IN SEARCH FOR GENDER AWARENESS IN TECHNOLOGY EDUCATION

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1. Introduction

Sweden is one of the most gender equal countries in the world according to "The Global Gender Gap report" (Haussmann, Tyson & Zahidi, 2012). Despite this, gender differences are shown in choice of education and profession. Although the Swedish school system has pursued gender equality within technology education, it is obvious that the gender gap remains. The history of technology education shows a male dominance, where women initially were not allowed to enter technology studies. It was not until after World War II that women became a target group when the technology industry needed to recruit more workers (Berner, 1996). Today, 15% of the technology students in upper secondary school are girls (Skolverket, 2013). This picture has been more or less the same since 1970. At university, the number of women has generally increased to about 25%. There are differences between the programmes, but the imbalance remains.

In this introductory section I will present the background to my study; the gendered subject of technology and technology education in the Swedish school system and the research questions addressed.

1.1 The subject of technology and technology education in the Swedish school system - a brief overview

In Sweden, technology education is offered at the compulsory school level as well as in upper secondary school. Technology in compulsory school has historically been connected with practical work and boys experiencing school fatigue. The status of technology is still low compared to natural science, an area fit for boys talented at studies. Technology has been a mandatory subject since 1980. It was connected to natural science because the content was perceived to be close to physics, chemistry and biology. The large number of natural science teachers also seemed to be enough to handle the extent of technology education. By this incorporation, a curriculum for technology was never designed until 1994 (Elgström & Riis, 1990; Fröberg, 2010; Lpo94).

At the upper secondary school level, technology education has been offered in technology grammar schools since the beginning of the 20th century. Also, vocational schools and professional schools have offered two-year programmes in different technology areas. Around 1950, many men fulfilled their engineering dream by studying at evening schools (Berner, 1996). The school reformation Lgy70 implied that all secondary school educations should be three years long, irrespective of whether they are practical or theoretical programmes (Skolöverstyrelsen, 1970). The Technology Programme

was supposed to help prepare for civil engineering studies in technical university or, by adding one year, for college engineers. In 1990, the programmes for technology and natural science were combined, and the previous fourth year transferred to technological university and Bachelor of Science and Engineering. The union had an immediate effect on the numbers of technology students, which radically decreased, and ten years later the Technology Programme was back again (Fröberg, 2010).

Technology universities and institutes have offered education in civil engineering as long as grammar schools. Today, many technology areas are represented both in master and bachelor engineer educations.[1]

The Swedish school system, from preschool to upper secondary school, has recently gone through an extensive reformation in structure, in marks and curricula.[2] The curriculum for technology in compulsory school is, e.g., more detailed in comparison with previous curricula and the relation between technology and gender must now be highlighted in education. In upper secondary school, both structure and curricula are more fixed. The gender perspective is written down in both technology courses and in the goal for the programme (Skolverket, 2011a; Skolverket, 2011b).

1.2 Aims and research question

[1] See e.g. (http://www.ingenjorsvagen.se/hitta-utbildning/).
[2] Lgr11, Läroplan för grundskolan, förskoleklassen och fritidshemmet 2011.
Gy11, Läroplan, examensmål och gymnasiegemensamma ämnen för gymnasieskola 2011.

The aim of this thesis is (1) to contribute to increasing gender awareness in technology education and (2) suggest strategies to break gender boundaries. The overall research question is:

What is done within the education system to contribute to gender equality in the subject of technology and in technology education?

This question is broken down into the following more specific questions in the two articles:

"How gender aware is technology education?" and *"What methods are used in order to break gender boundaries?"* (Paper 1)

"*What gender-oriented initiatives have been made and in what arenas do they take place?"* and *"What feminist perspectives can be traced in these efforts?"*(Paper 2)

2. Theoretical framework

The theoretical standpoint of this thesis is gender theory. Gender is the perception we have about male and female, the relation between them and their social organization. Why men and women are unequal in technology and technology education is a question of power. Within feminism and feministic epistemology, several scientists have presented theories showing that power between men and women is unbalanced and that knowledge is situated and gendered (Harding, 1986; Wajcman, 1991; Butler, 1990; Haraway, 1988; Hirdman, 2003; Connell, 1999).

The imbalance between men and women has been examined by Harding who describes how power relations are permeated by two principles; segregation and hierarchy (Harding, 1986). Those who endeavor for power depreciate other groups and hierarchy is created between those who have power and those who do not. Man is a standard for the "normal" and is superior. According to Harding, gender appears at three levels: symbolic, structural and individual. At the symbolic level, we find ideas and norms, but also linguistic divides, e.g., active/passive and strength/weakness, which mirror attitudes towards male and female. At the structural level, gender mirrors traditions and describes how social activities are conducted and organized, e.g., division of labour by sex. Finally, at the individual level, gender is made as a form of socially constructed identities. There are many ways to be a boy/girl and a man/woman. Some overlap and some vary depending on context. Harding (1986) considers that the gender segregation in technology is hard to explain unless all levels are studied and the inequality between men and women is attended to.

