KTH ROYAL INSTITUTE
OF TECHNOLOGY

Licentiate Thesis in Education and Communication in the Technological Sciences

The making of the engineering student

A study examining the societal and cultural production of the subject, the engineering student

PATRICIA KINGDON

Stockholm, Sweden 2022

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Abstract

This thesis makes a novel and original contribution to the discourse surrounding engineering education, and how it can be made more accessible to underrepresented groups. The study includes two contexts representing two different perspectives. Two studies are conducted, one examines upper secondary school pupils' views of engineering students and the other the societal and cultural production of the engineering student in a recruitment campaign for KTH Royal Institute of Technology. Few earlier studies have examined the messages communicated in initiatives aiming to increase and broaden the recruitment of underrepresented groups to technical universities. Still, many initiatives sharing this goal are initialised in Sweden. The theoretical framework applied by discourse analysis and governmentality analysis enables a critical examination of the discursive framework surrounding the engineering student. The thesis concludes that there is a power struggle between a discourse of a contemporary technologist and a traditional technologist and that this position is exclusively but only for the most advanced engineering students, excluding BSc students as communicated by a KTH recruitment campaign.

Keywords: Engineering education, recruitment to engineering education, broadening of the recruitment base to higher education, power and knowledge, underrepresented student groups at technical universities

Sammanfattning

Moderna samhällen förutsätter att människor är ansvariga för att göra val av olika slag, t.ex. val av utbildning och yrke. Dessutom förväntas yrkesvalet att överensstämma med individens självuppfattning. Detta gör att den sociala och kulturella produktionen som omger yrken och utbildningar är av betydelse för individens val. Denna uppsats syftar till att undersöka det diskursiva ramverket för som definierar ingenjörsstudenten i en rekryteringskontext. Ungas intresse och attityder till tekniska utbildningar är ett väl utforskat område. Detta gäller dock inte de budskap som kommunicerar med syfte att bredda rekryteringen till tekniska lärosäten. Denna uppsats och de ingående studierna kombinerar dessa forskningsområden på ett unikt sätt. Det teoretiska och metodiska tillvägagångsättet är inspirerat av diskursanalys och governmentalitesstudier, ett perspektiv som försett analysen med en kritisk blick som resulterat i att denna uppsats är ett originellt bidrag till diskursen som omger ingenjörsutbildningens tillgängliggörande för underrepresenterade studentgrupper. Detta kombineras med en praktisk metod som utvecklats specifikt för en av de två studierna som ingår i uppsatsen, studie ett vars fokus är på gymnasieungdomarnas uppfattningar om ingenjörsstudenter. I studie två undersöks de budskap som kommuniceras i en rekryteringskampanj för KTH. Den avslutande analysen visar att det pågår en diskursiv kamp mellan en diskurs av traditionell karaktär och en av nutida karaktär. Den traditionella som lyfts fram av gymnasieeleverna bygger på ett reduktionistiskt förhållningsätt och traditionella värden som personlig framgång (ekonomisk framgång och social status). Den nutida som lyfts fram i kampanjen bygger på ett holistiskt förhållningsätt och vikten av att bidra till en gynnsam samhällsutvecklingen för alla.

I teorin bjuder den senare in nya studentgrupper i högre grad. Intressant nog sker inte detta eftersom den nutida ingenjörsstudenten exkluderar alla studenter som inte är civilingenjörsstudenter på KTH Campus, vilket är det äldsta av KTH:s fem olika campus. Detta innebär att den breddning som sker endast är gällande för en liten skara individer, de bästa.

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Finally, to family and friends, thank you for your love and support, in particular my daughter Mimmi. You inspire me!

Stockholm, 2022
Patricia Kingdon

List of appended papers

Paper 1

Kingdon, P. (2013). The successful student. A study examining how young Swedish people represent engineering students discursively. In M. J. de Vries & I. B. Skogh (Eds.), *Technology teachers as researchers. philosophical and empirical technology education studies in Swedish Tuff research school* (pp. 199–222). Rotterdam: Sense Publishers.

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Paper 2

Kingdon, P. (2018) The cosmopolitan engineering student. An analysis of a recruitment campaign for KTH Royal Institute of Technology in Stockholm. *International journal of technology and design education*, 28, 787-802.

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Part I

1 Introduction

This thesis examines the societal and cultural production of 'the engineering student' in higher education (HE). In particular the values and attributes linked to the engineering student. Though focus in on the production of subjectivity this thesis makes a novel and original contribution to the discourse surrounding making engineering education more accessible to underrepresented groups.

The 21st century has seen increasing individualization and economic polarization, a development which has made individuals increasingly responsible for making choices, including choosing education and occupation (Beck, 1992; Bradley, 2016; Giddens, 1991). In this day and age, an occupational choice is not meaningful unless it is a good match with the notion of self, which is why how occupational/ educational choice is perceived is significant. Several factors influence our perceptions, e.g., personal experiences, milieu and worldview. Still, existing and past discourses set boundaries for what it is possible to say, and think, about a subject matter.

Beck (1992) argues that increasing individualization has caused bias and inequality in the education system to recced into the background. Thus, individual or group rejection of engineering education could be mistaken as a personal choice, when it is,

in reality, an effect of existing inequalities within the system. Examining the societal and cultural production of engineering education (HE) and engineering students deepens our understanding of the difficulties faced by technical universities as they strive to expand their recruitment of underrepresented groups to engineering education. Earlier studies of difficulties associated with recruiting underrepresented groups at technical universities have exposed that gender stereotyping and the pervasive nature of masculine culture in engineering have hindered the recruitment of women to engineering programmes (Archer, 2003; Archer & Hutchings, 2000; Archer et al., 2003; Berge et al., 2019; OECD, 2008; Powell et al., 2012). On the whole, women outnumber men in higher education in Sweden (SCB, 2015). With this in mind, the unbalanced gender representation at technical universities is an exception (Ottemo, 2015).

Engineering communities and government both strive to increase and broaden recruitment to educational programmes leading to careers in science and technology. A likely reason for government engaging in the call for engineers is a correlation between how many engineers the nation has and how well it does in the global economic race (EU, 2004; Krige, 2000; OECD, 2004; OEEC, 1960). According to the Swedish national committee, the technology delegation (in Swedish Teknikdelegationen) over 100 projects with the shared aim of increasing young people's interest in science and engineering were initiated, between 1991-2009, in Sweden(Bergström, 2009). The initiatives vary from small-scale projects, e.g., local projects, to projects with a specific target group, e.g., increasing the recruitment of female students or national reforms with

extensive funding. Whatever focus and degree of funding these initiatives had, they sprang from a shared concern in the Western world for young people's lack of interest in educational programmes leading towards careers in science and technology (EU, 2004; Osborne & Dillon, 2008).

Although this is a massive concern, few studies focused on examining the messages communicated in these initiatives have been conducted (Andrée & Hansson, 2014). However, according to a Norwegian study of first-year Science, Technology, Engineering & Mathematics (STEM) students, as many as 95 percent of the participating students say they visited websites of universities or colleges before making their choice, and 60 percent say that these sites inspired them (Schreiner et al., 2010). Therefore, I chose to explore the societal and cultural production of engineering students in a recruitment campaign for a technical university promulgated on the university website (Kingdon, 2018). One could, of course, question if university websites influence individuals' choice of education. What if those who visit a university website already have made their choice? Still, these websites are a location where the technical universities socially and culturally reproduce themselves.

1.1 Definitions

Hereafter follows a presentation of some concepts central for this thesis. Starting with the concept *the call for engineers*, which is first used in the article The Successful Engineering student (Kingdon, 2013). The term is a result of a need for a short term for *initiatives that share the aim to increase young people's interest in pursuing educational programmes leading towards careers in science and*

engineering. The term, introduced by me, includes recruitment initiatives, as well as the rationales behind these initiatives, i.e., thoughts regarding how young people are to be motivated to choose to study at a technical university.

