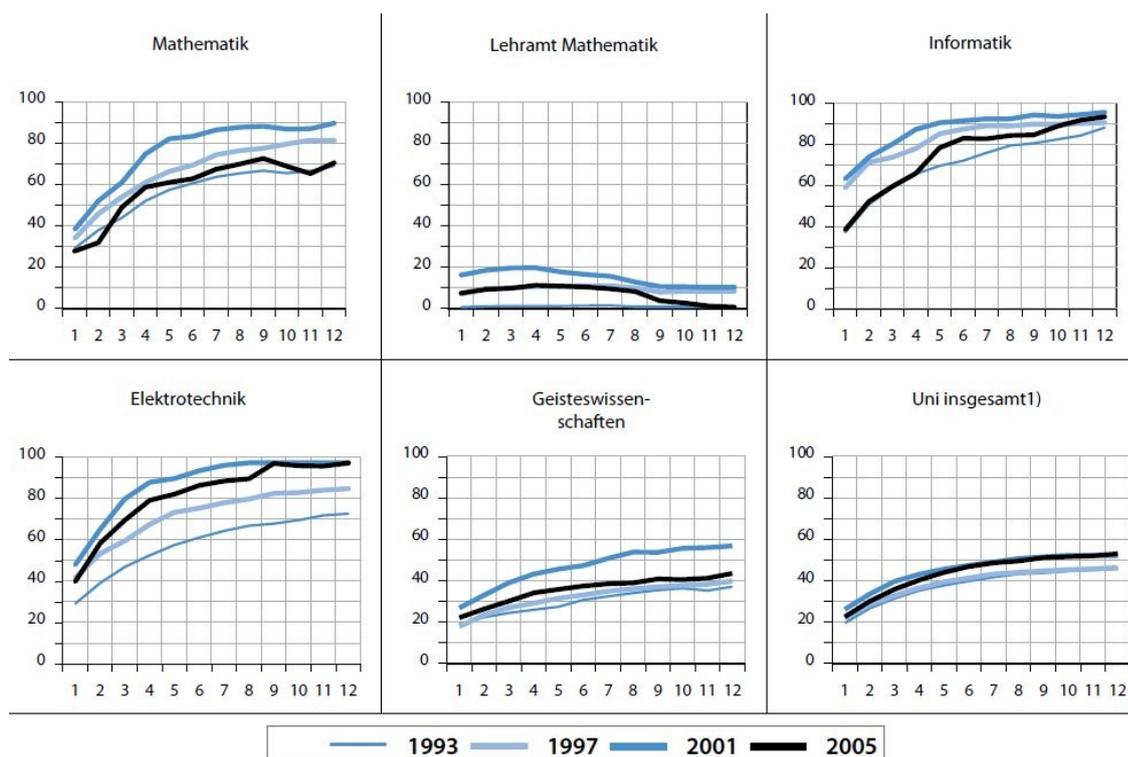


Figure 1.22. Progress of employment in the first 12 months following graduation at university by subject (in %).

Another HIS survey with a focus on the whereabouts of university graduates (Kerst & Schramm, 2008) provides information on the working hours compared for men and women. The results show that in general more men than women work in full time employment whereas the percentage of women in part time employments exceeds the number of part time employed men (figure 9.2). The data is based on the second survey of graduates from the year 2000/01. The survey was done in winter 2006/07, and there were 5.426 respondents out of 165.000 graduates from the year 2000/01.

Working form	Full time employment						Part time employment						No agreed working hours					
	Men			Women			Men			Women			Men			Women		
Year	93	97	01	93	97	01	93	97	01	93	97	01	93	97	01	93	97	01
<i>Subject area</i>	University of Applied Sciences (University of AS) degree																	
Engineering, Computer Science	96	96	96	81	87	85	2	2	2	14	11	13	3	2	2	5	3	3
Economics	96	98	94	83	77	82	0	0	3	14	18	18	4	2	2	3	5	1
Social Care	81	-	75	66	57	47	19	-	22	32	40	46	0	-	4	2	3	7
University of AS degree total	94	96	93	74	69	67	3	2	4	21	26	27	3	2	3	6	5	7
	University degree																	
Engineering, Computer Science	95	96	96	85	81	85	3	2	3	12	15	13	2	1	1	4	4	2

Mathematics, Science	85	86	89	72	76	66	9	10	7	24	18	27	6	4	4	5	6	7
Medicine, Pharmacy	93	94	98	78	72	77	5	5	1	20	26	22	2	1	1	2	2	2
Education, Psychology	78	75	79	54	63	57	16	18	15	37	33	36	6	7	7	10	4	8
Law	89	92	88	76	84	78	3	3	6	11	12	17	8	5	7	13	5	5
Economics	96	95	95	83	85	84	1	3	2	12	14	15	3	2	3	5	1	1
Teacher Training	77	84	90	60	67	80	20	14	10	38	30	18	3	2	0	2	3	2
Magister	68	74	70	57	57	57	13	16	20	28	28	28	19	10	9	15	15	15
University degree total	88	89	89	68	70	72	6	7	7	25	25	23	6	4	4	8	6	6

Figure 1.23. Working hours by subject and kind of graduation for graduates from the years 1993, 1997 and 2001 (second survey, 5 years after graduation). (Source: HIS-Absolventenbefragung 2008)

Employment in STEM by gender - Germany

The German Institute for Employment Research (IAB) provides the following data for women and men in STEM domain who are employed as mechanical and electrical engineer, physicist, mathematics chemist in the years of 2003, 2006 and 2009 (classification: 60 = engineer; 61 = chemist, physicist, mathematics) (see figure 1.24). The data shows that the proportion of women increases to a low extent in the field of mechanical and electrical engineering. The proportion of women in mechanical engineering increased from 4.6 % to 6.2% in 2009; in electrical engineering the advancement was only 0.3 % to 5.6% in 2009. The proportion of women in physics and mathematics was a little higher: in 2003 the share of women was 12.5% and in 2009 the share was decreased up to 16.2%. The highest advancement could be established in chemistry.

2003-2009												
	Mechanical engineering			Electrical engineering			Physics / Maths			Chemistry		
	2003	2006	2009	2003	2006	2009	2003	2006	2009	2003	2006	2009
Employees (total)	142.416	139.889	150.362	171.925	163.276	155.100	24.215	23.607	23.618	40.454	39.732	40.909
Proportion of women	4,6	5,2	6,2	5,3	5,4	5,6	12,5	13,7	16,2	22,8	24,5	27,4
Proportion of men	95,4	94,8	93,8	94,7	94,6	94,4	87,5	86,3	83,8	77,2	75,5	72,6

Figure 1.24. Employment and STEM domain (Source: IAB, 2009)

2003- 2009												
	Mechanical Engineering			Electrical Engineering			Physics / Maths			Chemistry		
	2003	2006	2009	2003	2006	2009	2003	2006	2009	2003	2006	2009
Unemployed (total)	16947	8359	5453	12714	6724	3818	3.330	2.272	1.469	5.476	3.586	2.439
Proportion of women	29,2	13,9	5,4	12,5	7,0	3,2	20,1	15,0	8,3	19,6	13,7	8,2
Proportion of men	9,5	5,1	3,4	6,6	3,8	2,4	10,8	7,7	5,4	9,4	6,4	4,6

Figure 1.25. Unemployment and STEM domain (Source: IAB, 2009)

The following figure shows the data about the unemployment of women and men in field of mechanical and electrical engineering, physics, mathematics and chemistry. In general, on the one hand, the unemployment of women in these STEM-related fields is proportionally more frequent the case than the unemployment of men. On the other hand, the unemployment proportion of women and men in these domains were decreased to a high extend: e.g. the proportion of unemployed women in mechanical engineering declined from 29.2% in 2003 to 5.4% in 2009. These findings could be also established for men, but they had generally a lower unemployment rate.

Employment in STEM by gender- Europe

Eurostat data could be seen as an additional source for the analysis of the employment in STEM careers. In comparison to the other European countries the share of men in fields of science and engineering exceed the share of women to a high extend (figure 9.5). According to Eurostat Germany has proportionally higher share of men (4.7%) than women (1.3%) who worked as scientist and engineer. In Poland, in contrast, the equality of the proportion of men (2.5%) and women (2.9%) in science and engineering domain is nearly balanced.

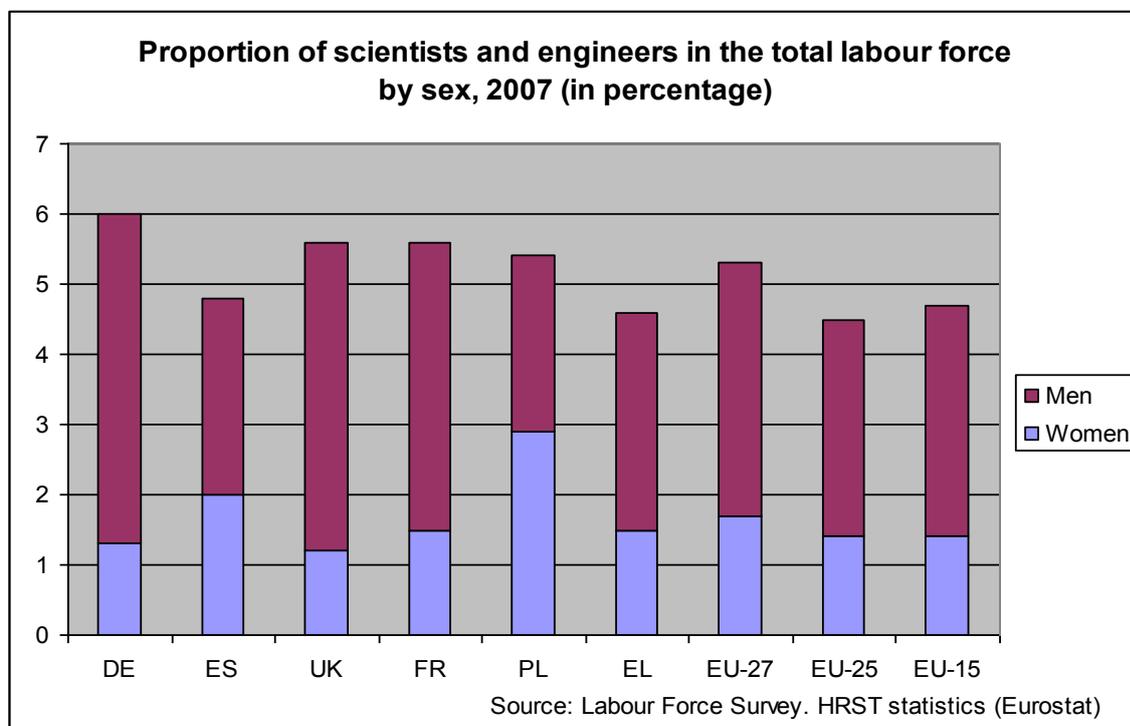


Figure 1.26. Proportion of scientists and engineers by gender (Source: Eurostat, UOE, data extracted July 2008)

Income

The gender differences with regard to the income in STEM professions are subject to this section. Significant gender gap could be established regarding the income of female and male engineers and scientist according to a study of Schramm & Kerst (2009). One of the significant difference is established between subjects like electronically engineering, mechanical engineering and industrial engineering with a average income of 54.700 € for men on the one hand, and the average income of 49.200 € for women (see figure 10.1).

	<i>Gross-annual income per year (in Euro)</i>	
Subject	Arithmetic average	
	Men	Women
	Technical college degree	
Civil Engineering, surveying	43.850**	36.050
Electrical engineering, mechanical engineering, business engineering	54.700**	49.200
Computer science	-	-
Economics	57.300***	47.600
Technical college degree total	52.400***	41.750
	University degree	
Civil Engineering, Surveying	-	-
Electrical engineering, mechanical engineering, business engineering	60.450	56.00
Science	52.500**	44.700
Mathematics, computer science	58.600	54.300
Economics	67.650***	54.600
University degree total	55.050***	42.350

Figure 1.27. Gross-annual income, technical college degree, university degree

Significant higher income of men: * $p < 0,05$

** $p < 0,01$

*** $p < 0,001$

The IG-Metall reported due to their study regarding the ICT-job sector that the salaries per year in this sector are rather high. Figure 10.2 shows the salary of the job domain of consulting, service technique, commercial administration and software development.