Models of male structures and the relations between them have been described by Connell (1999). One model, *the hegemonic masculinity*, describes how "the average man" represents a norm both men and women must respond to. The power relation shows that men are the ruling gender and women are commonly subordinate to men.

The *gender system* describes how structures and processes create inequality in society and are maintained by *the gender contract*, the invisible rules and norms between males and females at the group

level (Hirdman, 2003). Hirdman's theory describes how the gender contract is kept up by segregation between men and women, how male activities are higher valued than female activities and how we all contribute, often unconsciously, to creating the gender system. The stronger the segregation between the sexes, the less the authority of male norms is questioned.

However, gender roles are not pre-established, they are constantly re-interpreted and socially constructed (Butler, 1990). Even absolute male environments and activities are affected by the actors' social gender.

3. Related research

The research field of gender and technology has not been initiated from within the technology arena but rather from varying and inter-disciplinary environments. The low recruitment of women in technology education and work places was one of the first issues to be attended to by feminist scientists (Sundin & Berner, 1996).

3.1 Research in gender and technology

Technology is still a male-dominated area and the distinction between sexes is shown in working life. Women are in the minority, even if the gap tends to level out faster among highly educated professionals, because the number of female students is increasing more than the number of male students (Löfström, 2004).

The strong historical connection between technology and masculinity has industrial roots where men have put themselves in technologically key positions. The gender marking of technology is implemented since men have an advantage in making the important decisions of how to frame technology (Cockburn & Ormrud, 1983; Cockburn, 1985; Faulkner, 2003; Mellström, 2003). One of the important factors behind male dominance in technological professions is the pleasure men get from technology (Harding, 1986). Ritual demonstrations of practical technological qualifications among engineers have created male groups in which women are excluded. Moreover, men are generally more successful than women in claiming their qualifications, especially technological qualifications (Wajcman, 1991).

Not only are decisions and knowledge about technology gendered, artifacts are also gender marked, symbolical and material (Faulkner, 2003). One example is by distribution and salary of work. Computer science is a field of technology with very few female professionals and even less women at high posts. Architecture, on the other hand, is one example of equal distribution of workers, but among architects there are few women in leading positions. Cockburn is one of the leading international feminist researchers in the gender-technology field. She describes the gender marking of technology from construction through manufacture and sale to use. A classical example is the microwave, originally designed for single men heating up ready-cooked food, re-designed for multiple combinations of home cooking by women (Cockburm & Ormrod, 1993).

Characteristic qualities designed directed to male or female users often amplify gender stereotypes. In other studies she has shown how male dominance and hierarchy are established in the technology work field (Cockburn & Ormrud 1983; Cockburn 1985).

Wajcman (1991) describes two dominating forms of masculinity in the world of technology. One is based on physical strength and the other on practical and mechanical skills. Both forms describe how men culturally and socially identify with technology and machines forms women seldom identify with. The connection between men and technology has been examined by Mellström, one of the many Swedish masculinity researchers. He says that the hegemonic masculinity in technology is only one among several masculinities (Mellström, 1996).

3.2 Research in technology education and gender

Internationally, the technology didactic research field is quite young and small, not least in Sweden. How technology in compulsory school is taught and what syllabus is chosen has been studied by several international researchers. A majority of studies are focused on curricula and other frameworks (Zuga, 1997). Since the subject historically is close to industrial arts with male dominance, girls' interest has been suppressed. The interest among young girls and women in technology is low in the western world, especially in Scandinavia, and also in Japan (Schreiner & Sjöberg, 2008). A study among schools in five EU countries (Finland, Austria, Estonia, Germany and France) shows that the subject of technology is neither

given priority in school nor is the development of education methods (Rasinen et al, 2009). The study confirms that girls already lose interest in technology in early school years. In Sweden, technology in compulsory school has low priority (e.g. Teknikföretagen, 2013; Teknikdelegationen, 2010). Studies at compulsory school show that the subject of technology gets less space on behalf of physics, chemistry and biology because the teachers lack education in technology (Bjurulf, 2008). Swedish studies also have shown that girls´ interest are depending on syllabus and teaching methods (Skogh, 2001; Lindahl, 1991).

Berner is one of the Swedish pioneers in gender, technology and education. Her studies about the engineer's role, how it is gendered and how this is mirrored in school and at workplaces highlights male culture, sexual harassment and elitism (Berner, 1996). Several measures to attract women to technological universities and colleges have been carried out. Many women though think of technology as something masculine and this affects their choice of education (Henwood, 2000; Salminen-Karlsson, 2003).

Within the education system, power over technology is shown by, e.g., those who define technology knowledge, how it is taught and who should teach it. International studies show that men as the powerful sex have preference in the interpretation of technology and what to teach in technology institutes (Harding, 1991). Education is formed by men's needs and preferences, and there is too much focus on instrumental learning instead of problem solving and the social aspects of technology. The picture is similar in Great Britain and

USA (Murphy, 1991). A new form of teaching engineering has been adapted at several universities.