A central concept in this thesis is *the subject*. In most cases, when not used when speaking of a school subject, the term is used in a Post- Foucauldian manner. Michel Foucault (1926-1984) 'who provided the starting point for discourse analysis's understanding of the subject' (Winther Jørgensen & Phillips, 2002, p. 14), holds that the subject is a bearer of the kind of knowledge that the discourse produces (Hall, 2001). Foucault (1983) explains the concept as follows:

> There are two meanings of the world subject: subject to someone else by control and dependence, and tied to his own identity by a conscience or self-knowledge. Both meanings suggest a form of power which subjugates and makes subject to (p. 212).

Furthermore, Foucault writes:

> This form of power applies itself to immediate everyday life which categories the individual, marks him by his own individuality, attaches him to his own identity, imposes a law of truth on him which he must recognize and which others have to recognize in him. (p. 212).

The time of publishing of the articles and the licentiate thesis varies from 2013- to 2022. During this time my knowledge of the theoretical approach has developed. An effect of this is that I use some terms differently in the articles and in the thesis. This has led to that I use the term: identity position and the term: subject in the articles, while in the thesis I use the term subject. Thus, be aware that when I use the term identity position it is applied, in the same way, as I later use the notion: the subject.

I also use different terms when speaking of engineering programmes in the articles and in the thesis. This is a result of a confusion on by behalf between the English term used in Sweden for what in an English-speaking context is called *Master of Science* (MSc) and *Bachelor of Science* (BSc). In Sweden the programme *civilingenjörsprogrammet* sometimes translates to Master of Science in Engineering and högskoleingenjörsprogrammet translates to Bachelor of Science in Engineering. The terms MSc and BSc are also used in the Swedish context. In addition, there are two-year programmes in engineering, in Sweden called Master's programmes. In an English educational context there are no such programmes, therefore I use the term MSc for these programmes. In the articles I use different variations of the term, but in thesis I comply strictly to English-speaking terms MSc and BSc.

1.2 Aims

This thesis aims to explore the societal and cultural production of the engineering student in HE. I argue that a critical examination of how the subject, in focus, the engineering student is rendered through discourse can contribute to new insights and deepen our understanding of how to make engineering education more accessible to underrepresented groups. The objective has been narrowed down to the following research questions

1. What ideas, values, dispositions and desires that shape the subjectivity of the engineering student
2. What discourses are involved in shaping the subject, the engineering student?
3. Who is 'invited' to study at a technical university as a result of the subject, the engineering student that is produced in the examined contexts?

1.3 The context of the study

This study is limited to a Swedish context. Nonetheless, the call for education of more engineers is a phenomenon shared by many nations (EU, 2004, 2005; OECD, 2008). Thus, this study is also of interest to readers beyond the Swedish context. The concern to increase the recruitment of underrepresented student groups is also a concern for HE in general, e.g., recruiting students with a family background where higher education is not the norm. Thus, this study is of interest also for readers outside STEM communities.

1.3.1 Overview of educational programmes at technical universities

The European Federation of National Engineering Association (FEANI, 2005) proposes four different levels of advancement in the engineering profession. The levels are 1) craftsmen, 2) engineering technicians, 3) professional application engineers, and 4) professional theoretical engineers. Technical universities in Sweden offer three main types of degree programmes, all of which are associated with advancement levels three and four.

The three-year-long Bachelor of Science programmes (BSc) come in several specializations in engineering aim to produce application-oriented engineers (level 3). The five-year-long Master of Science in engineering programmes (MSc) also come in several specializations in engineering aiming to produce theoretical-oriented engineers (level 4). In addition, many technical universities offer two-year-long MEng programmes. These programmes are for students with a BSc degree who wish to further their studies within a specific field. Generally, a MSc degree or a MEng degree is valued more highly. Also, engineers who hold an advanced degree on average have higher salaries than engineers that hold a BSc degree. In Sweden, there is a high demand for engineers on the labour market. Still the demand for application-oriented engineers has varied greater than the demand for theoretically- oriented engineers (Högskoleverket, 2002).

BSc programmes have a relatively short history in Sweden. They were introduced on a trial basis in 1989/90) and were initially of two years duration (Fagrell & Geschwind, 2020). However, they were rapidly revised to be three years in duration. KTH was one

of the first technical universities to offer BSc programmes. During the first few years places in these programmes grew from 1000 to 5500 (Högskoleverket, 2002).

BSc programmes have suffered from several problems since their introduction in Sweden. One problem is the low graduation rates (the lowest of all first cycle programmes (Bachelor level) in Swedish higher education (UKÄ, 2020). The National graduation rates for BSc programs was 45 percent in the academic year of 2020. Not much lower than national graduation rates for the MSc programmes, which in the same academic year was 52 percent (UKÄ, 2020)[1]. The graduation rate is higher among female students for both degree types[2]. Low graduation rates do not necessarily mean that those who have dropped out before taking out their degree do not work in the engineering field. As many as eighty percent of the students with more than 75 percent of the credits needed for a BSc degree, were established in the sector within a year of dropping out. The equivalent figure was 85 percent for students, with 75 percent of the credits needed for a degree in MSc (UKÄ, 2013).

[1] Degree frequency (percent) within nominal study time plus three years after the intended degree (vocational and other degrees). Beginners in vocational degree programs followed up to, including the academic year 2017/2018.

[2] According to a register study by The National Agency for Education (2002) the degree of examination was 37 percent for women and 33 percent for men after five years (Högskoleverket 2020).

1.3.2 Overview of upper secondary school in Sweden focusing on ways to qualify for further studies at technical university

In Sweden, the guiding principle for selecting students for higher education is based on upper secondary school grade point average (GPA), as well as National University Aptitude Test (NUAT) (Söderlind & Geschwind, 2017). In Sweden, upper secondary school is a voluntary school form. Still, 90-94 percent of all 16-19-year olds were enrolled in a year 10-12 programme in the Autumn of 2014 (SCB, 2015). Swedish upper secondary school has two main tracks, one leading to working life, the other to higher education (different upper secondary school programmes qualify the student for specific educational programmes in higher education).

There are several alternative ways for students to acquire the necessary pre-requisites to study at a technical university. The most common way is a degree from either the Natural Science Programme or the Technology Programme. Students can also acquire the necessary pre-requisites through adult education (Komvux). Twenty-one percent of all students entering HE in the academic year of 2014/15 did this (UKÄ, 2016b)[3]. In addition, several universities and colleges offer one-year-long bridging programmes (in Swedish Basår). Often, this alternative

[3] 14 percent of the beginners at college or university had completed their upper secondary school with municipal adult education (Komvux). Another 9 percent had studied only in municipal adult education (this alternative is only an option for those who are over 20 years old).

qualifies the student to enter an educational programme at the same technical university. The bridging programme is an alternative for those with an upper secondary degree from any of another specialisation than the ones specialising in Natural Science or Technology. Just over 70 percent of the 4750 students who commenced a bridging programme in 2012/13 continued to study engineering directly at technical universities or technical colleges UKÄ (2016a). Since 1993, it has been possible for higher education institutions to develop alternative procedures for admission. This alternative is scarce, in particular in technical universities. However, it has been used successfully in the Engineering Physics programme (Söderlind & Geschwind, 2017).