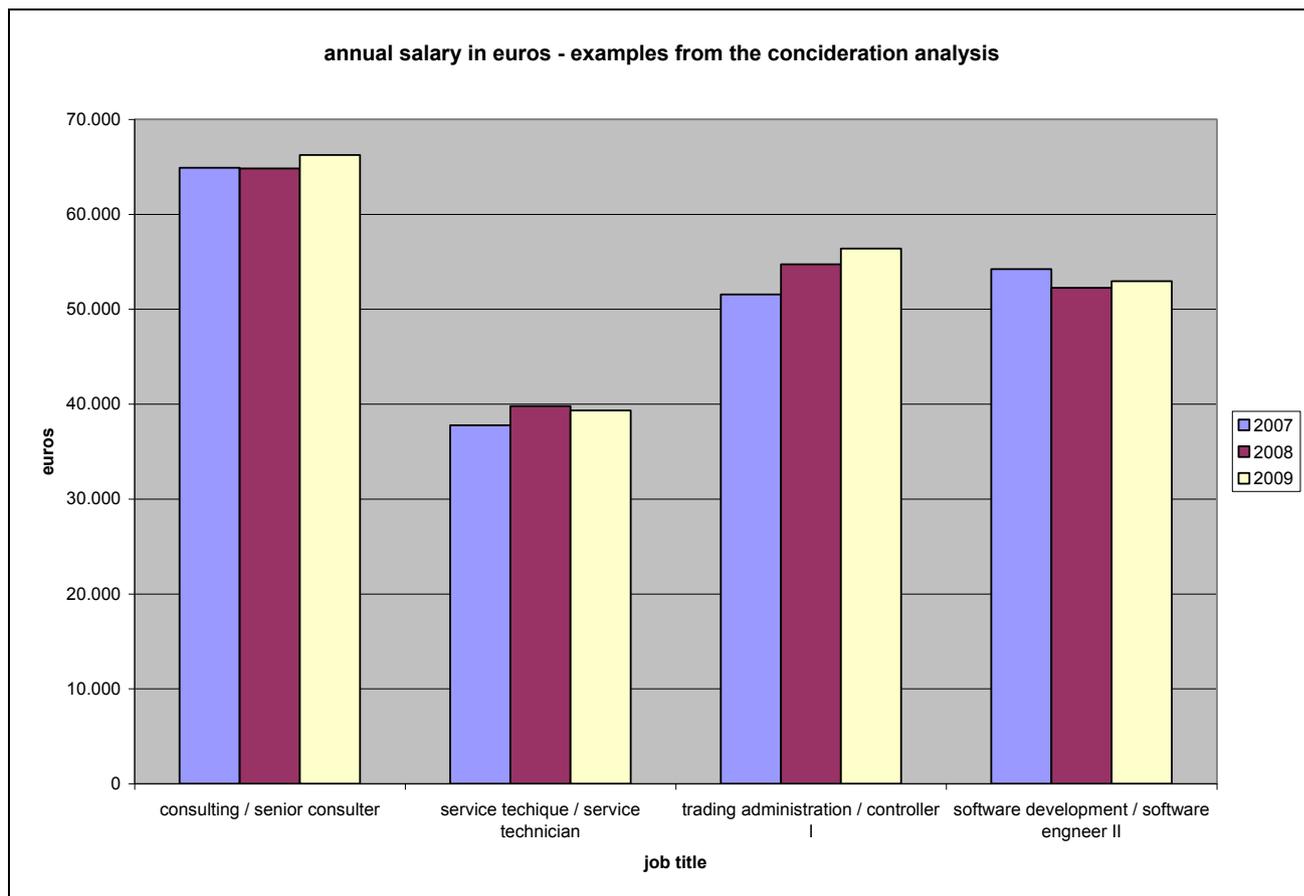


Figure 1.28. Income study in ICT (Source: http://www.igmetall-itk.de/index.php?article_id=1173)

Figure 10.3 shows the income of engineering, informatics and sciences graduates (median) in comparison to graduates of business administration in the year of 2007 (IG-Metall, 2007). The income of employees with a master or university degree in engineering, informatics and sciences got a higher salary (45.086 €) for their entrance in the labour marketing comparison to the other employees (43.631 €).

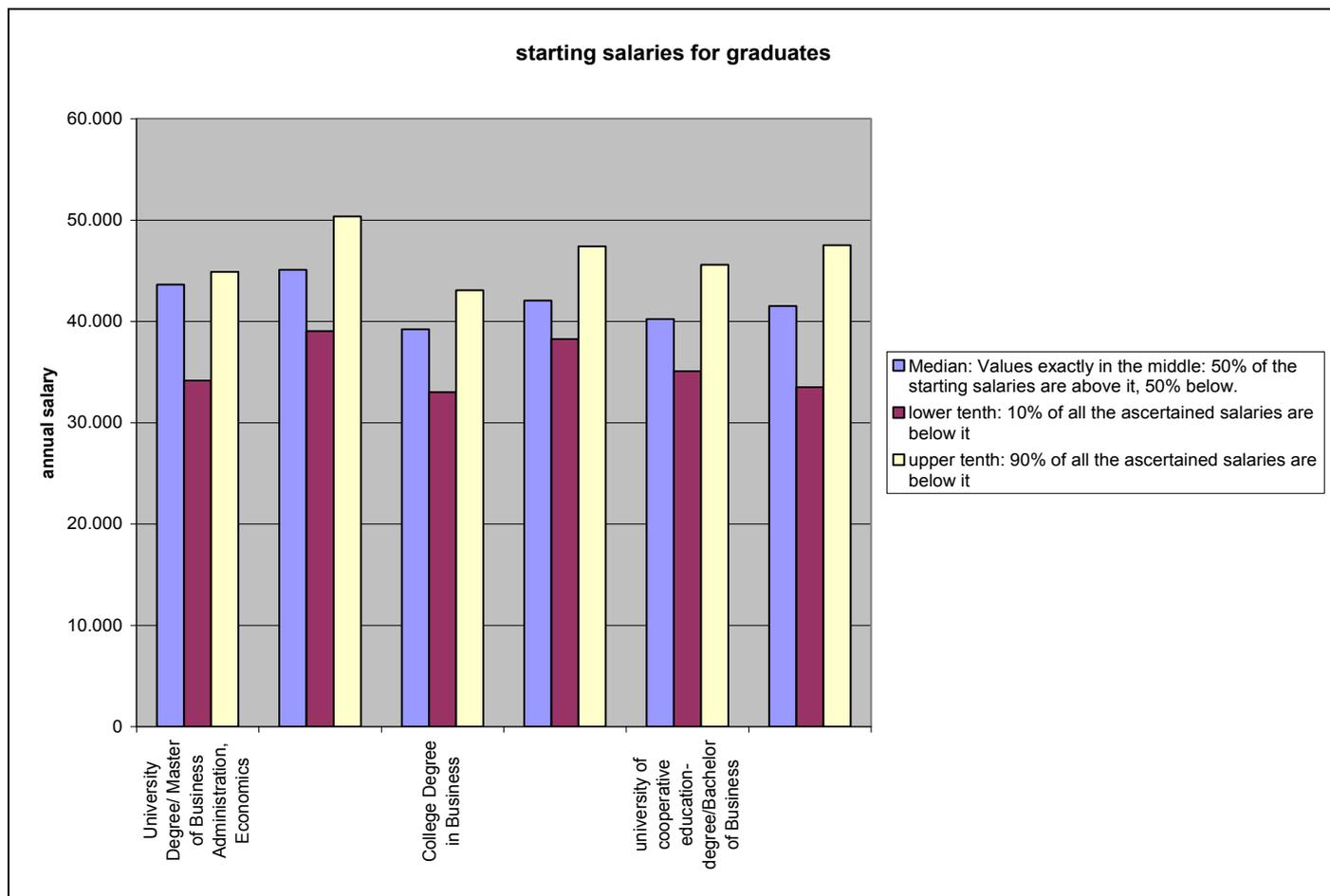


Figure 1.29. First income of engineering, informatics and sciences graduates in € (IG-Metall, 2007) (Source: http://www.igmetall-itk.de/index.php?article_id=508)

Due to the findings of the Deutscher Gewerkschaftsbund (DGB) study (2008) about the gross-income in 2008, the following figure gives an overview over low (red) to high salary (dark green) of young female and male full time employees (< 30 years) in different domains (office, production, sales, health and social fields) could be divided as follows:

gross salary-apportionment at young full time-workers (without trainees) 2008

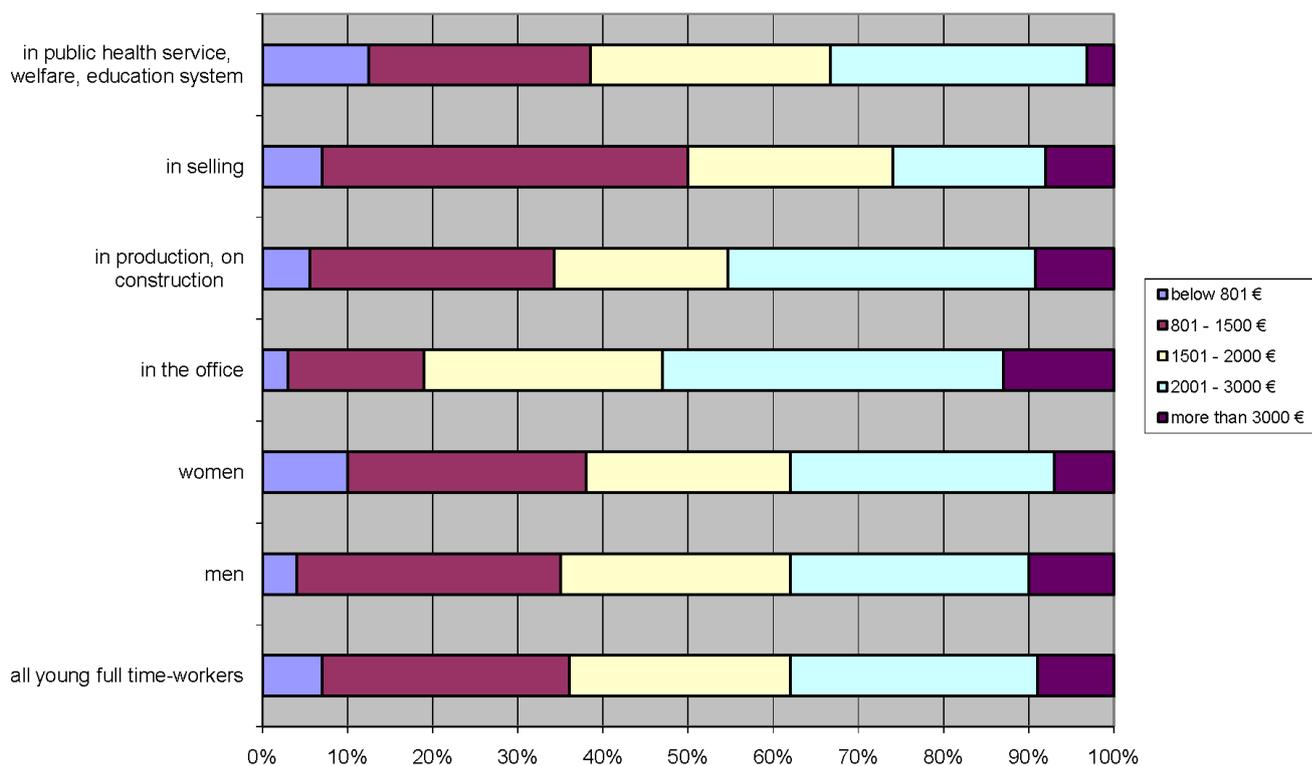


Figure 1.30. DGB-Index Gute Arbeit: Junge Beschäftigte, gross income of young full time employees (<30 years) in the year of 2008

Main result is that 62% of the young full time employees had a gross income less than 2000 € per month. Besides, the share of female employees (10%) in the lowest income level is twice as much as the share of male employees (4%).

Women and STEM careers

According to the findings of Ihsen (2008) women of a degree in further education and in leading positions could get difficulties regarding combining family and career. Mostly, they have to handle probably bad family-career-conditions, e.g. they are supposed to have a high flexibility with regard to their working time (work at the weekends). Further, some of these women are in a „dual-career-couple“ relationship that means both partners succeed a career, work at home, and the child care but this kind career assume a partner who is supporting the career of the woman e.g. by sharing the work at home or by hiring a housekeeper. In reality, a “dual career” by female engineers, that means taking family duties and career together, is often difficult to handle according to the findings of the Womeng consortium (2005). Common problems could be seen like peer pressure, work life balance and feeling guilty for not working out to the company’s highest expectations. One of the most problematic career factors is the maternity of women. At this point, women are more likely to take a part-time job and therefore they were part of discrimination (e.g. lack of support by superiors) or they were often considered only as assistance.