One mission in the Swedish school system is acting for equality, and the subject of technology is specially politically emphasised (Hedlin, 2009). General questionings about boys' and girls' equal treatment in school were raised in the '70s. Studies showed that girls got less attention than boys and were more often treated as a group, in contrast to the boys who were treated as individuals. Both male and female teachers followed the same pattern. Recent studies show that this differentials in the treatment of boys and girls remains (Hedlin, 2009). Girls are marginalised and some subjects are more gender marked than others. This is shown in textbooks, e.g., in physics where girls' experiences are excluded, signaling that this subject is not for them (Wright, 1999). Girls are also brought to a second position of ranking, a position affecting their personality and identity (Käller, 1990).

By making technology mandatory in compulsory school in 1980, hopes for gender equality in choice of higher education and profession were raised. However, the connection between boys and technology has maintained and the interest for technology among girls is not overwhelming – at least it does not affect their choice of higher studies. During the 1990s, "girls and technology" became a symbolic question. Gender-coded choices for upper secondary school became a discussion as well as how home economics and technology should act to promote gender equality (Hedlin, 2009). It was stressed that the problem lies in the fact that teachers have not

been able to adapt their teaching so that it fits girls' needs and interests. In line with this and more research (e.g., Teknikdelegationen, 2010) it was concluded that technology education must be strengthened and brought forward. This was supposed to be done by giving the subject of technology a new focus and syllabus from both male- and female-coded activities, together with a requirement of education including everyday application.

However, this does not mean technology has become more female. Berner (2004) notes this development is not self-evident. Schools are still focusing on men's history of technology, while women's inventions seldom are mentioned. Many people's expectations of a greater focus in the social context and human relations of technology have not been fulfilled. Still endless and repeating swotting in mathematical and analytical problem-solving dominates (Hacker, 1989). Practical everyday knowledge and insights are still regarded as suspect. Technology is associated with power, prestige and status characteristics of the patriarchal society. Technology also is associated with economy and paid work. Therefore, male technology is highly praised while female technology is marginalised.

One of the difficulties about technology is the broadness of the subject and that it contains so many areas of knowledge (Layton, 1994). This means there are no standard models or resources for developing the subject. The curricula can be interpreted in widely different ways (Bjurulf, 2008; Blomdahl, 2007). Therefore the teachers' preferences, how they interpret the subject and what knowledge they possess are decisive for what the pupils get. The content of "general knowledge in technology" is still left to be

decided. Since technology is described as inter-disciplinary, neither the boundaries of the subject nor the gender aspects are obvious.

However, choices of content are not solely important to create a gender-inclusive education. Providing a comprehensive view valuing both technology process and product is also necessary (Nisbet, Pendergast, & Reynolds, 1998) in order to create a more permissive and open atmosphere in technology education, e.g., through the choice of "untraditional" examples relating to both girls and boys and methods emphasising process instead of "the right answer" (Nisbeth et al., 1998; Lindahl, 2011). One way is by working in small groups, without support from the teacher. This, however, presupposes activity from all group members. To create a gender-neutral environment for education, the tasks and the learning surroundings must allow the pupils to use different ways of solving the assignments. Nisbet et al. (1998) report that boys often use "trial and error" while girls often spend much time discussing and planning before they start. By working contextually, you also get the opportunity to value technical solutions. Also, girls' acquirements are gained by putting the task into an everyday perspective. According to Murphy (2006) and Faulkner (2003), girls are more inclined to understand the background of a task. They identify with the user and judge products and systems in terms of what is user-friendly. Boys, on the other hand, more often approach technical tasks in an isolated manner and see the context as irrelevant. Faulkner says girls show that they posses many of the capacities needed for successful engineering work. However, tempting women this way, by dividing technology into male and female areas, is treacherous, says Berner (2004), since it is hiding the issue of power and fortifies the idea that

technology and masculinity belong together. Not every woman and man fit into traditional working styles and therefore the division of "social" and "technological" engineering is gendered in a contradictory way. Men get high status positions in companies independently of how the qualifications are gendered.

4. Method

This thesis is based on both empirical material and literature studies.

4.1 Empirical study

In the first article, *Has technology in compulsory school succeeded in breaking gender boundaries*?, observations, interviews and a questionnaire have been carried out among teachers, school leaders and pupils at two compulsory schools. The two months of fieldwork was carried out during a period of one year from the start of elementary school and the end of upper secondary school.

4.1.1. Selection of informants

Two compulsory schools have been studied, one at the elementary level and the other at the lower secondary level. The schools are both located in the same city and the pupils share their social background. The first school, year 1-5, was chosen because of its technology profile. The second school is the one most pupils from the first school attend when starting year six. By choosing these schools, all

pupils shared the same social background. The schools also belonged to the same public administration, i.e., the same political and economical conditions.