1.3.3 Overview of the Technology programme and the Natural Science programme in upper secondary school

As previously described, there are two educational programmes in upper secondary school that prepare individuals to further study at a technical university or college in Sweden. One is the Technology Programme, and the other is the Natural Science Programme. The Technology Programme was introduced in 1966. Up until 1993 pupils in this programme could choose to study three or four years. The 3rd provided a HE entry diploma, for further studies at technical university (Fröberg, 2010). The 4th year was preparatory to entering the workforce as a professional application-oriented engineer. An educational reform in 1992 changed the structure considerably. One of the main changes that emerged from this reform was the removal of the 4th year. Industry, professional and accrediting bodies were critical to the change (Vene, 2019) and in 2011 the 4th year was

reintroduced on trial, and in 2016 it was made permanent (Skolverket, 2014).

Another result of the 1992 reform was that the Technology Programme was transformed into a profile within the Natural Science Programme (also a three-yearlong programme). After two years pupils choose further studies in either Natural Sciences or Technology. Only 1/3 of the pupils choose to further study Technology Sciences (Fröberg, 2010). This percentage of students entering technology was not considered sufficient. Thus, to encourage more students and new groups of pupils, e.g., girls to take an interest in studying technology, a new programme, the Technology Programme was introduced in 2000 (Fröberg, 2010). The outcome was positive. The new Technology Programme (or the return of the technology programme) attracted more students than the previous profile within the Natural Science Programme. However, the Technology programme was not successful in recruiting girls, whose interest in studying technology dropped from 15,5 % (when technology was a profile in the Natural Science Programme) to 13,5 % (Fröberg, 2010, p. 169).

1.4 Study design

The study includes two contexts representing two different perspectives. The first study examines upper secondary school pupils' views of engineering students (Kingdon, 2013). The second study explores the societal and cultural production of the engineering student in a recruitment campaign for KTH Royal Institute of Technology (Kingdon, 2018)[4].

Both sub-studies focus on the production of the subject, the engineering student, and the discursive framework that renders the social and cultural production of engineering knowledge and engineering education. The guiding theorization is the same in both sub-studies, while the design differs. The sub-studies are presented separately in the articles included in this thesis and as a synthesis in the results section.

1.5 Reflections on my role as a researcher

When I joined the graduate school Technology Education for the Future (in Swedish: Teknikutbildning för framtiden) in 2009 one of the first things that crossed my mind was that one of the more frequent topics, at conferences, in papers and in oral discussions was how STEM-subjects in compulsory school should contribute to motivating young people to become interested in further careers as engineers and scientists. This made me ask: Why is it that STEM subjects, especially the school subject Technology are treated as a pipeline for directing

[4] The studies presented in this thesis were performed between the years 2010-2018 in Sweden

young people into educational programmes leading towards careers in engineering? Why are the learning outcomes not in focus as well as how pupils are to reach these goals? Compare, for example, with the social sciences, how often do we hear that social sciences are expected to contribute towards making young people interested in becoming scientists in the Social Sciences or politicians? Or how often do we hear that physical education is to help towards developing more athletes?

I found that I was not the only one asking why STEM- subjects had become viewed as a means to increase the production of engineers and scientists. Osborne and Dillon (2008) conclude that school science has suffered from being treated as a pipeline for bringing forward future scientists. They argue that

> '…the goal of science education must be, first and foremost, to offer an education that develops students' understanding both of the canon of scientific knowledge and of how science functions'(Osborne & Dillon, 2008, p. 7).

Their position on the role of the curriculum is in stark contrast to the objectives defined for the Technology Delegation, appointed by the Swedish government in 2008. They were explicitly commissioned to 1)investigate how the recruitment of pupils, especially girls, to the specialization in Natural Science in

Swedish upper secondary school could be improved[5], and 2) launch a recruitment campaign to increase the number of pupils in that specialization. I find this approach both uncritical and naive. Instead, I propose to investigate the societal and cultural production within science intense educational programmes, as well as in engineering education in HE. Such investigations are likely to deepen our understanding of the recruitment difficulties. My choice of subject matter is also influenced by my background in media and communications studies (upper secondary school). In addition to my teaching degree and experience in teaching media subjects in upper secondary school, I have a degree in media and communication/culture studies. As a non-engineer, I have not been subjected to the engineering position myself. Nor have I 'invested' three to five years in studying to become an engineer. This, I believe is an advantage when it comes to performing a study of norms regarding engineering students and engineering education for the reason that I have not been subjected to the norms that are explored in this study.

[5] The Natural Science specialization was chosen for the reason that it is the specialization that brings forward the highest numbers of students to science-intensive educational programmes.

2 Prior research

2.1 Students' interest in science and engineering

A primary concern of research focusing on science education has been to examine factors influencing young people's interest in science and technology. However, several studies confirm that interest and/or attitude is but one of many factors influence vocational choices. For example, several studies show that vocational choices are expressions of identity (Beck, 1992; Bøe et al., 2011; Eccles, 2009; Giddens, 1991; Osborne et al., 2003; Schreiner, 2006; Schreiner & Sjøberg, 2007; Ziehe & Stubenrauch, 1984). Ulriksen et al. (2010) observe that identity is also a known factor for determining if enrolled students succeed or not in higher education. This is in particular valid for STEM studies where research has highlighted the importance of identifying as a 'science person' to succeed. The International Relevance of Science Education survey (ROSE) shows that even if young people have a positive attitude towards science and engineering this is not enough for them to choose to study either science or technology (Schreiner, 2006). Eccles' research (2009) examining students' choice of specific major shows that a student needs to be confident of their ability to do well in the courses required and believe that majoring in science is personally more valuable for them than majoring in something else. Dick and Rallis (1991) argue that two factors are highly influential when individuals make vocational choices, 1) the individual beliefs about themselves, and 2) the individual's beliefs and values regarding different careers. This is also confirmed by Eccles (2009), who concludes that aptitudes,

cultural milieu, past experiences and socialized attitudes influence the beholder's beliefs.

Schreiner's (2006) analysis of the ROSE survey results shows that young people in Norway highly value self-realisation and self-development, e.g., they want their future occupation to interest them and be meaningful to them. The same study shows two groups of 15-year-olds who might consider studying STEM-subjects although, science is not their favourite school subject. Schreiner terms these groups *selective boys* and *selective girls*. The selective boy expresses that he much rather works with technology than with humans. He believes society benefits from science, but he is not engaged in environmental issues, nor is he particularly interested in shaping a fit body. The selective girl expresses an interest in medical research but does not believe in further technological development. She is engaged in environmental issues, and wants to work with humans. She does not particularly want to become a scientist. The selective girl is also interested in shaping a fit body, and she values self-realisation (Schreiner, 2006). These results are similar to those of Dunteman et al. (1979) who defined people as thing-oriented or person-oriented. Thing-oriented individuals are interested in manipulating and understanding objects in the physical world (cf. selective boys), and person-oriented individuals are interested in understanding human interaction and helping people (cf. selective girls). The same study also shows that among the categories: students in non-science, students in social science, and science students, engineering students were the most thing-oriented and female students were person-oriented to a higher degree than male students (Dunteman et al., 1979; Eccles, 2009; Schreiner, 2006).

2.2 Messages in recruitment activities

Berge, Silvfer and Danielsson (2019) examine engineering students' characteristics as they are presented on several technical university websites. They identify four identity positions (themes) in the data. These are 1) the traditional technologist, 2) the contemporary engineer, 3) the responsible engineer, and 4) the self-made engineer. These positions are either produced within one societal discourse or an intersection of several societal discourses; 1) technological progression, 2) sustainability, and 3) neoliberal ideals. The discourse renders the identity position of the engineer (the engineer to be, the engineering student). For example, within the discourse of technological progression the engineer's ability to contribute to this progression is seen as a foundation for the development of society (Berge et al., 2019). This narrative is by no means new. Nye (2004) gives several examples of how technical skill and mechanical power are claimed to be a means to improve the level of civilization in society in his book *America as Second Creation*. Berge et al. (2019) describe the identity position of the traditional technologist (produced within the discourse of technological progression) as an individual who is interested in solving technical problems and design (cf. the selective boy). They also find two types of traditional technologist positions in the data, one associated with (masculinised) practical skills and another with theoretical-oriented skills.