Reflection on women in STEM careers

Several studies focused on the employment situation of men and women in STEM professions (see Briedis et al., 2008, Schramm & Kerst, 2008, IG-Metall, 2010). The HIS survey according to Kerst & Schramm (2008) provides information on the working hours compared for men and women. The results show that in general more men than women work in full time employment whereas the percentage of women in part time employments exceeds the number of part time employed men. According to Eurostat (2008) the share of men in fields of science and engineering exceed the share of women to a high extent in comparison to the other European countries. The German Institute for Employment Research (IAB) analysed the employment situation in STEM-related domains in the years of 2003 to 2009. The results represented a positive tendency for female employees in these fields: they achieved higher proportions of employment at the labour market during the years. But in general, more men than women work in full time employment whereas the percentage of women in part time employments exceeds the number of part time employed men, on the one hand. The part-time employment of women might be an opportunity to combine family duties and career on the other hand. This might be a solution at least for certain time of the career pathway of women. Similar findings regarding the gender differences in terms of income in STEM could be realized to the disadvantage of women (Schramm & Kerst, 2008). The income of men with university degree e.g. in science field is much higher than the income of women with the same university qualification.

Summary of Chapter 1

The public authorities have provided a lot of measures regarding career guidance of further study and career information for pupils and students in general. This guidance is subject to different stages of the educational pathways. With respect to STEM-related study subjects and careers a lot of initiatives by various organizations and university departments are provided in particular for promoting girls in this area. Yet, most of the young women pursue an educational path that could be compared to a “leaky pipeline” and thus they are still under-represented in STEM-related careers. Different reasons for the low share of women in STEM could be established according to the educational stages. Due to the findings of the TIMSS study gender differences in mathematics and science self-concept could be found to the advantage of boys. The findings of the PISA study (2006) have shown clear gender differences in secondary school with regard to literacy and mathematics and science performance. Two-thirds regarding the literacy level V (proficiency level V) are girls. In contrast, the boys were better in mathematics and science performance: 60% of literacy level IV and V are boys. The gender differences of female and male pupils in STEM-related subject become more distinctive in secondary school in comparison to those in primary school. The interest and self-concept about the competencies in mathematics and science are strongly to the advantage of boys. At university, most of the female students still prefer to study stereotypical study subjects like education or social sciences, but the growth rate for PhD by women increases slightly in STEM. With regard to full time employment in STEM the under-representation of women could be show. According to different studies there are in general more men than women work in full time employment. This may have various reasons which relate to disadvantages (e.g. leading positions and income) but also advantages (e.g. opportunity to combine family duties and job) for women in STEM.

Base on the current situation of women in STEM careers and the empirical results of SESTEM, this project aims at indentifying factors which might enhance and hinder girls and women to choose a STEM-related study or career, in order to promote more girls in STEM and elaborate gender-sensitive practices for teachers.

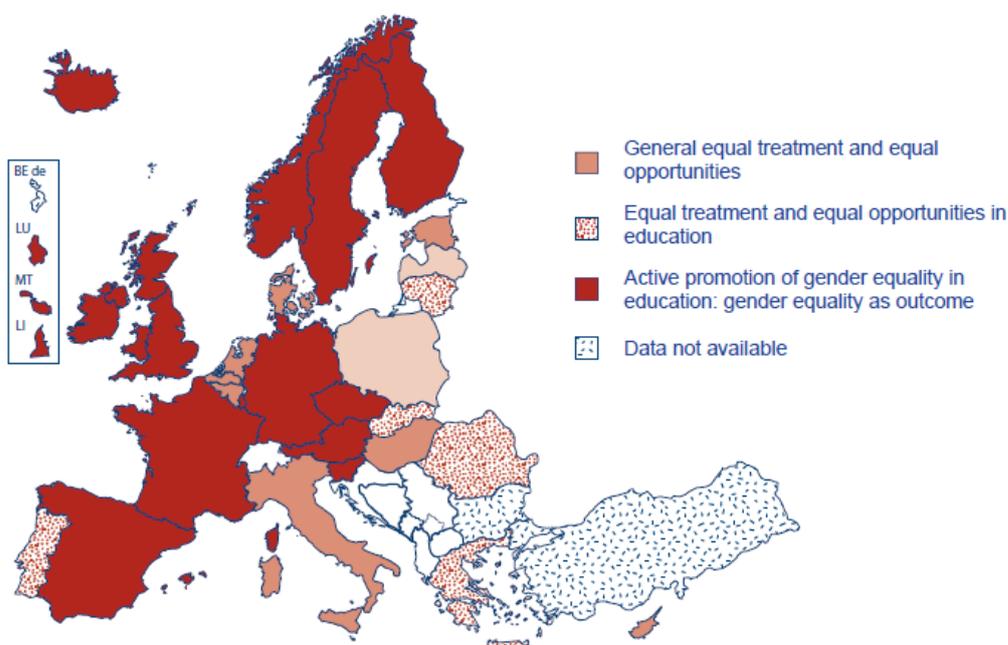
2. Legislation, regulation and national initiatives regarding gender and STEM in each national educational system

Current situation in STEM

The results of the survey of the Institut der deutschen Wirtschaft in 2008 have shown that 53.2 per cent of the surveyed companies perceive a lack of employees with respect to STEM-related qualifications in particular in tertiary educational level. STEM careers are still esteemed as male domains but several facilitation measures for men and especially for women are already introduced in order to resolve this lack of qualified employees. Further, these measures for women in STEM aim at increasing the attraction for women, thus they will take a STEM-related career into account (Böhme et al. 2009).

Policies in Europe regarding gender equality in education

According to Eurydice (2010) almost all European countries include equality provisions in their constitution and signed international declarations such as the CEDAW (Convention on the Elimination of All Forms of Discrimination Against Women) convention. Further, all of them have adopted specific legislation. Three legislative models can be discerned based on the organisation and purpose of such legislative frameworks in education: general equal treatment and equal opportunities, equal treatment and equal opportunities in education, and gender equality in education. The following figure shows the types of legislative frameworks for gender equality in education in Europe of the year 2008 and 2009.



Source: Eurydice.

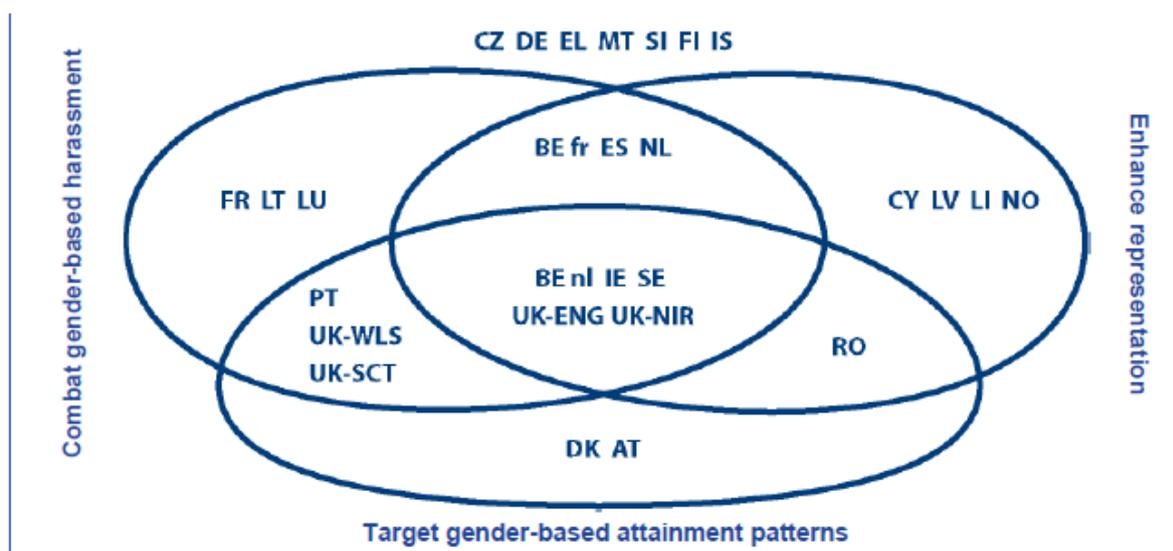
Figure 2.1. Types of legislative frameworks for gender equality in education in Europe, 2008/09, Source: Eurydice

Additional notes:

Germany: The legislative framework varies between the *Länder*; **Latvia, Poland and Portugal:** There are only provisions in the Labour Code; there is no specific law on equal treatment and equal opportunities.

The next section deals with the main aims of the European policies. The most important goal of gender equality policies in education is defined to challenge traditional gender roles and stereotypes (Eurydice, 2010). According to Eurydice, (2010), besides designing an appropriate, gender-sensitive curriculum, a common policy tool in this regard is to provide guidance for pupils, most importantly for girls, to encourage them to choose non-typical vocational training or higher education fields of study. Providing guidance to break down gender-specific barriers to education is also seen as a tool for improving attainment levels and for reducing differences in attainment.

Besides these main educational policy aspects, most countries have additional policy priorities regarding gender equality in education. Three important priority areas can be shown (see figure 2.2). Firstly, there are policies focusing attention on the hidden curriculum and school climate, mainly to combat gender-based harassment in schools. In this case, measures are not gender-neutral but specifically and explicitly target gender-based violence, harassment or bullying. Secondly, another policy priority is to enhance the representation of women in decision-making bodies in the education sector. Policy tools in this area include, for example, measures to increase the number of female principals or women participating in monitoring or regulatory bodies. Finally, a limited number of countries identify the objective of counteracting gender-based attainment patterns. Germany (“DE”) could not be categorized in one of the three priority areas cause of the different legislative framework between the federal states (Länder).



Countries without substantial gender equality policies in education: EE, IT, HU, PL, SK

Figure 2.2. Gender equality policies aiming to challenge traditional gender roles and stereotypes in primary and secondary education, 2008/09. (Source: Eurydice)

Horizontal segregation

As it was mentioned in the first chapter, the share of women in STEM educational pathways follows a leaky pipeline. According to Eurydice (2010) the gender equality in Europe is related to two concerns, the horizontal and vertical segregation. The horizontal segregation deals with the problem that women and men choose different study subjects in higher education, with women being under-represented in engineering and science. According to Leuze & Rusconi (2009) the gender segregation could be seen as “source of social inequalities” (p. 3).

Several initiatives already exist in Germany for promoting more girls and women in STEM-related subjects and careers. According to the horizontal and vertical segregation two of most important German initiatives will be introduced in the following section.

Horizontal segregation in Germany - National initiative “Komm, macht MINT”

Due to the lack of qualified female employees in STEM domain (in German “MINT”), the federal minister of education, Annette Schavan, has started the national pact for promoting girls in STEM in June 2008 (BMBF, 2008). The pact is a part of the Federal Government’s qualification campaign 'Advancement through Education'. This campaign aims at encouraging more girls and women to pursue vocational trainings, university degrees and careers in the areas of mathematics, information science, the natural sciences and technology (Eurydice, 2010). The “Komm, mach MINT”-initiative describes the national pact between politics, economy, science and media (Böhme et al., 2009). The pact includes different measures, public relation activities and cooperation partners for enhancing girls and women in STEM domains within three years. Memorandum of this pact aims at enhancing girls’ interest for STEM-related studies and careers (see: <http://www.komm-mach-mint.de/Komm-mach-MINT>). The pact objectives include the following aspects:

- Increasing the share of female students in science and technology-related subjects at university (to European level)
- The proportion of women with regard to new hires in STEM should be enlarged
- The proportion of women with regard to leading positions, university and science should be increased and supported to at least one per cent per year
- The proportion of women with regard to leading positions in particular high-talented women should be promoted in the related companies.

Different initiatives are provided by the Bundesministerium für Bildung und Forschung (BMBF) according to the national pact (see: www.komm-mach-mint.de):

- Involvement in the financing of arrangements and workshops for attracting more women in STEM careers
- Recovery of females role models with respect to generate job-oriented arrangements
- Inclusion of the topic in existing specialized employees’ initiatives and campaign
- Offer for internships especially for girls and women under the scope of job orientation
- Specific measures before and during the study in order to promote young women’s study orientation and decreasing the drop-out rate
- Development of family-friendly job environments for women and men in technical jobs (inclusive their effective public relation presentation)
- Generating effective public relation materials for a presentation of successful women in STEM careers

- Specific media offers and dissemination of the issue in the frame of job orientation by federal employment office (“Bundesagentur für Arbeit”).
- Active cooperation between the committee office and common projects⁴ as well as the dissemination of data and materials for the evaluation of the pact

Vertical segregation

The vertical segregation describes the currently existing 'glass ceiling' in tertiary education: while the share of women exceeds the share of men amongst higher education graduates, nevertheless they are slightly under-represented at doctoral level, and there are even fewer women with regard to the academic staff in universities (Eurydice, 2010).

Vertical segregation in Germany - Center of Excellence Women and Science

With regard to the vertical segregation in Germany one example will be introduced in the following based on the findings of Eurydice (2010). In Germany, in order to increase the share of female scientists in leading positions in universities, the Federal Ministry of Education and Research facilitates targeted projects within the framework of its Gender Mainstreaming Strategy in Science. One of the most important concerns of the projects is e.g. the establishment of a 'Center of Excellence Women and Science' (CEWS) which serves as the national coordination, information and counselling agency for scientific and political establishments, institutions, women scientists, and companies. The Federal Ministry also supports research institutions that offer their employees facilities for childcare.