With help from the school leaders, teachers were contacted and suitable classes selected. All technology teachers were invited to take part in the study. Two of the teachers at the upper secondary school said no; all the others accepted. The selected classes were the ones that had technology on the schedule at the time of the study. All pupils' parents were informed about the study and they had to confirm their approval of their child's participation.

4.1.2 Observations

Technology lessons were observed as a starting point for the interviews and questionnaires. Each class was observed during a technology lesson and notes were taken of the pupils' work and their attitudes towards it. The notes have served as support during the interviews and when describing the schools' technology works in the article. The main focus of the observations was to become acquainted with each other. I wanted all informants, especially the pupils, to feel comfortable during the interviews and it was important to have something in common to refer to during the conversations.

4.1.3. Interviews

Teachers and school leaders were individually interviewed and group interviews were carried out among the younger pupils, i.e., the elementary school, year 1-5. The interviews were semi-structured, consisting of four to five questions. All questions were aimed to encourage the informants to give a picture of the gender awareness and education methods in technology at their school.

Pupils were interviewed in groups of eight to ten. Interviews were chosen because the youngest did not have the skills of reading and writing it takes to fill in a questionnaire. I preferred to do the same in all classes, at the same school, in order to get comparable material. Group interviews were chosen because individual interviews would be time wasting. Each group was selected together with the teacher in order to get a balanced mix. The questions considered their experiences of technology lessons in school, their image of technology and their dreams about the future (see appendix 3). The questions to teachers and school leaders dealt with their professional competence and experience of technology, their view of technology and how to work with the subject of technology (see appendix 1 and 2).

The interviews were recorded, transcribed and analysed.

4.1.4. Questionnaire

For the older pupils, school year 6-9, a questionnaire was circulated. This method was chosen because of the possibility to get answers from each individual in a smooth and time-saving way. During a

technology lesson, the pupils were in a classroom with computers and filled in the available questionnaire by logging in to the schools pedagogical platform and their personal pages. The questionnaire contained both multiple-choice and open questions. Here, the questions were more specific and because of the informants' age and school level, other questions were possible, e.g., what they have learnt in technology during schooling and what programme they planned to study in upper secondary school (see appendix 4). Two classes with 42 pupils were invited to complete the questionnaire and 38 of them were present on the day.

The questionnaires were transcribed with help from one of the teachers, since I did not have access to the pedagogical platform.

4.1.5. Analysis of empirical data

The method adopted for the analysis of this qualitative research is the categorisation of the informants' perception of the subject of technology and technology education (Kvale, 1997). The stories from pupils and adults were first separated. Their answers were categorised by dimension and each category was separated into sub-categories. In the material from the pupils, one of the categories was, e.g., attitude towards technology and sub-categories were creative, experimental etc. In the teachers' and school leaders' material, the categorisation was done in a similar way but focusing on, e.g., education, curricula and frameworks. The answers for the multiple-choice questions have been compiled into charts and diagrams (see

appendix 5). Answers to open questions have been categorised like the interviews.

Finally, the material was looked upon from a gender-theoretic perspective by paying attention to symbolical, structural and individual genders (Harding, 1996).

4.2 Literature study

The second article, *Challenge traditional structures—ways of building gender equality in technology education,* is based on literature studies among actions for gender equality in upper secondary school and university.

Official documents from the government, the industry and schools regarding gender equality in upper secondary school and universities in Sweden from the last twenty years were studied (see appendix 6). In the beginning of the 1990s, worrying reports from the industry showed that the interest in technology education was far too low from an economic perspective and that women were still at a numerical disadvantage. The gender issue was revived and various actions were initiated by the government and industry.

The studied documents were, e.g., governmental bills, reports and investigations on behalf of the government carried through by national agencies like The Swedish National Agency for Education or industrial organizations like *Teknikföretagen* and The Royal Swedish Academy of Engineering Sciences, IVA. Also, documents of gender

equality missions from individual universities and technological colleges like The Royal Institute of Technology and Chalmers University of Technology were studied.

4.2.1. Analysis of the selected literature

In order to find out why women still are in a minority in technology education, the actions have been compiled by type. When mapping the actions, a structural pattern became visible. By organizing them into five arenas, named after the physical or virtual location, and analyzing them from a gender-theoretic perspective, gender structure became mirrored by the three gender levels (Harding, 1996).

4.3. Ethical considerations

The empirical study has been guided by some ethical principles. Both schools have been informed of the nature of the study both in writing and orally and gave their approval to take part. Teachers allowed observations in the classroom and a personal interview. All parents were informed by a letter, sent forward by their teacher, and asked to give their written approval of participation. The letter informed them of the aim of the study and of their anonymity. Fictitious names have been used for the school locations, the names of the schools and everyone taking part in the study. Recorded and transcribed interviews were marked with their fictitious names and kept in safe custody.