The practical-oriented identity position is associated with BSc students to a higher degree, whereas the theoretically skilled identity position, is associated with MSc students. The identity of a contemporary technologist (also produced within the discourse of the technological progression) is a construct that

emphasises generic skills and social aspects of engineering, e.g., communication skills and creativity. However, the authors only find a few examples in their data to support this. This way of speaking is more or less restricted to general information on websites. In comparison, the identity position, the self-made engineering student/engineer, associated with an individual who has the 'right' attitude, an attitude of strength and desire, is well-represented in interviews and texts produced by students. The identity position of the self-made engineer is a bearer of the rationales, also seen in the discourse regarding the entrepreneurial self, that uphold that every individual is responsible for making themselves attractive to the job market (Berge et al., 2019). The sustainability discourse promulgates a view that engineers are the key to solving sustainability problems. However, only few examples where students 'confess' to such identity position are found in their data. Interestingly, they find no problematization of continuous technological progression from a sustainability perspective. Furthermore, they conclude that the websites produce an identity position, in line with a young person who is both sporty and socially active without putting their education at risk.

Women are represented to a higher degree than men on the examined websites, in comparison to statistics on gender representation at the universities. This Berge et al. (2019) suggest is intended to communicate that women and students are both capable and welcome to study engineering. Two of four universities apply the same method when representing students with a non-Swedish background (Berge et al., 2019).

Andrée and Hansson (2013) present a discourse study of the messages communicated in the Swedish recruitment campaign

'Den breda linjen' [The Broad Line], the campaign ran between 2009-2010. The aim was to increase the recruitment of pupils to the Swedish Natural Science programme in upper secondary school. Andrée and Hansson identify four broad sets of messages in the campaign communicating why the Natural Science programme is desirable. The messages are:

1. It leads to formal qualifications, which give young people access to further education and careers.
2. It is associated with success (being successful/not being excluded from desirable communities)
3. It enables young people to develop particular competencies.
4. Science is fun, and therefore the programme is desirable (Andrée & Hansson, 2013).

Next, Andrée and Hansson scrutinize these messages in the light of an expectancy-value model proposed by Eccles in 1983. Eccles' model is a result of empirical studies on four key values that predict students' choices of science-intensive education.

The key values are:

1. Interest-enjoyment values- students' interest in the subject and enjoyment, e.g., to that extent students' experience enjoyment when participating in science education.
2. Attainment values- to what extent science education is in line with the students' identities (beliefs, personal values, desires and goals).
3. Utility value- to what degree the choice enables the student to reach other goals such a future education or occupation (fewer personal goals).
4. Relative cost- negative consequences of a specific choice relative to other possible choices, e.g., risk of failure, or fear of social consequences (Andrée & Hansson, 2013).

Two dominating values were identified A) *formal qualifications* and B) *success*. Message A is associated with a high attainment value without establishing relations to the field of science, which communicates that no particular interest in science is required for a student to choose a science-intensive education. Instead, the message focus is on the doors that the formal qualifications gained from pursuing the Natural Science programme open. Message B builds on attainment value and relative cost. This combination of these two messages communicates that the Natural Science programme protects the individual from failure and exclusion in the future. Paraphrasing (Popkewitz, 2004) any recruitment attempt, as any pedagogical model, fabricates desirable and undesirable subjects.

With this in mind, they suggest that one student might experience inclusion, whereas the other experiences marginalisation and/or exclusion (Andrée & Hansson, 2013). In the light of this they suggest that the communicated messages construct a subject that invites per se. 'thing-oriented students' (Dunteman et al., 1979) or 'selective boys', and that this might exclude 'person-oriented students' (Andrée & Hansson, 2013).

2.3 Gender representation at technical universities in Sweden

Women comprised 32 percent of the cohort of all students admitted to MSc programmes in the academic year of 2014/2015. The corresponding figure for the BSc programmes was 26 percent (UKÄ, 2015). When comparing these figures for all beginners it is obvious that engineering programmes are male- dominated. In the same academic year, 57 percent of university entrants were women (UKÄ, 2015). Several studies concerned with gender representation in engineering education (HE) argue that the unbalanced gender at technical universities endures due to a symbolic association between masculinity and technology (Berner, 2003, 2004; Dakers et al., 2009; Faulkner, 2000, 2001, 2007; Mellström, 1999; Wajcman, 1991). Layton (1993) observes that women have been restricted to the role of a user or a consumer, while men have monopolised design, decision making, and development. Faulkner (2001) argues that the continued male dominance of engineering is due in large measure, to the enduring symbolic association of masculinity and technology by which cultural images and representation of technology converge with prevailing images of masculinity and power.

For example, the engineering identity has a strong sense of nuts and bolts, although engineering work rarely has this character (Faulkner, 2007). In addition, the prevailing image of the geeky engineer/student is a strongly limited and excluding of women (Margolis & Fisher, 2002; Ottemo, 2015). Cockburn (1996)argues that what women know has not been acknowledged for knowledge of technology, e.g., household technology.

According to Salminen Karlsson (2003), the unbalanced gender representation at technical universities and colleges in Sweden was not perceived as a problem until the early 1980s. She argues that the increasing interest in increasing the number of women and the recruitment activities to follow targeting women correlated with an increase in student places at technical universities and colleges were experiencing difficulties filling these places. Salminen Karlsson (2003) observes that the recruitment initiatives targeting women in the 80s reloaded heavily on an inherent assumption that women would change their preferences if only they received the correct information. Henwood (1996) critiques this assumption and argues that women make conscious decisions when joining or rejecting a technology education. Ottemo's (2008) report on gender patterns in engineering, computer science, IT and automation and mechatronics and electrical engineering (the EDITS-area) at Chalmers technical university concludes that outside of lessons, a wide range of activities occurs, i.e., student rituals that promote the identity of intellectual masculinity. Ottemo (2008) argues that these rituals not only exclude women. They also exclude men who reject this kind of masculinity.

2.3.1 The hard/soft dichotomy and holistic vs. reductionist approaches to problem solving.

An example of how technology has been, and still is, differentiated as either male or female is the usage of the hard/soft dichotomy. According to Faulkner (2001) inert and powerful technology is associated with the 'hard' side of the hard/soft dichotomy. While smaller-scale technology, e.g., kitchen appliances and organic technology, is associated with the 'soft' side. Faulkner (2000) argues that the hard/soft dichotomy also differentiates learning processes as either female or male, e.g., abstract theoretical and reductionist approaches to problem-solving are associated with the 'hard' side (male). According to Ottemo (2015), the reductionist approach dominates in engineering education. In reference to two studies of technology education by Kimbell et al. (1996) and Murphy, both in school context, Faulkner notes that girls demonstrate an emotional connectedness together, with concrete empirical and holistic approaches when problem-solving (deep-understanding). While boys demonstrate reductionist approaches to a higher degree than girls, especially when doing mathematical problem-solving (Faulkner, 2000).

Faulkner (2000) argues that the deep understanding approach applied by girls to a higher degree is mistaken for a lack of confidence or ability. Sjögren's (2011) study of engineers working in four organizations in information and communication technology (ICT) in Sweden shows that the hard/soft dichotomy also is applied in working life when engineers value their colleagues' competencies. Soft competencies are valued less than hard competencies. In the study male engineering colleagues' competencies are associated

with the hard competencies to a higher degree than female engineering colleagues' competencies (Sjögren, 2011). Again, we see a relationship between power, technology and gender.