Conclusion – gender equality in policy

This report explored in Chapter 3 whether and how European countries address the issue of gender equality through their education policies. It showed that while most countries have similar concerns, they target different issues and to differing degrees. In Germany, the horizontal segregation deals with the problem that women are still under-represented in STEM-related subjects. Therefore, the national pact for promoting girls in STEM has been started in June 2008 in Germany. To increasing the share of women in STEM the pact aims at encouraging more girls and women to pursue vocational trainings, university degrees and careers in the area of STEM. The vertical segregation of women in leading positions in Germany is still subject to policy and higher education. Therefore, the Federal Ministry of Education and Research facilitates targeted projects which based on a Gender Mainstreaming Strategy in Science.

⁴ E.g. projects of the “Kompetenzzentrum-Technik-Diversity-Chancengleichheit” is funded by the Bundesministerium für Bildung und Forschung (BMBF)

Promoting girls in STEM (initiatives)

The following section introduces a selection of examples of networks, initiatives, projects and associations related to the issue of SESTEM – Supporting Equality in Science Technology and Mathematics related choices of careers. The examples consider the promotion of gender equality in STEM at school and university level and are furthermore related to career choice by women in relation to STEM. Governmental activities from the Länder and from the Federal Government as well as from public, private and non-profit organizations are taken into account. The information is provided in German language. A description of these resources in English is available in the SESTEM Resource Library (see <http://sestem.iacm.forth.gr/project.php>; www.unibw.de/paed/personen/ertl/sestem; Annex 2).

The main content of some of the most important initiatives will be presented in this section. The most important national initiative is the “Komm, mach MINT”-initiative which was subject to the previous Chapter (see <http://www.komm-mach-mint.de/Komm-mach-MINT>). An other important initiative is “MINT Zukunft schaffen” aims at recruiting and teaching experts from STEM-related jobs (see <http://www.mintzukunftschaffen.de/>). As STEM- “ambassadors” these experts talk about the advantages in STEM and their own career pathway in schools and at open days of their companies with pupils and students in order to promote more pupils in STEM-related studies and careers. Furthermore, the initiative is regularly in touch with schools and parents as well as they provide information about current STEM projects, competitions etc on their homepage. The “Agentur Mädchen in Wissenschaft und Technik” aims at promoting science- and techniques-interested girls to get the opportunity to enter a motivational, scientific and technical environment of universities and research universities for girls.

Main concern of the Agentur Mädchen in Wissenschaft und Technik is a holiday program in cooperation of universities (TU München, LMU München, Bundeswehr Universität München etc.) and research institutes (e.g Max-Planck Institut) for girls with regard to different STEM issues e.g. “wind, weather and climate (change)” (see https://portal.mytum.de/am/index_html_alternativ). The initiative “CyberMentor“ concentrates on the facilitation of girls in STEM fields by the offer of a electronically mentoring program for girls (see <https://www.cybermentor.de>). Center of Excellence – Women and Science (CEWS) is an initiative with the goal to realise gender equality in science and research field. The activities of CEWS are linked to national politics (see <http://www.cews.org>). For further information about the current initiatives in Germany see Annex 2.

Furthermore, the SESTEM Resource Library includes additional information, e.g. on teaching and learning materials for teachers and pupils.

3. Teaching practices and effects on the career choice of the girls and the boys

As the importance of facilitation measures for girls in STEM was mentioned in Chapter 2, this section will analyse the current teaching practices and the influence of STEM-related teachers on the educational pathways and career choice of male and female pupils. Attitudes of teachers are important and could influence the career choice of girls and boys. Particularly girls are receptive for opinions of socializers e.g. teachers in STEM-subjects. Thus the need of enhancing girls in these subjects is given.

3.1. Model of study course choice by Dickhäuser et al. (2002)

In the following, the model of study course choice by Dickhäuser et al. will be introduced in order to shed light on the influence factors for girls' usage, choice and persistence in a STEM-related subject as main subject. Research findings about the study course choice for computer science by Dickhäuser et al. (2002) suggest that the expectancy and the value as well as the perception of these factors, which are produced by socializers, could influence the behaviour in and the persistence on the course. In their model (see figure 3) the behaviour at the computer of users was led back to specific success expectation on the one hand and the value of computers on the other hand. This value is divided into three parts: the intrinsic value, the perceived utility, and the attainment value. The intrinsic value of a task appears in case if a person assesses the scope of a task as enjoyable. The attainment-value includes the perceived importance of success of this task for one person's self-view. For example solving a programming problem could have a high value for a person if the solving of problems concerning the computer has a general importance for this person. The utility defines the value that the accomplishment of a task lets one get closer to a short-term or long-term achievement of a goal. For example, a participation in a computer course could be of a high value if a person appraises the knowledge of this course necessary in order to increase the opportunity of a well-paid job in the future. The computer specific aptitude concept has impact on the expectation and the value; in turn, this computer specific aptitude concept depends on the attribution of one's performance at the computer. Further, similar to the findings of Dick and Rallis (1991), this model includes important socialization factors like parents and teachers who could have influence on the expectancy ("expectancy socializers") and the value ("value-socializers") of pupils.

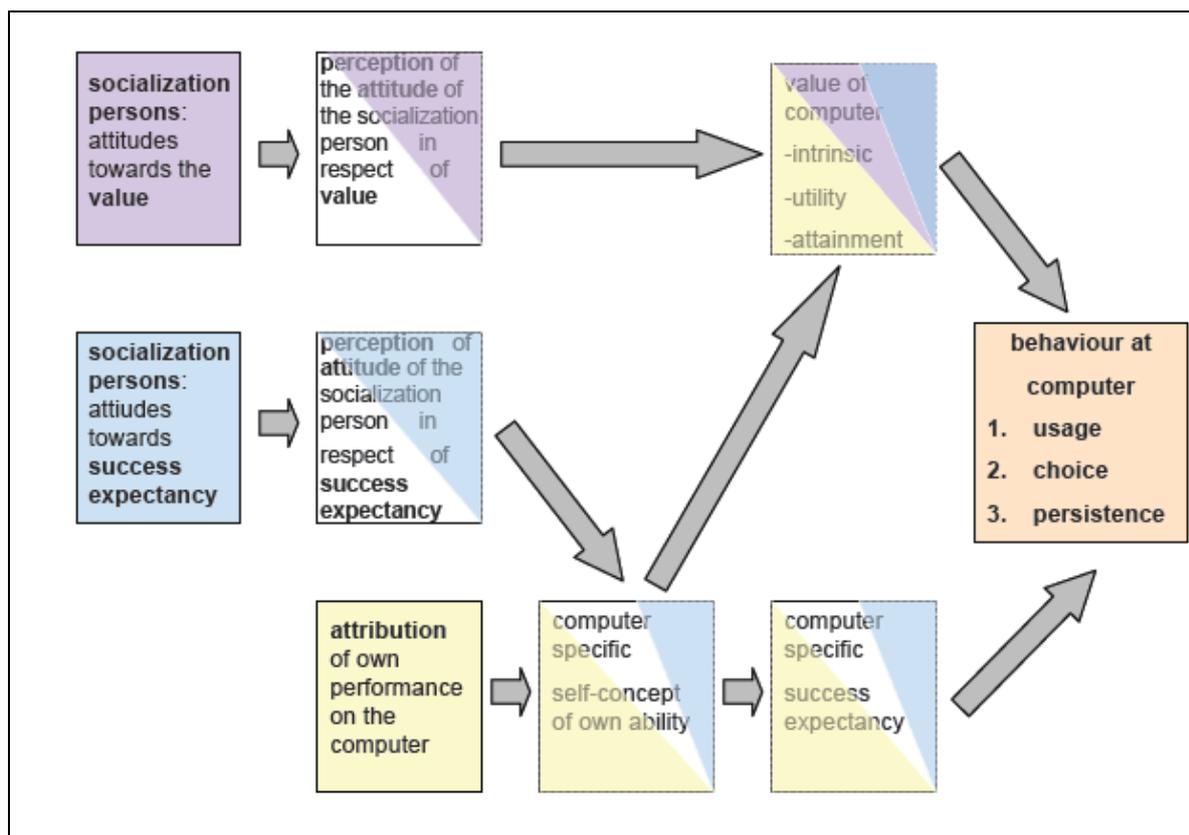


Figure 3. Model of study course choice by Dickhäuser et al. (2002)

In this respect we could find similarities to the model of Dick and Rallis (1991) which also describe the impact of socialization factors e.g. parents or teachers on the perception of pupils' abilities in general.

3.2. Educational practices by the teachers at specific educational level

The following section shows the need of measures for facilitation of girls and women in STEM according to the different educational stages with regard to the (school) socialization of pupils (Schwarze, 2010).

- Pre-primary school

Since birth, the construction of typical female and male gender starts, e.g. by buying stereotypical toys for girls or boys. In addition, most of the mothers with children from the age of three to six work (60%) in the year 2007 (BMFSFJ 2009), that means the education of pre-primary school children is more and more subject to Kindergarten teacher. Therefore the practical and technical topics should be part of the Kindergarten teacher's vocational training. Besides, collection of age-based materials regarding explorative application of STEM should be offered for children.

- Primary school

Already in primary school, the pupils are familiar with technical devices. According to the survey results of KidsVerbraucherAnalyse (2008) pupils of the age of six to 13 years had experience with several technical tools (Egmont Ehapa, 2008): e.g. 18% of the children have got a own computer and 51% of them use the computer of the family. In addition, 13% of the primary school children are owners of a mobile phone

and in secondary school, pupils from ten to 13, the share of mobile phone owners increases to 64%. Media-related studies in this respect dealt with interests of girls and boys (Initiative D21). Linked to this, teacher could use this knowledge of the existing competencies and integrate them to their specific class (Schwarze, 2010).

According to the findings of Praetorius et al. (2010), the importance of the role of teachers for mathematics performance of primary pupils and their assessment of pupils' self-concept in mathematics is reported. The results showed how teachers assess the performance in mathematics with regard to the own appraising of pupils' self-concepts of their mathematical ability. The main result is that the mathematical achievement is predicted pupils' mathematical self-concept by the ratings of teachers to a greater extent than by pupils' assessment of mathematical self-concepts. In addition, some of the primary pupils underestimate their abilities which mean they have got an unrealistic view of a low competency regarding the mathematics self-concept (Praetorius et al., 2010). Thus, the need of interventions by teachers in class for enhancing those children is given. Further, they suggest that the diagnostic skill by teachers for the assessment of self-concept of primary pupils should be strongly developed. This aims to facilitating pupils' (negative) attributions concerning their performance in mathematics. Moreover, current re-attribution methods could not be applied in primary school by teachers without experts yet or are developed for pupils who are ten-year olds or older (Praetorius et al., 2010).

- *Secondary school*

Secondary schools of general-education have shown a lack of interfaces regarding technical job trainings, studies or professions because of their curricula. This fact could be found in the teaching education courses of future teachers. A technical job-orientated class could be the foundation of a gender-sensitive teaching which provides information about STEM-related domains (Schwarze, 2010). Further, a lot of initiatives for girls of secondary school are provided (see chapter 2).

Lack of self-concept in science and unfavourable attribution pattern of girls: Opportunities for enhancing a positive self-concept of female pupils used by teachers could be “re-attribution” tools (2002).

According to a sociological perspective the doing gender is a common term (Faulstich-Wieland, 2004; Budde, 2006). Budde (2006) considers gender as a social construct generated by interactions. He focused on the “dramatization of gender” at which this term refers to Erving Goffman (1996). The construction of the concept of “gender” in school contexts aims to reveal facilitation measures for teachers. This dramatizing of gender often leads to the typical stereotype attitudes. The “doing gender”-phenomena in school means in particular that girls' stereotypes attitude in STEM were supported by teachers' gender stereotype-related statements in class.

He postulates an un-dramatizing of the gender and suggests three steps for the process: First, the gender situation should be examined. Second, it should be differentiated that there is no strict separation into “the girls” and “the boys”. Third, interactions should be linked to un-dramatizing aspects. That means for the educational practice that schools should arrange an environment beyond a re-masculine-processing for boys and an abandonment of protection of girls by teachers (Budde, 2006). These steps are under the scope of questioning the stereotype-related image about masculinity and femininity in order to strengthened pupils' competency of gender sensitiveness (Budde, 2006).

Teaching methods, teachers, and school organisation

As the importance of the perception of socialisers' attitudes and values regarding the computer or STEM performance was shown in the model of Dickhäuser et al. (2002), the teachers in STEM classes and in particular their attitudes about pupils in STEM play a crucial role for the pupils' subject preferences. Challenging already existing gender roles and stereotypes in schools is not an easy process. A measure most often mentioned in the literature is eliminating sex-stereotyping through revision of school texts, reading and display materials, examination questions, etc. Others include increasing focus on teacher-led work, switching to mixed-sex pairing or single-sex grouping where appropriate, or offering greater learning support (Eurydice, 2010). Teachers and school managers also need practical guidance on the legal context for gender equality and on how to develop an appropriate school climate as well as information on teaching and subject content (Myers et al., 2007). The following section will present good teaching practices.