5. Summary of papers

5.1. Paper 1: Has technology in compulsory school succeeded in breaking gender boundaries?

This article contains a study of two Swedish public compulsory schools, one elementary and one lower secondary school, and how they respond to the technology subject from a gender perspective. The schools are located in the same city and the pupils from the elementary school often continue their studies in the lower secondary school. Through observations of technology lessons, interviews and a questionnaire among pupils, teachers and school leaders, a picture of the gender awareness in technology become visible.

The elementary school is known for its investment in technology. The classes use two common methods and the school leader support continuing training in technology for all teachers. The first method, Brainwaves, is introduced in grade one. Creativity and inventiveness is central. The pupils examine technical artifacts, invent new ones and show their creations with pictures and models. They also compete in solving a problem involving technical invention. The second method is Skellefte-technology, which starts in grade two and continues to the fifth year, the last at this elementary school. Skellefte-technology has another, much more controlled, approach compared to Brainwaves. The pupils work in pairs, girls with girls and boys with boys. They are also matched by personality. Every lesson contains a task decided by the teacher that is to be carried out during a particular period of time. The tasks are often problem

oriented and place demands on special documentation. The interest in technology among the pupils was very high. The teachers stress in particular that girls' confidence in technology has grown through these methods.

The lower secondary school has little in common with regard to content and working methods in technology education. The subject also gets a minimum amount of time in the schedule, something that both teachers and pupils deplore. Pupils say they want more practical and challenging lessons and content adapted to today's technology. Teachers lack time and active support from the school leader to develop the subject. The illusion of technology in an integrated science course is one explanation of why technology has difficulties in taking its proper place. A lean range of textbooks and updated technology material, together with few offers of training for teachers, are other facts that have affected the situation of the technology subject in the school.

Gender awareness among teachers varies. In the elementary school, gender was an important issue in technology education. The school leader was very dedicated to improving girls' technical self-confidence. In the lower secondary school, gender was not an issue for all teachers but something the female teachers were concerned about. No gender-aware methods were used. For the female teachers to carry through changes in technology education, active support from the school leader is indispensible.

Parts of this article are published in the book "Teknikutbildning för framtiden" (2011, Hansson, Nordlander, Skogh Eds.).

5.2. Paper 2: Challenge traditional structures ways of building gender equality in technology education.

Accepted for publication in *Technology Education—Practicing Teachers Researching Teachers Practice.* Skogh, I-B & de Vries, M. (Eds.) Series: International Technology Education Studies. Sense Publishers (In press).

This article records a study of actions aimed to increase the number of female students in technology education in upper secondary school and university. The actions are presented according to their action arena and are finally discussed on the basis of feminist theories and their connection to educational strategies.

By way of introduction, the article describes feminist theories and how they are used in the school debate. In liberal feminism, the focus is the individual e.g., by increasing interest and motivating women to make gender-crossing choices. Radical and socialist feminism focus is in the political system. Radical feminism stresses the power system where males are at the top and the norm of society. In education, the question of separating boys and girls in order to benefit girls' learning and development is often heard e.g., by single sexed classes. Allocation by quota is another method i.e., setting aside a number of study seats for women in male-dominated education. Socialist feminism advocates compensation for pupils

with weak financial opportunities. Postmodern feminism sees gender as a complex picture of social structures. No clear-cut solutions can eliminate gender inequality and actions must be taken from a broad perspective and adapted to the situation. After the theoretical view, the introduction of the article gives a short historical brief of womens' access to technological education during the 20th century. Then the study is presented.

A survey is made of how the government, the profession and technological universities and colleges during the last twenty years have been working to increase the number of female students both making women join the education and carry it out. After mapping the types of actions, a pattern of groups became obvious groups around the different kinds of arenas in which actions are initiated. It was clear that several levels inside and outside schools are active in these actions. To clarify both their physical location and structural level, I call the arenas *square, mass, entrance, classroom* and *boardroom arena.* In the *square arena,* open recruitment efforts are made commercials, information campaigns and competitions. The *mass arena* contains activities aimed to facilitate for those who have showed an interest in the education. It can be e.g., exhibitions for invited guests or seminars. In the *entrance arena,* efforts aimed at facilitating the choice of studies for women are made. The basic year is one example of a course adjusted to higher technology studies that gives students qualifications for a technology programme. In the *classroom arena,* methods to make education gender aware are visualised. It is seen in what textbook is chosen, the content of the subject, who is teaching it and how the class is composed. In the

boardroom arena, decisions about the hierarchy of school staff and possibilities of their careers are made along with composing the structure of the programme. For upper secondary school, there are differences between schools; if they are public or private.

The result of the study shows that ideas from liberal feminism still dominate the choice of initiatives. Most of the efforts are also carried out in the public arenas—*square* and *mass*. Radical try-outs in the *entrance* arena have been initiated by the government, some of them very successful, but it is mostly at smaller universities they have been adapted properly. In order to achieve proper gender awareness and reach lasting results, the *boardroom* arena is central. However, this is a question of power.