3 Theoretical framework

The analysis in this thesis draws on discourse analysis and governmentality analysis. Together with earlier research, this theoretical framework enables the analyst to explore how a discourse functions, including the different modes by which human beings transform themselves into subjects (Foucault, 1983; Olsson, 1997). Governmentality analysis developed in the wake of discourse analysis. Generally, governmentality studies explore liberal mentalities of governing (ideas on how to govern, and is often employed in studies examining the politics of representation. Both perspectives are relevant when exploring the shaping of the subject, the engineering student and the discursive framework that renders the subject, including exploring possible effects regarding who is 'invited' to study engineering in HE and who is not.

3.1 Discourse analysis

Discourse research developed in the 1980s and is today applied in a wide range of research disciplines (Wetherell, 2001), including engineering education research (Case & Light, 2011). Discourse studies deal with how discourses are organised over time, focusing on activities, phenomena, and power relations within the meaning production (Wetherell, 2001).

A discourse is never one statement or only one text. Hall (2001) explains this as follows:

> The same discourse, characteristic of the way of thinking or the state of knowledge at any one time (what Foucault called the episteme) will appear across a range of texts and form a conduct, at a number of institutional sites within society (p.73).

Foucault's (1993) view was that the discourse governs how a topic, a phenomenon, can be talked about and still be meaningful. It also regulates who can say what and with what authority. Winther Jørgensen and Philips (2002) provide the following explanation:

> The starting point is that although we have, in principle, an infinite number of ways to formulate statements, the statements that are produced within a specific domain are rather similar and repetitive. There are innumerable statements that are never uttered, and would never be accepted as meaningful. The historical rules of the particular discourse delimit what is possible to say (p. 13).

Foucault's (2010) point was that meaning is found in the actual knowledge- and meaning-production- not in the object or the entity. Consequently, there is no autonomous, conscious, stable entity to uncover. Quite the reverse, the focus is on exploring the conditions (set in advance) that the subject has to fulfil to become part of the current discourse. Consequently, the focus of discourse analysis is to explore what the discourse 'does', and how it 'functions' (Olsson, 1997). Winther Jørgensen and Phillips (2002) present discourse analysis as a process where 'the analyst has to work with what has been said or written, exploring patterns, and identifying social consequences of different discursive representations of reality' (p. 21). The outcome of the analysis is a description of the surfaces of events, pertinent details, minor shifts, and subtle contours (Dreyfus & Rabinow, 1983)[6]. The analyst does this by getting to know the history and organization of the cultural practices in focus. This is necessary as the meaning production takes place within the discourse.

[6] The discourse method can be archaeological or genealogical, or both. The archaeological analysis is diagnostic whereas the genealogical analysis seeks to make the meaning-making visible from afar (Dreyfus and Rabinow, 1982). It 'seeks the surfaces of events, small details, minor shifts, and subtle contours' (Dreyfus and Rabinow, 1982, p 106).

3.2 Governmentality analysis

Mitchell Dean (2010) who has been influential in developing governmentality studies, defines government as follows:

> Government is any more or less calculated and rational activity, undertaken by authorities and agencies, employing a variety of techniques and forms of knowledge, that seeks shape conduct by working through the desires, aspirations, interests and beliefs of various actors, for definite but shifting ends and with a diverse set of relatively unpredictable consequences, effects and outcomes (p. 18).

Nicolas Rose (1999), another influential researcher and developer of governmentality studies suggest that government 'also embraces the ways in which one might be urged and educated to bridle one's own passions, to control one's own instincts, or govern oneself' (p. 3). In the early nineteenth century, government and governing took on new forms in response to increased personal freedom and industrial agency. It was no longer possible to direct citizens with discipline and punishment. The new rationalities– liberalism (not to be confused with a political ideology) involves a cautious, delicate, economical, modest way to govern (Rose, 1996).

The starting point for the governmentality perspective is a lecture by Foucault, held in the late 1970s at Collège de France as part of the course on 'Security, Territory and Population'

(Foucault, 2000). Since then, governmentality has developed into a perspective that involves analysis of the government, of ourselves, the government of others, and the government of the state (Fejes & Dahlstedt, 2013). Joseph (2010) states that 'governmentality raises the issue of how institutions and practices behave and how they come to work in the way they do' (p. 223). This includes the meaning-making of 'the discourse framework that renders their practices meaningful through the construction of particular (or subjects)' (Joseph, 2010, p. 223). Rose (1999) again, on the role of the analysis:

> '…their role is diagnostic rather than descriptive: they seek an open a critical relation to strategies for governing, attentive to the presuppositions, their assumptions, their exclusions, their naiveties and their knaveries, their regimes of visions and their spots of blindness' (Rose, 1999, p. 19).

Dean (2010) sums it up with the words:

> To analyse government is to analyse those practices that try and shape, sculpt, mobilise and work through the choices, desires, aspirations, needs, wants and lifestyles of individuals and groups. This is a perspective, that seeks to connect questions of government, politics and administration of the space of bodies, lives, selves and persons (p. 20).

3.2.1 Cosmopolitanism and unfinished cosmopolitanism

A source of inspiration for this thesis is Thomas Popkewitz, Ulf Olsson, and Kenneth Peterson's research regarding the shaping of subjects within the educational practice. A central concept in Popkewitz's research is the notion of cosmopolitanism and its double gesture of inclusion and exclusion. Inspired by Popkewitz, I use the notion as a critical tool to enable a discussion regarding the effects of the societal and cultural production of engineering education and engineering students.

Cosmopolitanism entered into contemporary sociology, philosophy, and education at the turn of the twentieth century (Popkewitz, 2008). A cosmopolitan is a socialized individual who embodies the national exceptional (Popkewitz, 2003). The rationale entered the field of pedagogy, transforming into a 'converting ordinance' linking individual self-realization to collective belonging[7]. In the 21st century, the concept of lifelong learning entered the field of pedagogy. Lifelong learning assumes that all individuals need to be, prepared for a world in constant flux and a future where change is a ubiquitous feature of contemporary life, and therefore learning can never cease. Yet again, the educational system is responsible for transforming individuals (Hultqvist, 2006; Petersson et al., 2007; Petersson et al., 2006). This induced Popkewitz (2008) to introduce the term 'the unfinished cosmopolitan', which he describes as follows:

[7] For example, the Swedish reform folkhemmet in the 1930 and 1940s (Popkewitz, 2008).

> Today's cosmopolitanism, I argue is spoken about in universal term of a lifelong learner who acts as the global citizen. I call this cosmopolitanism unfinished in the sense that life is continually in process and innovation through choices, with no end point in sight (p. 112).

Moreover, Popkewitz argues that all forms of cosmopolitanism expose an embedded fear of 'the child' who could be potentially dangerous in the future (unless the child transforms into a cosmopolitan citizen). This fear takes the form of the delinquent child, the savage, and the barbarian (Popkewitz, 2003; Popkewitz, 2008). Popkewitz et al. (2006) argue that today's savages, are those at risk of falling behind, those in need of help, e.g., ethnic and racial groups, who are marginalized. The autonomous cosmopolitan of today is responsible for developing a personal lifestyle in line with rationalises, and for creating an environment supportive of learning and the security and health of everybody (Popkewitz et al., 2006). This narrative embodies the ability to problem-solve, chase desires and work in a global world where there is no finishing line (Popkewitz et al., 2006).

4 Method

The analysis in thesis explores different ways in which engineering students are classified, categorised and shaped into the subject position, the engineering student.

A diversity of practices (some on an institutional level) constitute the subject. The transformation of human beings into subjects would not be possible unless humans actively transform themselves. This process is e.g., seen in the texts produced by students, and published in the recruitment campaign KTH from the Inside. Paraphrasing Foucault, the students, in these *confess* to different discourses. Whereas, the data in the study of upper secondary school pupils' views consists of a vast number of statements that signify different ways in which engineering students are classified, and categorised, thus what they are subjected to.