3.3. Good teaching practices

The need of measures for facilitation of girls' in STEM was part of the first section of chapter 3. This need also results of the gender differences regarding the finding of the IGLU, TIMSS, and PISA studies. The focus of this section will lie on description of good practices for teachers. Two main aspects for the improvement of gender-sensitive teaching in STEM subjects should be taken into account in this section as these represent typical German approaches:

- 1) Reflective co-education in class
- 2) Motivation of girls in STEM

In the following, different teaching practices related to the two aspects will be described which could give teachers an overview about gender-specific methods regarding STEM-subjects.

1) Reflective co-education in class

Most of the German schools have co-educated teaching classes. As we mentioned already the gender differences with respect to self-concept in STEM in Chapter 1, this section deals with the framework of reflective co-education. The framework of *reflective co-education* (see Faulstich-Wieland & Nyssen, 1998) is a basis for several aspects of facilitation-some of them are gender-specific and others relate to a general improvement of course quality. According to Nyssen (2004), the framework mainly aims at

- Revising curricula adapted to the experiences, interests and goals in life of girls and boys
- Reflecting and reducing gender stereotypes produced by teachers
- Taking girls and boys seriously by their individuality without reducing them to their gender

2) Motivation of girls in STEM

The quality of the teaching design of STEM-related subjects should be improved in general but the specific focus should lie on the increase the attraction and motivation of girls for STEM (Jahnke-Klein, 2006). Due to the findings of Jahnke-Klein (2006) a higher quality of mathematics and science class teaching design could be achieved by the class if the proportion of STEM-content would be more meaningful and were less based on calculation, because girls prefer to learn new content with more meaningful tasks in mathematics and sciences class. In this manner, female and male pupils can both benefit from the class to the same extent. Further, a deceleration of STEM classes may be to the advantage of girls' need. Girls often want to work

thoroughly in class in order to develop a fundamental understanding of new content, thus they sometimes need more time to comprehend the whole meaning of the content. That means the time pressure concerning the completion of a task in STEM while introducing new content should be reduced in mixed-gender classes, so that the pacing is adequate for those pupils who need more time to reflect at the beginning. This could be realised with strengthening the individual and cooperative unities in class. E.g. the deceleration is supported by longer time-periods of thinking about the new content and structuring the questions in this individual learning phase before the pupils ask questions in whole sentences. With this measure pupils learn to listen to each other and ask if something is not clear. In addition, for enhancing the self-confidence of girls in STEM, structuring aid as “security-giving measure” may be helpful at the beginning of a STEM-related subject but during the time teachers should put successively the responsibility on their males and particularly female pupils with regard to the experiments in STEM. Further, the motivation of girls could be affected by achieving successful experiences in STEM-class. Therefore, a transfer of successful experiences should be provided for girls already in primary school to manifest a positive self-concept of girls in STEM. In secondary school, a temporary introduction of single-sex classes for STEM subjects like physics may provide such a success moment. According to Hannover and Kessels (2002) the girls of a 8th grade of a temporary single-sex class in physics had more fun during the class and showed more activity. They found that in this single-sex situation the girls have forgotten to be a girl in a male co-notated school subject. Other measures for facilitation of girls with similar effects are specific working groups in STEM for girls or summer universities for women. Such a separation of gender in class could be realized also in class units as the separation by gender in groups for tasks in STEM. Further, a participation of girls in national STEM-competitions could have positive effects on girls’ success perception.

A further aspect is the provision of appropriate attribution. The method of *re-attribution* extends the motivational aspect to test outcomes and aims at providing students with beneficial attribution patterns (Faulstich-Wieland & Nyssen, 1998; Ziegler, 2002). Ziegler (2002) suggests re-attribution trainings to strengthen girls’ positive or realistic assessment of their skills regarding their self-concept competency and interest. According to Heller and Ziegler (1996) the goal of this measure is to “provide gifted female students with realistic knowledge about their own ability and knowledge” (p. 200). A first step could be to provide adequate performance-related feedback to pupils (see Hartmann et al., 2007), in particular if they are assessing their performance suboptimal, e.g. “your performance in this test wasn’t well” instead of person related feedback, and e.g. “you were bad at this test”. Further, it can be beneficial when assisting pupils in explaining their outcomes. Studies have shown that attributing low outcomes on a variable cause, e.g. “You didn’t learn hard enough for this test”, provides pupils a better motivation for future learning than an attribution on stable causes like e.g. “You’re not gifted”. In contrast, if pupils have high outcomes, it may be more beneficial to explain this with internal factors, e.g. a high ability of the pupils instead of external factors like that it was an easy task or it was only pure chance. By this, re-attribution measures may have a two-sided effect: they are appropriate to provide a better foundation for estimating one’s own knowledge and ability and therefore help to provide positive motivation and emotions (see also Frenzel, Pekrun & Götz, 2007). Other approaches try to increase pupils’ motivation in general, e.g. by a gender-appropriate task structure and tasks that are appropriate to the different interests of girls and boys (see Faulstich-Wieland et al., 2008; Hartmann, Wiesner & Wiesner-Steiner, 2007). Higher motivated pupils are expected to invest more mental efforts in the subject, which is often a key for better learning outcomes (see Salomon, 1984).

For further interventions with respect to teaching practices regarding gender-sensitive teaching and methods (e.g. Concept Mapping) in class see the method book “Good Practice Guidelines” (see <http://predil.iacm.forth.gr/outputs.php>: section good practice guidelines) that was developed

in context the European Project PREDIL⁵ and on basis of the results of the findings with regard to gender equality in the learning process with the help of new media by Ertl & Helling (2010).

3.4. Practices at university level

As we mentioned above the preferences of the high school graduates for their further educational pathways are not consistent and often not decided yet, there is the need of the universities to strengthen their information about their studies in particular in STEM to attract more potential students. Thus, strategic starting points for the recruiting of students in STEM are proposed by Herdin et al. (2009):

- *Preference strategy*

A specific STEM-related consulting and information service should be developed. Further, gender differences could provide indicators to what extent strategies may inspire and attract in particular women in STEM.

- *Offer strategy*

This strategy describes the question, if the demand of STEM studies for STEM-interested school graduates is sufficient and adequate for the target group. The analysis of German regions could identify the success factors with respect to the design of the study course offer.

- *University attachment strategy*

If the preference for STEM subjects is given but the share of students who start their study at local university is still low. At this point it would be necessary to analyze factors (e.g. demographic aspects, attractive study offer of other German Länder) for such a low uptake of STEM-related studies in order to specify the local university course offer.

- *Employee attachment strategy*

The structure and tradition of regional labour market could strengthen the motivation of students. In particular it could lead to a higher proportion of female employees in STEM. This tradition was e.g. in eastern Germany the case with regard to female engineers in employment.

To sum up, introducing initiatives for facilitation of women in STEM with regard to an uptake of a study at university is according to Herdin et al. (2009) not enough to realise the lack of qualified employees in the field of STEM. Therefore, it would be subject to the universities of the different German Länder to evaluate their study offers and to check the specific needs of their future students according to qualitative and quantitative aspects.

⁵ For more details about the PREDIL project (Promoting Equality in Digital Literacy) and the conferences presentations see <http://predil.ku.sk/>

4. Gender and educational practices and strategies for families

4.1. Parental involvement in school

Parents are mostly involved in the decision making process of pupils regarding their future study or career pathways. The parental support is decisive to the promotion of gender equality in schools (Eurydice, 2010). Gender equality has been found to be enhanced by parents' involvement in the general work of schools, participation in specific gender projects and support of developing a more equity-orientated school culture (Eurydice, 2010). It is also important to create spaces and opportunities where less privileged parents have a voice and representation; this might be achieved by the provision of different forms of support such as information booklets, drop-in sessions and discussion groups (Maguire, 2007). This is particularly important because – as already pointed out in Chapter 1 – parents are a link to the world outside, which does not necessarily provide equal gender opportunities.

Further, Sonnert (2009) has analysed two approaches, the ‘role-model’ and ‘opportunity-structure’ approaches, with regard to the parental influence on the career choice of women and men scientists. The role-model approach describes that women tend to be influenced by women; men, by men. The opportunity-structure approach asserts that those who can communicate knowledge about the occupation will could be seen as an influence factor. He found three important aspects in his study. The result is that the role-model hypothesis was soundly rejected, and the opportunity-structure hypothesis was strongly supported. Based on this, three important findings could be retained. The first result is that female scientists are more likely to mention parental influencers than male scientists but the reasons for this result could not be generalized on the basis of the data of Sonnert. In addition, the second finding is that fathers were more likely than mothers to be mentioned as influence factor. This is from Sonnert perspective in part explainable: “by an opportunity structure type of argument to the effect that men (fathers) have traditionally been closer to science and technological pursuits than have women (mothers), even when controlling for educational level” (Sonnert, 2009, p. 939). The third finding is whereas both women and men were more likely to name a parent as an influencer for their scientific career the more education this parent had (in support of the opportunity-structure hypothesis), this increase was steeper for the male scientists than for the female scientists.

4.2. Roles and expectations of the parents (according to children’s sex)

Gender stereotypes and the „Doing Gender” control the self-perception of pupils’ competencies in science and they have impact on pupils’ career choice. Pupils learn about stereotypes in science in school as well as at home (Correll, 2001). According to the findings of Hoose and Vorholt (1997) parents assessed their daughter competencies in science and technology less often than their sons’ competencies, even if both gender achieve the same competency level. Only if the girls achieve high performance in science and have high interest in this field, they got support by their parents with regard to an uptake of a technology-related job. Another reason has to be taken into consideration for girls’ the stereotype-related career choice: the relation between the performance in STEM and the performance in other female stereotype-related subjects plays a decisive role. Thus, girls performance in school is conforming to the stereotypes, they are better in humanities and social sciences than in relation to STEM-subjects (Solga & Pfahl, 2009). A further reason could be the lack of female role models in STEM careers, e.g. girls with high performance in STEM still feel uncomfortable in STEM domains or they do not see the

compatibility between STEM career and family commitments (Solga & Pfahl, 2009, Schwarze, 2010).

As the impact of mother and father as socializers is mentioned in the career choice model of Dick and Rallis, the parental influence on pupils' career choice based on the Identity Control Theory is analysed by Li and Kerpelman (2007). The findings illustrated that parent–daughter relationship predicted the young women's (undergraduate students) anticipated distress, as well as their willingness to fit parental views concerning their career aspirations.

Differences between the father–daughter and the mother–daughter relationships emerged. Greater frequency could be noticed by mother–daughter discussion about career appeared to reduce a daughter's feeling upset or willingness to change should the father disagree with the daughter's career choice. Further, feeling like a different person from her father emerged as a negative predictor of feelings of distress should disagreement with either parent occur. The ability to express disagreement with father was negatively related to daughters' distress. These findings could be relevant for the career choice of women in STEM: promoting a positive relationship of daughter–father, thus young women could feel free during their discussion about the career and not emotional hinder by fathers disagreement with the career plans.

5. Gender and students’ motivations regarding orientation and career’s choices

In this section, we will show the main factors and motivating for a career choice in STEM by female pupils. First, we will introduce the essential theoretical career choice model of Dick and Rallis which describes the most important influence factors on career choice of pupils as e.g. cultural milieu, socialisers, experiences, and self-concept. This model will also build the basis for our further empirical research in this project. Second, based on the model of Dick and Rallis we will get more insights to the different approaches concerning the socialisation process of girls in general. Later we will focus on the main socialisers (peers, parents, and school institution) who could have impact on girls’ career choice in STEM. Third, we will concentrate on technical socialisation as well as on the social background. We will also describe how important the information about study options and career pathways in STEM is during secondary school for pupils’ decision for a career. Subsequently, we will illustrate further factors that could have impact of the career choice process of girls and women. Finally, we will concentrate on motivational factors and interest concerning gender differences with regard to the decision for STEM-related careers.

Career choice model

Regarding the career choice and gender, different factors could have impact on the motivation of students. In the students’ career choice model by Dick and Rallis (1991), the aptitudes and the cultural milieu influence the perception of socialisers and the interpretation of experiences, which, in turn, have impact on the pupils’ self-concepts as well as career values. Socializers could include parents, teachers, counsellors, friends and other persons. All these persons could have more or less influence on the perception of students and thereby on their choice of career (see figure 13).