6. Result

In my search for gender awareness, a central question is asked: What is done within the education system to contribute to gender equality in the technology subject and in technology education? Two main areas have been examined: technology education in compulsory school and attempts to reduce the gender gap in higher technology education.

The result of the articles will be reported from a gender-theoretic view at the three gender levels: symbolical, structural and individual. In some areas, the levels overlap.

6.1 Symbolical level

The symbolical level contains the attitudes, interest and content of the technology subject.

6.1.1. Compulsory school

The elementary school had strategies for presenting and engaging technology from the first year of school. The teachers' attitudes were the starting point. An enthusiast took the first step of changing technology education. The ideas spread, more teachers joined and the school leader decided to implement the ideas for all pupils. Positive attitudes to technology are one of the issues for the school, and it is shown at the symbolical gender level by engaged and interested pupils. Several pupils say technology "is the best subject". The content of technology showed a broad and varied mix. A central theme is everyday technology. The first year allows the pupils to examine something technical from home. They unscrewed the parts and looked at what is inside. Some of the parts were used to create a robot. Sketches and a model of the robot were later made and showed at an exhibition to which family and friends were invited. From the second year, technology was presented through tasks in a box, where instructions and material were enclosed. The tasks involved e.g., electronics, building and construction, measurement, but also social exercises and problem-based laboratories.

The pupils' interest in technology in upper secondary school varied. Boys showed generally more interest. A majority said it is an

important subject and wanted more technology in school, especially new technology. They wished for more creative and challenging tasks, preferably something inter-disciplinary. The lessons and the projects in technology often supported the other natural science subjects, e.g., building loud speakers that were made in connection with the electronic sector in physics. One teacher mentioned a project in technology history where old artifacts were studied in cooperation with a museum. Another mentioned technical products examined in cooperation with the social science teacher. The discussion of content and the need for common planning has been discussed for a while and the teachers have agreed to carry through the speakers and the bridge builder projects for all pupils. This means electronics and building construction are two parts of the technology content. Many teachers said they lacked material and textbooks, which made the subject tough to teach.

Technology appears to be something different from other subject, something practical, a nice break from the other swot subjects. One of the teachers is not convinced about their interest in technology. *"It feels like [the pupils'] interest is not for the technology subject. I say it feels as a further mark you can add to your points."* The female teachers expressed the importance of supporting girls' interest in technology, but so far gender-inclusive methods or tasks have not yet appeared on the agenda.

6.1.2 Secondary school and technological universities

In the *square arena,* several actions have been made to increase interest for technology studies. In catalogues and brochures, information sometimes has been consciously gender-crossing or at least has intended to show a gender-neutral message by choosing pictures of both men and women when a traditional male programme is presented. The evolution of the media has led to some progress in how actions are presented. A TV serial of the daily work of an engineer, Internet voting for the best student project and networks for women are some examples. Many of these actions have been made by individual schools, companies or organisations.

In the *mass arena,* exhibitions, conferences and seminars have been a common action. Most schools arrange "Open House" to present and show the school. "Technology for girls" is project that has been going on for a long time, engaging teenage girls for a week over the summer, introducing them to technology. For women curious about technology education at university, Girls' Days and Girls' Courses are examples of actions for promoting more girls in technology. Projects aimed at increasing interest for special technology sectors, like "ChoseIT" and "SuperMarit", have also been seen. The IT sector has been especially emphasised in order to attract more women to these studies.

6.2 The structural level

The structural level contains methods for gender-aware education, how work is organised and the social interaction between actors in school.

6.2.1. Compulsory school

The elementary school's leader gave a lot of support to the technology subject. The school has decided on two different methods Brainwaves and Skellefte-technology and the teachers have been educated in using them. The methods are different but both involve problem-solving. The Brainwaves is based on creativity and inventiveness, Skellefte-technology on distinct working frames and everyday technology. The Brainwaves presents a wide entrance to technology by combining the construction, use and design of an artifact, while challenging the imagination.

Skellefte-technology shows two important gender-inclusive contents. Working together in pairs, girls with girls and boys with boys, puts the girls outside the traditional gender hierarchy where boys are in charge and girls are subordinated. One of the teachers described the traditional gender roles in class by saying, *"If you have a strong girl and a weak boy, the girl dominates. But if you have two equivalent, girl and boy, the boy takes over . . ."*. By actively creating opportunities for other kinds of cooperation in school, traditions are challenged. The other gender-inclusive content is that the method allows the pupils to solve a problem in different ways. *"Here, in this subject, you may try out what you think, because here is no right or wrong. You're always right until you have tried and seen if it was right"*, one of the girls said. In this way, both process and product is valued.