Inspired by the diagnostic feature of the governmentality perceptive, this study seeks to connect the meaning production in the empirical material of this study, in relation, to the rationalities (the surrounding discourse) used in the call for engineers– the strive to direct youth choice of education and occupation towards careers in science and engineering. The governmentality perspective provides the analysis undertaken with the necessary intellectual focus to examine how specific norms and ideas are brought forward as standards (regimes of truth) that shape the subject, the engineering student.

5 Summary of papers

Summary of Paper 1

The Successful Student: a study examining how young Swedish people represent engineering students discursively.

(Published in Skogh, Inga-Britt & De Vries, Marc J. (Eds.), *Technology Teachers as Researchers, Philosophical and Empirical Technology Education Studies in The Swedish TUFF Research School Series*: International Technology Education Studies, (pp. 199-221). Rotterdam: Sense Publishers).

5.1 Objective

This study examines upper secondary school pupils' views of engineering students. In focus is the subject, the engineering student that is produced as a result of the discourse(s) that are (re)produced by upper secondary school pupils as they share their views.

5.2 The design of the study

To explore this area, I conducted an empirical study framed as a mind-mapping exercise using coloured post-it notes and timed tasks to encourage individual reflection and group discussions.

114 participants[8] upper secondary school pupils from three upper secondary schools, and six school classes participated in the study, two classes from the Natural Sciences programme, two classes from Social Sciences Programme (both classes specialized in Economy) and two classes from the Technology programme (one was specialising in IT, the other in Urban planning).

The three schools were all located in the same town, a municipality with 100 000 inhabitants and a university/college that offers several programmes in engineering. The study conducted in the academic year of 2009/2010[9] included six school were made in order to collect the data (one for each of the six classes that participated in the study). The data was collected according to the Swedish Research council's ethical recommendations (Vetenskapsrådet, 2017).

All of the six school visits followed the same pattern. Starting with me asking the pupils to form groups of three to four pupils. For the first ten minutes, the participants wrote remarks on post-it notes individually. The post-it notes had four different colours. The colours separated four different categories (topics) of questions/statements.

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[8] The gender representation was 66 males and 48 females.
[9] The same academic year, this age groups interest to further studies in HE was 3-4 percent lower in this region compared the national average of 58 percent (SCB. (2010). Temarapport 2010:2.

The categories were:

1. Traits associated with engineering students' personalities
2. Knowledge and skills associated with engineering students
3. Views about the engineering education
4. Views about the engineering occupation

After the ten minutes of individual work, I asked the pupils to stick their post-it notes on a large piece of paper (poster-size). Each group has one poster. In the subsequent 15 minutes, each group discussed the remarks. The pupils were given red stickers to stick on notes that held a statement they disagreed with (they could use as many red stickers as they wanted). No sticker meant they agreed with the statement on the note. The whole activity took about 40 minutes. On each occasion, I recorded three of the four group discussions. The purpose of the recordings made was to make it possible for me to check if the participants shared something which could enrich my understanding of the statements made on the notes. This proved not to be the case thus they were not included in the analysis.

In total, the study generated 1200 remarks made on post-it notes, 123 red stickers (to show disagreement), and 18 recordings of group discussions. The analytic process involved several steps. The guiding principle was to organise the statements according to the same line of thought, e.g., smart, intelligent, knowledgeable, knows a lot, etc. In the sorting process, new categories and sub-categories took form. Next, the themes were scrutinised through the eyes of the theoretical perspective of this study.

5.3 Selected results

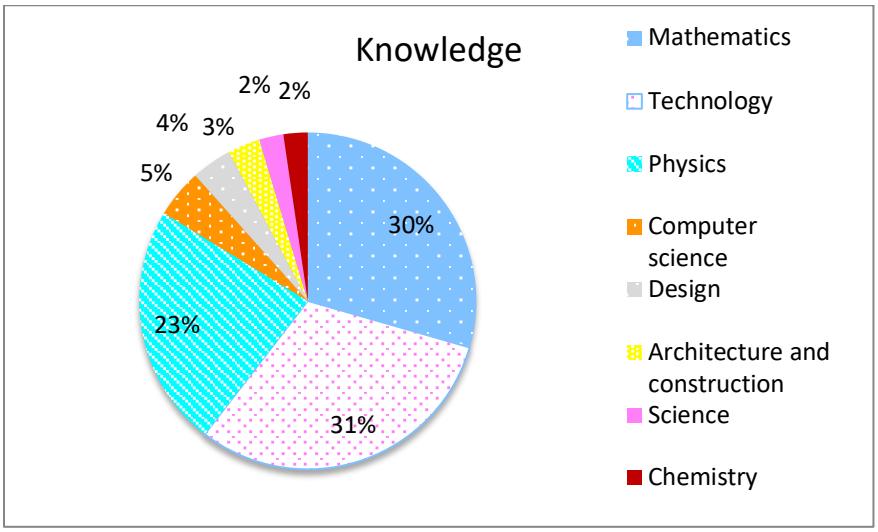
The analysis revealed four themes, 1) Interest and knowledge, 2) Learning, 3) The Engineering profession and 4) Attitude. Here, when presenting a summary, I use only percent. I do this to give an idea of how strong the support is for a statement or theme (similar statements). The full results of study one are to be found in the paper 1: The Successful Student (Kingdon, 2013).

5.3.1 Interest and knowledge

- 42 percent of 114 participants suggested, or agreed with a remark that described engineering students as intelligent or smart.
- 11 percent of 114 participants designated engineering students as knowledgeable.
- 7 percent of 114 participants said that engineering students are interested in technology.

The participants' views on what engineering students know is shown in Figure 1.

Figure 1: Perceptions of engineering students' knowledge.



As seen in the figure the participants demonstrated a strong association with the subjects: Mathematics (30%), Technology (31%), Physics (23%). Chemistry (2 %), Architecture and Construction (3%) and Computer Science (5%) are acknowledged, but clearly do not receive the same strong support as Mathematics, Technology, or Physics.

5.3.2 Learning

The analysis of the data shows a strong support for engineering students being good at learning. 82 percent of the 114 participants support a statement suggesting that engineering students are industrious active students, organised, focused, accurate, disciplined, autonomous, future or goal-oriented, and have the stamina to study a lot. In summary, all of the remarks in this category are aligned with the description of a self-

managed individual. This result reinforces a view shared by 44 percent of the participants, who either suggest or support a remark saying that studying at a technical university is demanding, which is reflected in the data by statements suggesting that when studying at a technical university you need to: study a lot to study a lot. The words: tough, demanding, hard and difficult are used to describe engineering education. In addition, 24 percent of the participants say or support remarks saying that studying at a technical university is stressful and time consuming. 5 percent suggest that those who study engineering learn easily. 11 percent of the participants suggest that engineering students are creative, which in this context is expressed in terms of, good at learning new things, or using what they know in new ways.