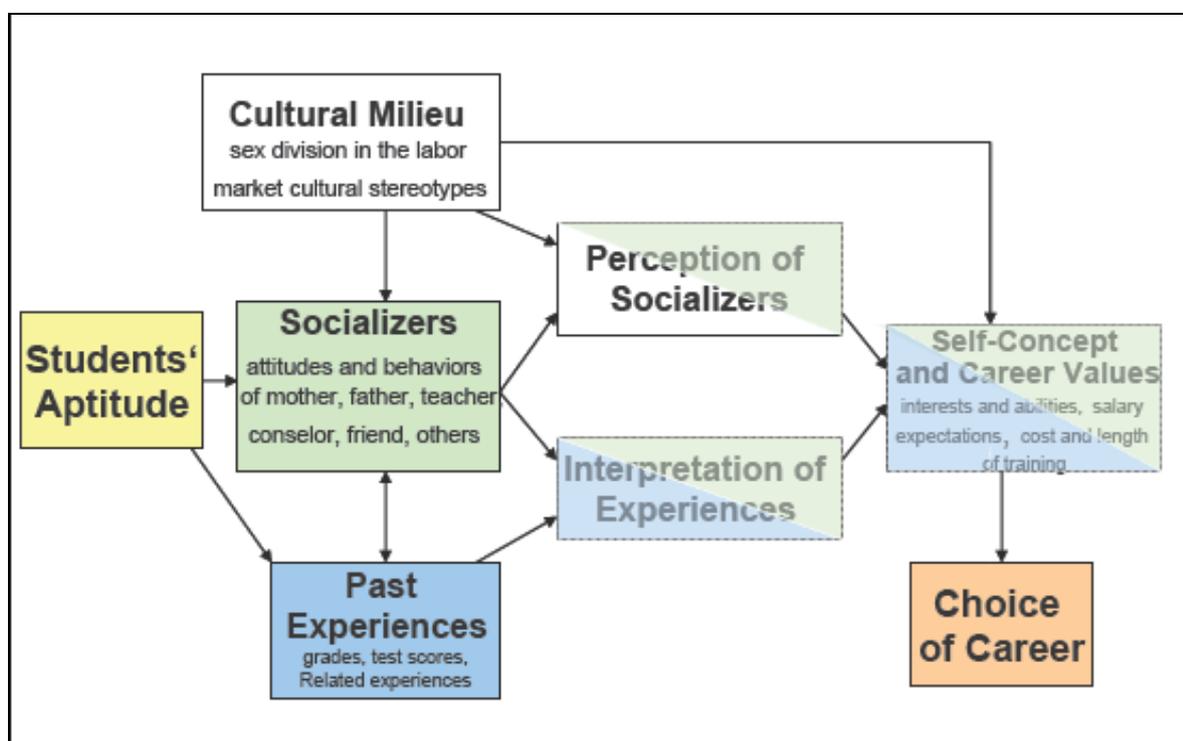


Figure 4. Career choice model by Dick & Rallis (1991)

5.1. Socialisation of girls regarding STEM

In the following, the importance of girls' socialisation with regard to their aptitudes and experiences during their childhood will be introduced.

Due to Ziegler (2002) the approach of cognitive aptitude differences between girls and boys on the one hand and the approach of differential experience regarding socialisation on the other hand should be discussed and reflected.

The thesis of native cognitive aptitude difference between boys and girls should be seen critically according to current research findings which could be summarized by the following four reasons (Ziegler, 2002):

- 1) Due to the results of a meta-analysis of older studies, the performance differences between the genders were overrated
- 2) Performance differences have decreased more and more the last years in particular with regard to the mechanical and areal imagination skills of girls (one possible reason may be the changing socialisation experience)
- 3) Some of the cognitive abilities can be trained
- 4) Tests for examination of gender differences are not elaborated enough

In addition, the differential experience regarding girls' socialisation should be considered of the analysis of gender differences in STEM. Girls' self-concept is affected by their socialisation experience which is influenced by the following aspects (Ziegler, 2002):

- boys achieved a higher basis of technical and physical experiences during the socialisation process
- lack of identification opportunities for girls (e.g. stereotype illustrations in school books)
- parents pass their own "aptitude theories" to their children
- teachers pass their stereotypical "aptitude theories" in correlation to their assessment of pupils' performance in STEM to their pupils

Other theoretical approaches and possible reasons will be illustrated in the following which may explain the perceived differences between women and men in STEM-related pathways and careers.

According to Beerman et al. (1992) the main reasons for the gender-specific differences in STEM are given below:

- girls' *self-confidence* is to a low extent than that of boys'
- boys show a better *self-concept* in science (in contrast, girls assess their aptitude lower than that of boys)
- girls' *aspirations* are lower than those of boys', therefore they are satisfied with moderate performance results (that means particularly gifted girls would not fully use their potential)
- girls have less *interest* in STEM-related subjects
- assessment of lower aptitudes for girls in relation to STEM by socializers like teachers and parents

Similar findings of gender differences in STEM with regard to women's careers could be noticed by Schwarze (2010). As it was mentioned in section 1.3.5, an increase of female students in STEM could be noticed but still in engineering professions the growth of women rose only 1%

from 10% to 11% in the year of 1999 to 2007 (IAB, 2007). According to Schwarze (2010) this situation based on *lack of*:

- *female role models* at all levels in technical companies
- offers regarding *practical application* of tasks and competencies
- *technical teaching classes* and practical modules
- teaching classes which take *female and male interests* to a balanced extend into account
- further education regarding *gender-sensitive didactics for teachers* according the educational pathways
- qualification of further teachers regarding *varied integration of technical* issues in class

Socializers

a) Influence of peers on career choice

The adolescence is the crucial period for pupils' identity formation and also for their identifying with specific subjects in secondary school. Some subjects are considered as masculine and others as feminine, subject choices are not simply driven by personal academic interests or even by abilities. They are more driven in some part by the desire to present oneself as a(n) (attractive) masculine or feminine person for the other pupils (Hannover & Kessels, 2004). Peers tend to reinforce gender stereotypical behaviour and they seem to punish non-conformity to this behaviour; this could have impacts on subject choices (Kessels & Hannover, 2006). For example Kessels & Hannover (2006) found in German secondary schools that girls who excelled in physics are more likely to consider themselves to be particularly unpopular with boys.

b) Influence of parent on career choice

In the following section, the influence of parents on the process of career choice will be introduced based on the model of Dick and Rallis and explain the role of parents in particular for girls. Parents could play an important role during school with regard to pupils' perception. Further, they could reinforce gender stereotypical expectations. Thus, several studies have shown that teachers' and parents' gender-stereotyped behaviour and expectations can undermine girls' confidence in their mathematical abilities and eventually discourage them from choosing mathematics-related courses in secondary school (Eccles and Wigfield, 2002; Turner et al., 2004). In particular STEM professions are seen as male domains and the image is still more stereotype-oriented in advantage of men. Most of the pupils consider their parents as important information source with respect to the educational pathways or career opportunities (Arbeitskreis Einstieg 2006). Solga and Dombrowski (2009) confirm the socio-cultural influence factors of the model of Dick & Rallis. They mentioned reasons why girls' performance in STEM especially science may be lower in comparison to boys: Girls' performances in STEM could be influenced by cultural beliefs and gender stereotypes, thus STEM-domains seem to be more likely to boys. In addition, the gender stereotype beliefs are provided by parents as well as by teachers as consulting instance with regard to the pupils' study choice: They are more likely to encourage boys to study a technique-oriented study subjects (Minks et al., 2008).

The choice, to which school type the pupils after the fourth grade of elementary school have to continue to, might set the course for her future career (Wentzel, 2008). In addition, parents have the function as idols for their children by working out the gender roles and transferring gender-specific attitudes. Hoose and Vorholt (1997) have shown that the imagination which parents have of their daughters could have great impact on the orientation of these girls: parents do perceive

the mathematics and technical skills of their daughters to a low extent. In contrast, parents assess social skills as relevant for girls.

Other findings are more concentrate on the influence of the mother. The model of transactional socialization by Pomerantz & Eaton (2001) shows that on the one hand the children's low achievement may lead parents in particular mother's worry in general. On the other hand the low achievement may manifest itself in feelings of uncertainty about how to manage the school performance standards. The child achievement could have impact on the maternal worry and on the child uncertainty. Both in turn, could elicit maternal intrusive support and practices which means that parents checking over children's homework and helping them when children do not asked for monitoring neither for helping by their parents. Further, the findings have shown that the children's achievement predict parents' worry about their achievement and children's uncertainty. At the same time, these mechanisms are linked to parents' use of intrusive support. The grades of children could be improved by these practices but they do not be a guarantee of changing a child of low-achievement into high-achievement. According to the findings of Mastekaasa and Smeby (2008) with regard to encouragement from parents, they found out that female students had been more often supported by their parents, especially mothers, to study their study programme, unlike if the studies are traditional or non-traditional. Further, female students who end up in male-dominated studies seems to receive encouragement from fathers to the same extent as male students. A possible reason might be that male-dominated studies tend to have a higher status than females-oriented studies and fathers are likely to emphasis the status by encouraging their sons and daughters.

c) The role of the school institution

Besides parents as most important counsellor in terms of career plans of pupils, the school sometime could give some hints about e.g. study options. According to the findings of a study from Arbeitskreis Einstieg (2006) about the career choice by pupils in Hamburg, school is named as second instance for career orientation by pupils of the previous gradations class from all surveyed school types, but the pupils assessed the influence by school on their career choice to a lower extent besides other sources like for example an internship or parents. Only 10 % found the school supportive for their choice. However, school was established in a positive way: school have an important function for pupils. They learn how to find further information about career paths like in specific books and journals about this issue (Arbeitskreis Einstieg, 2006).

The school institution (e.g. teachers) is also linked to parents' transmission of stereotypes to their children: Pupils and teachers carry into school the cultural adapted values which are dominant outside of school thereby replicating the gendered perceptions of parents (Lyons et al, 2003).

Technical socialisation

Linked to the socialisation factors of Dick and Rallis, the "technical socialisation" of pupils from the early childhood to their study or career plays an important role for pupils' further educational pathways. The following section will focus on the central terms of the "technical socialisation" (Acatech & VDI, 2009). The internalisation describes the process of development of young children's interest and motivation to deal with technique. The external support for individual technical and science-related competencies by parents and teachers may activate or strengthen the internal aspiration for dealing with technical activities. Characteristic stages where the primary technical socialisation could take place are at home, Kindergarten and school. Later, the secondary and tertiary socialisation is influenced by peer groups (pupils of the same age) and the media. Further, a successful technical socialisation could be presumed to be pre-condition for a choice of STEM-related careers (Acatech & VDI, 2009).

Social background

The social background of the family plays a decisive role with regard to the school performance of pupils (European Commission, 2008). According to the findings of Sammons (1995) female pupils of non manually-operated families and pupils of families with high income achieved better grades in school than the pupils of the control groups. Recent research findings by Melhuish et al. (2008) in the U.K. reveal that the different family-related and home-related learning environment aspects could have impacts on the school performances of pupils. In particular with respect to gender and the educational performance of young children (over 3 years), the influence of the family learning environment factors could be established. Such factors could be e.g. frequency of parental readings, visits of bibliotheca, playing with numbers and letters, drawing, learning of rhymes and song with the children. According to the findings girls had by trend a better promoting learning environment by the family in this age. The factor gender could have positive and negative influence on pupils' behaviour but it had less influence on performances in English language (in advantage of girls) and mathematics (in advantage of boys) (Sammons et al., 2008).

5.2. Career choice process

According to Abel (2001) career choice is a long process which starts already at adolescence when young pupils deal with the decision for a certain study or vocational training. Therefore, the need for facilitation regarding the career choice of pupils should begin not immediately before making the choice for career pathways. Further, in lower secondary school already pupils choose their subject specialisation or their main subjects but at this school level the career aspect does not be the main reason for their subject choice. The information about different study options could be important for the decision of pupils' study or career choice. As it was mentioned in the previous section, most of the pupils consider their parents as the most important information source with respect to the educational pathways or career opportunities. The secondary schools, in particular those schools of general-based education e.g. Gymnasium, offer less specific information about career pathways, thus pupils assessed them less meaningful as influence factor with respect to their career choice (Arbeitskreis Einstieg, 2006). This could be confirmed by Hany and Driesel-Lange (2006). They mentioned the neglect by education and policies of the promotion of facilitation for pupils of Gymnasium with regard to their competencies regarding the career choice. A typical graduate from Gymnasium has attained full age at the end of the school so he or she should be able to choose by their own. Often the decision for a study subjects will be make according to their affinities and not based on their skills. Nevertheless, the aptitudes and performances skills should match better together (Hany & Driesel-Lange, 2006), in order to avoid the high numbers of dropouts of undergraduates at university of pupils (Heulbein et al., 2005). However, a lot of "external" institutions (e.g. "Berufsinformationszentrum") or initiatives for general information about study opportunities and for STEM-related studies as well as career pathways are offered for pupils after secondary school (see section 1.2), Yet, this offer could be improved and might be addressed to pupils of different school types and their specific needs. To sum up, from economical and educational perspective such career or study choice orientations would be important (Hany & Driesel-Lange, 2006).