The lower secondary school did not have a common strategy for the technology subject or for gender-inclusive work. So far, several

teachers set the same two tasks building a bridge and speakers. The time for technology has been reduced to a minimum since the other natural science subjects (NO) are a priority. The teachers were uncertain of the technology content and lacked material for technology education. Working in an inter-disciplinary fashion with social subjects (SO) has been tried out, but today the areas are separated. *"I think that the NO-subjects disappear in these projects. It is more SO . . ."*, one teacher said. Several teachers also express that technology is applied science and see technology as a support to the other natural science subjects, a view they do not share with the pupils. The school leader adopted a wait-and-see policy towards technology. Initiatives for changes would be taken as a positive sign, but laid in the hands of the teachers, he says. However, lack of time and consensus in content and methods prevented the teachers to move forward. This uncertainty at the structural level prevents technology from taking its proper place. To help out, the school leader needs to point out the direction and give commissions to develop the technology subject. Education for the teachers and setting aside time to discuss and interpret the subject are the first steps towards change.

6.2.2. Secondary school and technological universities

In the *entrance arena,* programme structure is shown. Upper secondary school has been reformed three times during the period. The first reformation united the Natural and Technology Programme, with the effect that interest in technology decreased. In 2000, the Technology Programme was back and gave possibilities for local courses and orientations. By mixing theoretical parts with practical,

which qualified as either university or labour work, and broadening the choice of subjects, more pupils could be expected. The interest among pupils increased, not least among the girls, who were attracted to design and architecture orientations. In 2011, the Technology Programme was reformed and got five national orientations. One of the motives of the government was a closer connection to technological universities. In the *classroom arena,* courses from different areas have been mixed with the new and problem-solving has been emphasised. Today's Technology Programme has pointed out interdisciplinary studies as an important goal. In the *boardroom arena,* upper secondary school is a part of the public administration or, if it is private, the board of the owner. Generally, other competencies than pedagogical have been seen as more important skills to attain a senior position, which does not seem to have attracted women. By the communalisation of school, the economical issue has been made a priority.

To recruit more women into technology and science, the government, with funds from the labour market sector, initiated several actions during a period of time at some universities, e.g., the basic year, quotas for allocation, SVUX and new programmes. The basic year invited pupils to study math, physics and chemistry to qualify for technology studies and encourage students, especially women, to develop an interest in technology. After the try-out, several universities continued to offer it. A quota for allocation was a successful action looking at numbers of female students. After the action period was over, the try-out disappeared and the male-female ratio was "back to normal". Economical support for elder students, SVUX, has been tried out with good results. Changing the names of

programmes in order to attract new student groups has also been tried out. Often, it has increased the interest for a while, but then returned to where it was from the start. Another tryout initiated by the universities has been new combinations of courses for attracting women, e.g., by adding biology to a programme in energy highly increased the number of students, especially women. Some years later, the interest for the programme reduced, but the new balance between men and women remained. Changing names and content are initiatives from the local universities. In the *classroom arena,* new methods have been initiated, sometimes locally and sometimes from a wider perspective. The CDIO is a global, but not evaluated, method for making engineering students more prepared for the engineering profession through more hands-on projects. Local inter-disciplinary projects like MTS invite students to solve a technology problem in a social context. By gender scrutinizing, the education is examined from a gender perspective and highlights situations that need to be changed. In the *boardroom arena,* some gender-aware actions have been initiated. Mainstreaming is one of them, e.g., courses taught using gender-inclusive methods or giving special positive treatment. One of the results of mainstreaming is that several universities have adopted gender equality policies. Career planning is another way that has been tried out to support women's academic careers. The recruitment to the boardroom is similar from upper secondary school where economic skills have a priority.

6.3. The individual level.

The individual level comprises self-confidence and self- opinion.

At the elementary school, teachers testified that the pupils, especially the girls, have developed a good self-consciousness in technology and in their ability to solve problems. Pupils are proud to invite their parents, showing them their and their classmates' inventions. One of the teachers said, *"Yesterday . . . one of the girls came up to the classroom together with her grandfather. She didn't just show her own things, but she showed her grandfather the other children's inventions and told him about them."* Since both methods that are used at the elementary school involve many and different skills, other subjects are improved, say the teachers.

The gender differences have been challenged by these methods, especially Skellefte-Technology, say the teachers. It allows you to approach a problem in different ways and therefore encourages them to find their own way. In the Brainwaves, more gender-marked inventions are made, e.g., boys prefer weapons and machines and girls prefer things for the kitchen or their dolls. One girl, however, summarised her view on girls' and boys' interests and abilities in technology with the words, *" Girls and boys are not that different, both are human."* Their thoughts about the future included a wide range of gender-neutral whishes, from astronaut and computer engineer to inventor and designer.

At the lower secondary school, the knowledge in technology did not seem to have developed skills in other subjects. Most of the pupils answered in the questionnaire that technology did not help them to understand other subjects more easily. This one teacher means depend on the lack of problem-solving tasks in school. *"Here the*

pupils are school-talented, they have understood the message. But you're not facing problem solving in school", she says. Technology at this school has not inspired pupils for a technical carrier. Only a small group of pupils said they intended to study at The Technology Programme in secondary school. They were all boys and have one or two engineers in the family.