5.3.3 The engineering profession

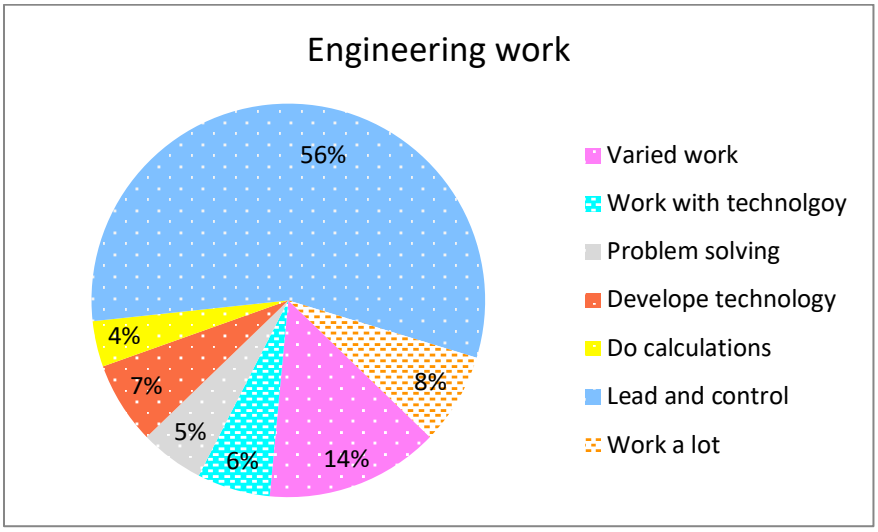
There is strong support among the participants for statements suggesting that the engineering profession leads to high status (societal and financial). 75 percent of the participants suggest engineers are well-paid, 4 percent say that engineers' starting-wage is good, 16 percent of the participants support a remark suggesting that engineers are successful, have a high status. In this category, I have also sorted statements suggesting that engineers are upper class, have a nice car, big house, and a good-looking wife[10] (these remarks were few in number). Also, 4

[10] The statement good- looking wife, was but one statement which was gendered, a statement that assumes that the engineer is male, if we agree on that today's society is based on heteronormativity.

percent of the participants use the word nice, 7 percent use the term smug when speaking of engineers. These remarks imply that pupils view engineers as having a high societal status.

What engineers do is perceived in a variety of way in these results. The participants also believe that engineers are likely to be in leading positions or that their work is such. The pupils' perceptions of engineering work are shown in Figure 2 below.

Figure 2: Perceptions of what is involved in engineering work.



5.3.4 Attitude

Only 10 percent of the participants suggested that studying at technical university is boring. The positive remarks were supported by 18 percent of the participants. These remarks came in two versions; 8 percent agreed that studying at technical university is fun, and 10 percent said that it is interesting. From this, it is clear that the participants were positive to a higher

degree. Considering that two school classes were from the Natural Science programme and another two were from the Technology programme it seems rights that the support for a positive attitude was stronger. Still these remarks were few in number.

5.4 Concluding discussion

The participants support a line of thought that suggests that studying towards a career in science and engineering is a 'ticket' to high social status. Though engineering education is associated with personal success, there is the risk of failing. In summary, to not risk failing as an engineering student, you need to master and have a desire to

- be good at mathematics, technology, and physics
- be self-managed and an autonomous subject
- be ambitious/ industrious and motivated
- have a desire to be successful

These results emphasise that engineering students are smart and knowledgeable, and the linkage to the school subjects: mathematics, physics and technology, together with the high support for engineering education being especially difficult and demanding supports a perception that engineering education is best, left to 'top–notch' students.

Summary of Paper 2

The cosmopolitan engineering student: an analysis of a recruitment campaign for KTH Royal Institute of Technology in Stockholm

(Published in *International Journal Technology Design Education* 28 (3), 787–802 (2018).

5.5 Objective

The aim of sub-study two is to examine values and attributes communicated by a campaign designed to recruit students to engineering education. Focus is on examining what kind of knowledge subjugates the engineering student.

I have chosen to examine the recruitment campaign, KTH from the Inside. Recruitment campaigns are suitable objects to explore because they are an arena for examining how technical universities societally and culturally reproduce themselves.

5.6 Study context

The recruitment campaign, KTH from the Inside, ran Jan- May of 2009 on the Web. The campaign focused on KTH students and their student projects, following a competition between twelve student projects. The campaign had two phases. I first phase involved an invitation to the viewers to vote on the best project. The second phase of the campaign starts as the three projects that received the most votes are presented, and from this point, the campaign follows these projects and the students behind them more closely, e.g., interviews with the students

managing the projects, blog posts written, or filmed blog posts (vlogs) by the students responsible for the projects.

5.7 Study design

A discourse analytical study of the campaign was conducted shifting between the campaign material and relevant theoretical perspectives. The empirical data compromised texts, images and films that were part of the recruitment campaign. Analysis was performed by a process which re-visits the primary data several times to ensure reliability. The analytical focus is on looking for continuities and discontinuities in the empirical data. The computer software QSR NVivo was used to organise the data and to highlight themes that unfolded in the process.

5.8 Selected results

Four main themes unfolded in the analytic process. 1) Expertise and tradition, 2) The life-long learner, 3) Making the future better for humanity and 4) A break with cultural and historical gender patterns.

5.8.1 Expertise and tradition

KTH has five different campuses but only the main KTH campus, in the centre of Stockholm is visible in the campaign. Eleven of the twelve projects in the campaign are managed by MSc students studying at the main KTH campus. The one exception is a project ran by BSc students at the School of Architecture which at the time of the study was an independent campus located in the centre of Stockholm (since then School of

Architecture has moved to the main KTH campus). This project was only involved in the first phase of the campaign. The higher status associated with advanced students emphasise that KTH is a university that excludes all but the most advanced students. By focusing on expertise and tradition (the main campus is the oldest campus) the campaign tells a story suggesting that KTH is university that develops high level expertise in the engineering field. The narrative of an elite university excludes all but the most advanced students from the narrative. In this case excluding students at BSc programmes, or those studying at KTH campuses in the suburbs. Ottemo (2008) argues that technical universities today are torn between wanting to broaden their recruitment base and being perceived only as an education for those who are committed to study. From what we see in the campaign, KTH from the Inside, KTH appears to only be interested in recruiting the most advanced students.

5.8.2 The lifelong learner

A recurring theme in the campaign is learning, i.e. in blog posts, the participating students write about how and when they learn. They also write about what they do when they find it hard to study. The message communicated is that engineering students are self-managed and self-disciplined individuals who embrace the notion of lifelong learning in all their activities, including activities in the future. In interviews with participating students, some say that the ideal job is a job that provides them with opportunities to learn, especially in a field in line with their interests. A student studying vehicle engineering, and also interested in sailing, says that the ideal job would be in the shipping industry. This student is also involved in a project

where he is part of a larger group of students developing an electrical water scooter. The examples above are expressions of a belief in an economic capitalization of the self- ceaselessly retraining, skilling and reskilling (Rose, 1999), a continuous event of planning, a never-ending process of making choices, innovation and collaboration (Popkewitz, 2008). This is why Popkewitz use the word 'unfinished' in his term the 'unfinished cosmopolitan'.

In some blog posts, the students offer advice to students. It is suggested that when it is hard to motivate yourself to study that you meet with other students to work together. The teachers at KTH are not present in any of the blog posts written by students. The message communicated is that the individual is responsible for your own learning, and to succeed you need to be self-managed. Lifelong learning has been a guiding line of thought for the politics shaping the child and the adult since the 1980s (Fejes, 2006; Popkewitz et al., 2006). Thus, it is not surprising that lifelong learning is shaping also the subject - the engineering student in the campaign, KTH from the Inside. Since the campaign, KTH from the Inside, only represents the most advanced students, the skills and attitudes associated with lifelong learning are only associated with this group of students.

5.8.3 Making the future better for humanity

All of the projects included in the campaign share the goal to facilitate improvements for humanity and society. The projects aim to better four different areas, these are:

1. medicine and health care
2. sustainability and durability
3. people's everyday life (e.g., accessibility in public spaces)
4. life conditions in developing countries.

Here, the message communicated is that technological developments can improve society and human living conditions on a broad front and the engineering student is responsible for doing so. The narrative is that of a person who has the right competencies and the desire to serve society- a saviour, guided by reason and science. In discourse terms (Post- Foucauldian), the students participating in the campaign 'confess' to this narrative by engaging in projects aiming to enhance society without being limited to national borders. Resulting in a subject in line with Popkewitz terms an unfinished cosmopolitan, a lifelong learner who acts as a global citizen (cf. Popkewitz, 2008, p. 112). Popkewitz suggests that there is a double gesture to the construct of a saviour. The rationale is that the savour requires an 'other' in need of saving. Which makes me ask, who are engineering students expected to save? Popkewitz (2003) argues that those in need of being saved are the less knowledgeable, those that the educational system has failed to transform into lifelong learners. Thus, these individuals must be those who today's engineering students, tomorrow's engineers are expected to save.