5.3. Gender differences in STEM regarding motivation

As we mentioned before in the model of Dick and Rallis, the career choice is strongly connected to the self-concept and values of a career that includes motivation and interest for this kind of career besides the other influence factors of the model. In general, the *motivation* is mostly linked to the career values which underlie the past experience and the attitudes of pupils' socializers (see Dick and Rallis, 1991). With regard to STEM, Engeser et al. (2008) reveal in their study that the key motivations for studying STEM-related subjects are future aspects e.g. career opportunities, but they revealed in particular that self-confidence is crucial aspect for the career choice in the STEM field. The self-confidence and self-concept in mathematics and science are linked together. As the importance of *interest* in STEM by gender is reported in the section above, the gender difference regarding the interest is subject to the following section. Thus, several findings are shown that girls are less interested in STEM-related subjects and have less self-confidence in comparison to boys (Ziegler, 2002; Beerman et al. 1992).

6. Conclusion

In the following, we will summarize the current situation of women in STEM from primary school to the first employment. Based on the situation of women in STEM, we will reveal the main problems for girls and women in STEM that hinder them to choose a study course or even career path in these fields. Finally, we might recommend on basis of the results of this report some solutions which aims at promoting and encouraging more girls and women in STEM careers.

6.1. Situation

Yet, most of the young women pursue an educational pathway that could be compared to a “leaky pipeline”. Thus, they are still underrepresented in STEM-related careers. Different reasons for the low share of women in STEM could be established according to the educational stages. Due to the findings of the TIMSS study gender differences in mathematics and science self-concept could be found to the advantage of boys. The findings of the PISA study (2006) have shown clear gender differences in secondary school with regard to literacy and mathematics and science performance. Two-thirds regarding the literacy level V (proficiency level V) are girls. In contrast, the boys were better in mathematics and science performance: 60% of literacy level IV and V are boys. The gender differences of female and male pupils in STEM-related subject become more distinctive in secondary school in comparison to those in primary school. The interest and self-concept about the competencies in mathematics and science are strongly to the advantage of boys. At university, most of the female students still prefer to study stereotypical study subjects like education or social sciences, but the growth rate for PhD by women increases slightly in STEM. With regard to employment in STEM several disadvantages could be found. Regarding the full time employment in STEM the under-representation of women could be shown. According to different studies there are in general more men than women work in full time employment. This may have various reasons which relate to disadvantages (e.g. leading positions and income) but also advantages (e.g. opportunity to combine family duties and job) for women in STEM. Further, due to the results of the HIS study (2009) women with a university or technical college degree in STEM-related subjects have got a significant lower income (on average) in comparison to their male colleagues. Some „dual-career-couple“ relationships could be successful but this way of living implies a partner who is supporting the career of the woman e.g. by sharing the work at home or by supporting regarding child care.

6.2. Problems

Based on the underrepresentation of girls and women in STEM-related studies and careers we could reveal various problems which have impacts on the low interests and motivations by women to work in STEM domains. During school the negative image and perceived stereotypes of a typical scientist in STEM might impede girls in school to develop a higher interest for STEM. Even if girls are equally gifted in subjects like German language and a STEM-related subject, therefore female pupils still rather choose stereotype-related main subjects and study courses. This might be linked to the lack of acceptance by boys and men in STEM fields. Girls perceive this lack of acceptance, if they have low self-confidence and self-concept concerning their competencies in STEM-subjects. Those girls will not take a study subject or career in these fields into account. One important problem is the fact that women have to deal with the obstacle of combining child care and career. Often there are not enough adequate child care possibilities

which could enable women to pursue their career plans as their partners. In most of the case they choose to stay at home or take a part-time job into consideration. Base on different obstacles the phenomenon of a dual-career-couple could only rarely be transferred into practice.

6.3. Solutions

In the previous section, we have shown some of the main problem for women to take a STEM career into account. This section will concentrates on possible solutions regarding politics, organizations, and teaching in schools. First, we will recommend developing more improved facilitation measures for girls and women in STEM: Women should receive the same amount of salary if they achieved the same degree as their male colleagues. Politics could also set on creating better child care facilitation for full-time employees, thus they can concentrates on their job and could be more flexible for the work conditions. The improvement of motherhood law is also subject to politics.

In general, organizations could contribute the situation of women in STEM by creating a more “women friendly” working atmosphere that means that the male colleagues should be more open minded to women who are successfully working in these fields.

In the SESTEM project we developed and created good practices for teachers at secondary school. The practices focus on gender-sensible teaching to avoid the stereotype-related thinking of boys and girls with regard to STEM careers. This could a first step to encourage girls to choose a STEM-subject at university but for long-term the need of implementation of adequate politics measures regarding the promotion of women in STEM is given.

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Annex 1.1. Career guidance in general

Name	Description	Link
Arbeitsagentur	Bietet Berufsberatungsmöglichkeiten für: Schüler, Studenten, Arbeitslose und Hochschulabsolventen	www.arbeitsagentur.de
BIZ	Spezielles Informationszentrum für Schüler und Lehrer über Ausbildung und Studium	www.arbeitsagentur.de/nr_26266/Navigation/zentral/Buerger/Zwischenzeit/BIZ/BIZ-Nav.html#d1.1
Planet Beruf	Spezielles Angebot für Schüler mit Bewerbungstipps und Beratung zu Ausbildungsberufen	http://www.planet-beruf.de/
EINSTIEG GmbH	Informationen zum Studium, Ausbildung, Beruf	www.einstieg.com

Annex 1.2. Career guidance for women in STEM

Name	Description	Link
Bundesweite Koordinierungsstelle Girls' Day - Mädchen-Zukunftstag	Die Mädchen lernen am Girls' Day Ausbildungsberufe und Studiengänge in Technik, IT, Handwerk und Naturwissenschaften kennen, in denen Frauen bisher eher selten vertreten sind oder begegnen weiblichen Vorbildern in Führungspositionen aus Wirtschaft oder Politik.	www.girls-day.de/
Programm des Ministeriums für Wissenschaft, Forschung und Kunst Baden-Württemberg	Studienberatung für Beruf und Karriere in Naturwissenschaft und Technik	www.schuelerinnen-forschen.de
Tastemint	TasteMINT ist ein innovatives personales Potenzial-Assessment-Verfahren, das Abiturientinnen an der Schnittstelle Schule – Hochschule die Möglichkeit bietet, ihre Stärken für den MINT-Bereich zu erproben.	http://www.tastemint.de/
Bundesministerium für Familie,	Informationsangebot zu Frauen und Karriere	http://www.frauen-machenkarriere.de/

Senioren, Frauen und Jugend	(Berufseinstieg, Selbstständigkeit, Wiedereinstieg)	Home/
MINT Zukunft schaffen	Angebot zur Förderung der MINT-Kompetenzen und Berufsorientierung im technischen Bereich	http://www.mintzukunftschaffen.de/navigator/suche/show/72

Annex 1.3. Aptitude tests for STEM

Name	Description	Link
Think Ing – Arbeitgeberverband Gesamtmetall	Kostenloser Eignungstest der Initiative „Think Ing“ des Arbeitgeberverbands Gesamtmetall, der die Eignung für ein Ingenieursstudium beurteilt.	http://www.think-ing.de/think-ing/die-qualifikationen/eignungstest
IT-Berufe.de (Arbeitgeberverband Gesamtmetall)	Zwei kostenlose Tests des IT-Berufsportals des Arbeitgeberverbands Gesamtmetall, die die allgemeine Befähigung für den IT-Beruf ermitteln und spezifische IT-Berufsfelder für Kandidatinnen und Kandidaten herausfinden.	http://www.it-berufe.de/index.php?node=6
Ludwig- Maximilians- Universität München	Kostenloser, sehr umfangreicher Eignungstest des Instituts für Informatik der Ludwig-Maximilians-Universität München für angehende Informatik-Studentinnen und -Studenten.	http://www.pms.ifi.lmu.de/eignungstest/
Ruhr- Universität Bochum	Kostenloser, ausführlicher Online-Test zur Ermittlung von persönlichen Stärken und Schwächen sowie möglichen Berufswegen von der Ruhr-Universität Bochum.	www.ruhr-uni-bochum.de/borakel/mein-berufsweg.htm

Annex 2. Initiatives

Name	Description	Link
Agentur Mädchen in Wissenschaft und Technik - Technische Universität München	<p>„Die Agentur Mädchen in Wissenschaft und Technik hat die Aufgabe, für technisch-naturwissenschaftlich interessierte und begabte Schülerinnen aller Altersstufen an Hochschulen, Forschungseinrichtungen sowie Schulen und Einrichtungen der Kinder- Jugend- und Mädchenarbeit ein anregendes Umfeld zu schaffen. Die Agentur baut auf dem Ferienprogramm <i>Mädchen machen Technik</i> auf.“</p> <p>Die Universität der Bundeswehr München beteiligt sich regelmäßig an dem Projekt.</p>	<p>https://portal.mytum.de/am/index_html_alternativ</p> <p>http://www.unibw.de/praes/universitaet/aktuelles/biosignale</p>
ARD/ZDF Förderpreis 2009 Frauen + Medientechnologie	<p>„ARD und ZDF verleihen den Förderpreis für exzellente Abschlussarbeiten von Frauen in den Ingenieurwissenschaften.“</p>	<p>http://www.ard-zdf-foerderpreis.de</p>
be.it be.ing	<p>„Informatik ist ein Beruf für junge Frauen. Mit diesem Studium bekommen sie Zugang zu interessanten Tätigkeitsfeldern in Medizin, Medien und vielen mehr. Die Initiative be.it berichtet über diese Möglichkeiten und stellt junge, erfolgreiche Informatikerinnen vor.“</p> <p>„Die Berufsbilder im Ingenieurbereich verändern sich und werden attraktiver für junge Frauen. Die Initiative be.ing stellt Tätigkeitsfelder und interessante Frauen aus der so genannten "Männerdomäne Technik" vor.“</p>	<p>http://www.werdeinformatikerin.de/</p>
Center of Excellence – Women and Science (CEWS)	<p>„Das Kompetenzzentrum Frauen in Wissenschaft und Forschung CEWS ist der nationale Knotenpunkt zur Verwirklichung der Chancengleichheit von Frauen und Männern in Wissenschaft und Forschung in Deutschland. Für dieses Politikfeld gibt das CEWS Denkanstöße, initiiert Veränderungsprozesse, die es wissenschaftlich begleitet, und gestaltet die erforderlichen Transferprozesse zwischen Wissenschaft und Politik aktiv mit.“</p>	<p>http://www.cews.org</p>

<p>Deutscher Akademikerinnen Bund e.V.</p> <p>Arbeitskreis Frauen in Naturwissenschaft und Technik im Deutschen</p>	<p>Ziele: „Akademikerinnen zu befähigen, ihr Fachwissen wirkungsvoll zu nutzen, den Status von Frauen und Mädchen durch Gendermainstreaming zu verbessern, lebenslanges Lernen zu fördern, dem Lebensmodell Karriere mit Kindern zum Erfolg zu verhelfen“</p>	<p>http://www.dab-ev.org/</p> <p>http://www.dab-ev.org/index.php?id=33</p>
<p>Deutscher Frauenrat: Lobby der Frauen - Bundesvereinigung von Frauenverbänden und gemischter Verbände in Deutschland e.V.</p>	<p>„Der Deutsche Frauenrat hat sich in seiner über fünfzigjährigen Geschichte zur wichtigsten Lobby von Frauen in diesem Land entwickelt. [...] Der Deutsche Frauenrat ist die Vereinigung von aktuell 56 bundesweit aktiven Frauenverbänden und -organisationen. Zu unseren Mitgliedern zählen konfessionelle Verbände und Berufsverbände, die Frauengruppen der Parteien, der Gewerkschaften und des Deutschen Olympischen Sportbundes, außerdem überkonfessionell und überparteilich arbeitende Organisationen mit vielfältigen sozialen und politischen Aufgaben.“</p>	<p>http://www.frauenrat.de</p>
<p>Deutscher Ingenieurinnen Bund e.V.</p>	<p>„Seit über 20 Jahren setzt sich der deutsche Ingenieurinnenbund für Frauen in technischen Berufen ein. Das bundesweit aktive Netzwerk besteht aus derzeit 18 Regionalgruppen. Neben gegenseitiger persönlicher Unterstützung in beruflichen und fachlichen Fragen, liegt der Schwerpunkt in der nationalen und internationalen Lobby- und Gremienarbeit.“</p>	<p>http://www.dibev.de/</p>
<p>CyberMentor</p>	<p>„Anliegen von CyberMentor ist es, das Interesse und die Beteiligung von Mädchen am MINT-Bereich (Mathematik, Informatik, Naturwissenschaften und Technik) zu steigern. Durch die Teilnahme am E-Mentoring-Programm profitieren Schülerinnen und Mentorinnen von verschiedenen Angeboten.“</p>	<p>https://www.cybermentor.de</p>
<p>do-Ing</p>	<p>„Die Ziele von do-Ing in Aachen sind: Mädchen und Frauen für Technik faszinieren! Für ein spannendes und interessantes Ingenieurstudium begeistern! Über Studieninhalte und die guten Berufsaussichten informieren!“ (Projektzeitraum: 1999-2004)</p>	<p>http://www.do-ing.rwth-aachen.de</p>
<p>Einstieg Informatik</p>	<p>„Einstieg Informatik ist das zentrale Projekt zur Vermittlung von Informatik an Kinder und Jugendliche im Informatikjahr - Wissenschaftsjahr 2006. Mit Workshops und Aktionen auf Messen und überall dort wo viele Jugendliche erreicht werden, wollen wir Informatik allgemein verständlich und spannend</p>	<p>http://www.einstieg-informatik.de</p>