What impact actions at higher school level have shown at the individual level is hard to measure from this material. Actions in the classroom arena mentioned above, e.g. CDIO-methods and inter-disciplinary projects, are aimed to challenge a broader group of students and by that give opportunity to use several individual talents. Moreover, actions in boardroom arena, e.g. career planning, is by its mission aimed to support individuals in their working life and therefore of big importance for each one being offered that opportunity.

7. Discussion

Although there are differences between school levels, structures and power systems, gender awareness is still a challenging issue. The power structure in schools is a mix of the balance between men and women, how they are distributed between subjects, teachers' academic positions and leader structure. The gender contract is maintained by segregation and hierarchy (Hirdman, 2003; Harding, 1986). We all agree to men's and women's equal opportunities but do not agree on the means. This thesis will highlight power structure

and how the gender system excludes girls and women from the technology field. It also highlights methods for including them.

In compulsory school, there are several factors that can prevent gender awareness in technology. First of all, it depends on the interpretation of the subject and how it is related to other subjects. The connection to science makes it more difficult to illuminate social aspects of technology. However, here, elementary school has an advantage in organisation with a more flexible schedule making inter-disciplinary studies much easier. The indistinct content of technology also allows technology being just applied science (Murphy, 2006; Faulkner, 2003; Nisbet et al., 1998). Today, the choice of technology textbooks is quite limited, which leaves many teachers and staff members making their own education material. Since most textbooks hardly challenge "the traditional technology content", this is a great opportunity for schools to develop both material and methods.

Secondly, the pervasion of gender awareness is a question of the low priority of developing technology and how it is educated that obstructs the development of the subject. The lack of available curriculum when technology was made a mandatory subject is one important sign (Elgström & Riis, 1990). The low priority in subject and education both have to do with money and what is offered. The fact that the profession of teaching math and science, including technology, has a low number of applicants to the Faculties of Education does not help the status of the subject. But an investment in teacher training in technology is an important way for teachers to

be offered both the tools and the time to discuss how education can be gender aware.

The last factor that prevents gender awareness considers the school leaders' vision and the hierarchy among the teaching staff. It takes a strong pedagogical leader to clarify that technology is important and gender awareness comes along with it. The teachers need that support in order to overcome power structures within the group. How important gender awareness and active support of gender-equal methods are is not clear to every school leader. It has to do with change of generations and your own understanding and consciousness of the gender issue. Further education in these matters is therefore a good investment.

At university and technological university colleges, the challenge looks different. The power system appears to be stronger at this level mainly because of the differences in status between teachers' profession the higher the academic level, the higher the status (Hirdman, 2003; Harding, 1986). A professor or tutor at a university is higher ranked than a teacher at an elementary school. For one thing, it reflects in their salary. There are also differences in status between technological subjects where some areas are seen as more male than others, and therefore ranked higher than others. These groups of male-dominated versus female-dominated technology areas create different study climates. Today's demands of the engineer, both being able to solve problems and work in a social context, also question the traditional technological education methods (Murphy, 2006; Nisbet et al., 1998) Among tutors, the

academic hierarchy has an impact on what you can develop within your subject and how gender aware you are allowed to be. Therefore, gender-aware methods must be decided in the *boardroom* and implemented by the professors and school leaders. Enthusiasts can be found in all schools, and they can achieve great progress for a period of time, but enthusiasm cannot build new structures by itself. Several schools have started the process, but gender awareness is an issue for every school, every tutor and every chancellor.

The new curricula in technology for compulsory schools, implemented in Fall 2011, addresses gender awareness, content of the subject and a multidisciplinary approach in more concrete terms (Skolverket, 2011a). How this will affect the pupils' attitudes, the teachers' opportunities and the school organisers' actions towards a gender-inclusive education is too soon to say, but it is certainly an important change to examine. This also goes for upper secondary school where new orientations are implemented and the curricula for technology now contain clearer wording concerning a gender perspective and tools to change traditional gender patterns (Skolverket, 2011b). Hopefully, these changes will affect the number of female students for technological education at university and university colleges. To what extent they do would be an important issue to look into. Finally, it would be of importance to evaluate efforts for gender inclusiveness in the *classroom* and the *boardroom*, both in compulsory school and university. Gender structures can be changed.

8. Contribution

This thesis discusses technology education from a gender theory perspective and highlights how the power system obstructs gender-aware actions. To reach further towards gender equality, the power system must be challenged.

The study in two compulsory schools confirms that the gender issue in technology education is known to everyone, some teachers and school leaders are more aware than others, but the methods for challenging this is not common knowledge. In the study a number of gender tools are highlighted. Together with actions in structure, gender awareness in education can be reached. By pointing out the three levels where gender appears, the unequal and weak areas become more visible. In the study of recruitment actions for higher technological education, action arenas are pointed out and organised. By connecting them to the three levels, the power system in technology education is exposed. The symbolic level has been in focus for many years of gendered actions in Swedish school politics. The individual level is dependent on changes at the structural level, so to get further, the structural level must be challenged.

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