	darstellen. Darüber hinaus sollen Jugendliche begeistert werden sich auch näher mit der Informatik zu beschäftigen.“	
Erster Deutscher Frauenstudiengang Informatik und Wirtschaft (FIW)	„Obwohl Frauen gute Voraussetzungen für ein Informatik-Studium mitbringen, sind sie mit nur 20 % unter den Studierenden zu finden. Damit nutzen sie ihr Potenzial für chancenreiche Zukunftsberufe nicht aus. Frauen wählen zumeist Studienrichtungen wie Sprach- und Kulturwissenschaften, in denen sie später leider weder gute Berufsaussichten haben noch ein hohes Einkommen erzielen. Wir wollen mehr Frauen als bisher für ein Informatik-Studium motivieren und ihnen den selbstverständlichen Umgang mit Technik ermöglichen. Damit folgen wir dem Vorbild vieler amerikanischer Women Colleges und deutscher Frauenstudiengänge.“	http://fiw.f4.fhtw-berlin.de
FiT e.V. – Frauen in der Technik	„Flexibel und mit gebündeltem Know-how Projekte zu Frauen und Technik / Naturwissenschaften durchzuführen - dazu haben wir uns in dem als gemeinnützig anerkannten Verein Frauen in der Technik - FiT- e.V. zusammengeschlossen.“	http://www.fitev.de
Frauen in der Geschichte der Informationstechnik	Dieses Werk entstand im Rahmen des Projekts „Frauen in der Geschichte der Informationstechnik“.	http://www.frauen-informatik-geschichte.de
Frauen in Naturwissenschaft und Technik e. V. (NUT)	„Der Verein <i>Frauen in Naturwissenschaft und Technik</i> NUT e.V. ist ein Zusammenschluß von Frauen, die in naturwissenschaftlichen und technischen Bereichen arbeiten oder studieren.“	http://www.nut.de
Frauen machen Karriere Dossier Mathematikerinnen	„Mathematik war lange Zeit ein männerdominiertes Fach. Heute gibt es fast genauso viele Mathematik-Studentinnen wie -Studenten und sie haben attraktive Berufsaussichten. Eine Karriere in der Forschung, eine erfolgreiche Laufbahn in der Wirtschaft oder ein Berufsweg in der Lehre - die Möglichkeiten mit Mathematik sind vielfältig. Das zeigt das neue Dossier „Zahlenkünstlerinnen“ auf frauenmachenkarriere.de.“	http://www.frauenmachenkarriere.de/Brancheninformationen/Bildung_und_Forschung/dossier_mathematikerinnen/

Genderaktivitäten im Wissenschaftsjahr 2006	<p>„Die Verankerung des Gendergedanken in den Wissenschaftsjahren und die ausdrückliche Ansprache des weiblichen Nachwuchses war Ziel des vom Bundesministerium für Bildung und Forschung (BMBF) geförderten und inzwischen abgeschlossenen Projektes <i>Genderaktivitäten im Wissenschaftsjahr 2006</i>.“</p>	<p>http://www.kompetenzz.de/Genderaktivitaeten</p>
Gender Networking	<p>„Um besonders Frauen zu einer Qualifizierung im Bereich Netzwerktechnik zu ermutigen, und ihnen damit eine deutlich verbesserte Positionierung in ihrem späteren Beruf zu ermöglichen, startete der Verein Frauen geben Technik neue Impulse e.V. gemeinsam mit der Cisco Systems GmbH und der Fachhochschule Bielefeld das Projekt Gender Networking. Das Qualifizierungsprogramm schließt mit einem international anerkannten Weiterbildungszertifikat ab. Im Rahmen des Projekts wurden zusammen mit den Partnerinnen und Partnern Qualitätskriterien und neue curriculare Elemente unter Genderaspekten entwickelt, die das Bewusstsein von Dozentinnen und Dozenten und Lehrenden für neue Zielgruppen in der Netzwerktechnik schärfen und mehr Frauen für dieses Feld gewinnen.“</p>	<p>http://www.gender-networking.de/</p> <p>http://www.kompetenzz.de/Projekte/Alle-Projekte-A-Z/GenderNetworking</p>
Gesellschaft für Informatik e.V. AG Frauen und Informatik Girls go Informatik	<p>„Die Fachgruppe <i>Frauenarbeit in der Informatik</i> (FRAUINFORM) der Gesellschaft für Informatik e.V. (GI) setzt sich für eine Gestaltung und Anwendung von Informationstechnik, die sich an den Interessen von Frauen orientiert, ein.“</p> <p>Girls go Informatik – Informationstage (2001-2006) zum Informatikstudium für Frauen.</p>	<p>http://www.gi-ev.de/themen/frauen-in-der-informatik/</p> <p>http://www1.gi-ev.de/fachbereiche/fa_81/</p> <p>www.girls-go-informatik.de</p>
Girls' Day – Mädchen-Zukunftstag Neue Wege für Jungs	<p>„Am Girls'Day - Mädchen-Zukunftstag haben Schülerinnen Einblick in Berufsfelder, die Mädchen im Prozess der Berufsorientierung nur selten in Betracht ziehen. In erster Linie bieten technische Unternehmen und Abteilungen, sowie Hochschulen, Forschungszentren und ähnliche Einrichtungen am Girls'Day Veranstaltungen für Mädchen an.“</p>	<p>http://www.girls-day.de</p> <p>http://www.neue-wege-fuer-jungs.de/Neue-Wege-fuer-Jungs/Jungenangebot-e-nicht-nur-am-Girls-Day</p>
Girls-inform.de – Christian-Albrechts-Universität zu Kiel	<p>„girls-inform.de ist eine Initiative des Instituts für Informatik der Christian-Albrechts-Universität zu Kiel, um Mädchen und junge Frauen an das Studium der Informatik heranzuführen. Sie besteht aus einem</p>	<p>http://www.girls-inform.de</p>

	Spektrum an Veranstaltungen, von Schnupperstudiumswochen über Vorträge zur Berufsorientierung bis zu Veranstaltungen im Rahmen des Girls' Day (Mädchenzukunftstag).“	
Idea - Mentoring für Schülerinnen und Studentinnen in Naturwissenschaft und Technik	„idea - das ist ein neues Service- und Beratungsangebot der Freiburger Universität für Studentinnen der naturwissenschaftlich-technischen Fächer und interessierte Schülerinnen. idea bietet Studentinnen und Schülerinnen: die Teilnahme an unserem Mentoringprogramm, ein interaktives Portal mit Informationen zu Studiengängen und Berufen aus Naturwissenschaft und Technik und anderen aktuellen Themen, die Möglichkeit eines gegenseitigen Austausches und der Vernetzung.“	http://www.idea.uni-freiburg.de
idee_it	„Das idee_it -Netzwerk möchte Mädchen und junge Frauen unterstützen, sich für die neuen und spannenden IT-Berufe zu entscheiden.“	http://www.idee-it.de
Informatica Feminale	„Deutschlandweites Sommerstudium für Frauen in der Informatik. Die Informatica Feminale bietet jährlich kompakte Lehre zur Informatik für Studentinnen aller Hochschularten und für an Weiterbildung interessierte Frauen. Studieneinstieg, Verbleib im Studium, Berufsübergang und lebenslanges Lernen auf universitärem Niveau stehen dabei gleichermaßen im Blickfeld. Dozentinnen und Teilnehmerinnen kommen aus dem In- und Ausland. Das Sommerstudium in der Universität Bremen ist ein Ort des Experimentierens, um neue Konzepte für das Informatikstudium zu finden.“	http://www.informatica-feminale.de
Ingenieurinnennetzwerk – IngNet e.V.	Ziele: „Professionelle Zusammenarbeit von Frauen aus technischen Berufen, Fachspezifische und bedarfsorientierte Weiterbildung, Gegenseitige Unterstützung im beruflichen Alltag, Verbesserung der rechtlichen Situation von angestellten und selbstständigen Ingenieurinnen im Beruf“	http://www.ingnet-online.de
Jump in MINT	„Auf diesem Portal findest du viele Informationen, Tipps und Angebote, mit denen wir dich unterstützen möchten, den für dich passenden Beruf zu finden: Berufsbeschreibungen, Ausbildungsplatzbörsen, Bewerbungstipps, Veranstaltungen, Informationsangebote für Deine Kommunikations- und Präsentationsfähigkeit, Links über Links zu weiterführenden Informationen und vieles mehr. Dabei werfen wir immer wieder einen ganz	http://www.jump-in-mint.de

	besonderen Blick auf die Welt der MINT-Berufe.“	
Komm mach MINT	„Internetseite des Nationalen Pakts für Frauen in MINT-Berufen. Der nationale Pakt zwischen Politik, Wirtschaft, Wissenschaft und Medien soll das Bild der MINT-Berufe in der Gesellschaft verändern, junge Frauen für naturwissenschaftliche und technische Studiengänge begeistern sowie Hochschulabsolventinnen für Karrieren in der Wirtschaft zu gewinnen.“	http://www.komm-mach-mint.de
Kompetenzforum Genderforschung in Informatik und Naturwissenschaften	„In unserem Forum lehren und forschen kompetente Wissenschaftlerinnen zur Gender-Thematik in ihren Fachgebieten. Besonderes Augenmerk liegt auf der Schnittstelle zwischen Informatik und Naturwissenschaft, die sich in ihren Modellbildungen gegenseitig durchdringen.“	http://gin.iig.uni-freiburg.de/h_seite.php?h_men=1
MINT role models	Um den weiblichen Nachwuchs in diesen Zukunftsbereichen zu fördern, hat der VDI Verein Deutscher Ingenieure e.V. zusammen mit weiteren Projektpartnern (Ingenieurinnen-Netzwerk und naturwissenschaftliche Institutionen) das Projekt MINT Role Models ins Leben gerufen. Das Projekt ist Teil des Nationalen Paktes für Frauen in MINT-Berufen "Komm, mach MINT." und wird vom Bundesministerium für Bildung und Forschung (BMBF) gefördert. Ziel des Projektes ist es, über weibliche Vorbilder junge Frauen für naturwissenschaftliche und technische Studiengänge zu begeistern sowie Hochschulabsolventinnen dieser Fachrichtungen für Karrieren in Wirtschaft und Wissenschaft zu gewinnen	http://www.mintrolemodels.de/
MINT Zukunft schaffen	Die Initiative „MINT Zukunft schaffen“ steht für den übergreifenden Fördergedanken, junge Menschen in ganz Deutschland für Mathematik, Informatik Naturwissenschaften und Technik zu faszinieren. Sie hat als Multiplikationsplattform die Aufgabe, das Engagement von Wirtschaft, Bildungsträgern und Politik in diesem Bereich zu stärken, um den Fachkräftemangel in MINT entgegenzuwirken. In weiteres Ziel ist es ein Botschafternetzwerk zu schaffen, das den alltäglichen Nutzen von MINT und die guten Karrierechancen öffentlich zu machen.	http://www.mintzukunftschaffen.de/
Technikum	Das Technikum wird ab dem 1.10.2010 auslaufen. Praktika im Technikum können noch bis einschließlich zum 30.09.2010 begonnen werden. Die	http://www.technikum.de/

	<p>Dauer eines Praktikums beträgt bis zu acht Monate. Technikum-Betriebe erhalten für die Praktika, die bis zum 30.09.2010 beginnen weiterhin eine Förderung. Das Technikum ist ein Praktikum zur Studien- und Berufsorientierung im MINT-Bereich (Mathematik, Informatik, Natur- und Ingenieurwissenschaften bzw. Technik). Schulabgängerinnen und Schulabgänger lernen während des Technikums technisch-naturwissenschaftliche Berufe kennen.</p>	
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