The campaign's framing of a subject engaged in a collective pursuit to save the world is by no means a new narrative. David Nye, a historian who has written a book about technological foundation narratives argues that technologies, i.e. the railroad, the canal and the mill, though man-made and contributes to over-run nature, these technologies were clustered to a narrative suggesting they were in harmony with God. Nye (2004) argues that 'technological foundation stories also provided a framework for the individual pursuit of happiness' (p. 11). These narratives also build on a rationale that suggests that technological development takes civilization to a higher level- a promise of betterment, a life of ease and abundance. This rationale has received criticism for treating the land as an 'empty space', leaving no room for counter-narratives or failure or losses, e.g., ecological losses (Nye, 2004). Sustainability is a mandatory subject/ perspective at KTH today. With this in mind, I find it surprising that the rationality that technological development by default takes civilization to a higher level is not exposed to critical scrutiny anywhere in the campaign. This could have been accomplished by discussing if it is 'right' to develop a quiet sustainable electrical water scooter (which is the case in one of the projects included in the campaign)? What if no development of an electrical water scooter is better? Is it good enough that four of twelve projects state that sustainability is a priority? Should not sustainability be a requirement for all student projects at a university that presents itself as leading in this field?

I argue that the lack of discussion of the problematic elements/aspects of technological development leads to an air of laissez-fairness is added to the construct of the engineering student as a saviour.

5.8.4 A break with cultural and historical gender patterns

Traditionally, engineers are associated with being thing-orientated before people-oriented (Dunteman et al., 1979). Eight of the twelve projects represented in the campaign are presented together with people- focus. Also, three of the four machine-focused projects are presented together with an ambition to promote sustainable technology. Consequently, the subject produced in the campaign is person-oriented before thing-oriented.

Earlier research shows that the hard/soft dichotomy has been used to a high degree to categorize label technology as either male (hard side) or female (soft side). In Sjögren's study (2011) professional engineers put forward that people-oriented technology projects are associated with the soft side of the hard/soft dichotomy. With this in mind, the campaign KTH from the Inside's focus on projects that facilitate improvements within a social domain. This is a field of engineering that is associated with female engineers (cf. Sjögren, 2011). The effect of this is that the recruitment campaign constructs a subject of a person-oriented individual rather than thing-oriented. I argue that this construct challenges the traditional view that engineering is foremost a field of knowledge for thing-oriented individuals (an individual interested in manipulating and understanding objects in the physical world) (Dunteman et al., 1979). Thus, the campaign breaks with the history of labelling

technology as masculine (excluding women) (Faulkner, 2001; Sjögren, 2011; Wajcman, 1991). Note that it does not matter that most of the students participating in the campaign are male. The message communicated is that the most advanced engineering students do people-oriented engineering work, independently of their being female or male.

Despite that the campaign KTH from the Inside invite person-oriented individuals, it also tells a story that KTH is foremost a university for the most committed students, those who are willing to study for five years in a MSc programme and who identify with the position of an unfinished cosmopolitan (see 2.4 and making the future better). I argue that this excludes many possible students, e.g., those interested in studying in a BSc programme at one of the unrepresented KTH campuses in the suburbs of Stockholm. Hence, it appears as if KTH is not prepared to break with the historical and cultural linkage to elitism to broaden the recruitment of students. The message communicated is that the broadening of recruits only concerns top-notch students with cosmopolitan aspirations.

6 Concluding results and discussion

Here, patterns identified in different discursive representations of the subject, the engineering student are discussed, in particular possible consequences that this may have on the recruitment to engineering education. Table 1, summarises the main ideas, values, dispositions and desires that shape the subject, the engineering student, as seen in the two sub-studies. The table illustrates similarities and disparities between the subject construct in the two studies.

Table 1: Main results: research question one.

Study one, Upper Secondary School pupils	Study two, the recruitment campaign KTH from the Inside
A Lifelong learner Self-managed hard-working, industrious and good at studying future-oriented	A Lifelong learner Self-managed, hard-working, industrious and good at studying future-oriented
Traditional technologist: intelligent, smart hard sciences/thing-orientation confident in mathematics, technology and physics	Contemporary technologist: a knowledgeable problem solver soft sciences/ person-oriented
	Socially and physically active
Guided by a desire to be successful	Guided by cosmopolitan ideals

6.1 Learning for life or a high social status

Both sub-studies produce a subject of an engineering student who masters the skills and traits of a lifelong learner. The campaign KTH from the Inside constructs a generically skilled individual who is creative, good at solving problems and making decisions, and masters critical thinking. This is in line with prior findings of Badran (Badran, 2007). The emphasis on generic skills mirrors ongoing discussions about contemporary engineering education, see for instance (Adams et al., 2011; Berge et al., 2019). In these discussions, some argue that communication and language skills should be in the curriculum of engineering education (Sahin, 2010). A term used in these discussions is global competence. The notion covers communication skills needed when working in a global society. The importance of having this competence is expressed strongly by the campaign, KTH from the Inside. First, by implication, since some of the student projects are realized on a global level. Secondly, as an effect, the participating students are themselves 'good' communicators, they are writing blog posts and producing vlogs. And in some of the blog posts they also talk about the importance of communication and global competence.

The campaign KTH from the Inside, communicates that learning is a lifelong journey of self-capitalization with no endpoint (lifelong learning), evidence to support this is drawn from blogs and interviews, where the participating students say that the ideal job allows them to work with their interests. For example, several students who study vehicle engineering say they want to work in the shipping industry. The students believe this would allow them to work within a field they are interested in,

water sports or sailing. This stance on the link between learning and work confirms prior results of Ziehe and Stubenrauch (1984), who conclude that vocational choices and avocational interests are expressions of identity. According to this line of thought, a choice of education has to be related to personal interests to be meaningful (Berge et al., 2019; Eccles, 2009; Schreiner, 2006). This line of thought is not identified in the first sub-study. The upper secondary school pupils express the view that there is an endpoint of the learning journey and that point is when the engineering student becomes an engineer. This meaning-making is communicated, in statements where they suggest that engineering education in HE leads to a well-paid job, preferably in a leading position and with a high social status. Although there is no support for the line of thought suggesting that learning is a ceaseless life- project, the engineering student is put forth as a future-oriented, self-managed individual who is willing to work hard to become successful. I interpret this to mean that upper secondary school pupils' viewpoint is that engineering students in HE need to master the skills and traits associated with being a life-long learner to succeed, otherwise they risk failure, or they were not suitable for engineering education in HE in the first place.

6.2 A traditional technologist vs. a contemporary technologist

A clear majority of the students participating in the campaign, KTH from the Inside are advanced undergraduate students. The students are either in their final year of a five-year-long

education MSc programme[11]. They also study at the oldest campus at KTH in Stockholm city. At the time of the campaign, KTH from the Inside, was running, KTH had five different campuses. Still, only the old campus located in the centre of Stockholm is visible in the campaign. I argue that excluding the campuses located in the suburbs of Stockholm and the BSc programmes communicates 'an air of elitism'. Consequently, characteristics and skills emphasised in the campaign are associated exclusively with this group of students- the top-notch. This construct links the engineering student to the notion of an elite.

The campaign, KTH from the Inside, communicates that students at KTH develop generic- and entrepreneurial skills. The narrative is that engineering students are knowledgeable problem solvers engaged in developing technological solutions that gain of society on the whole (more on this later in the section on guiding ideals).

A clear majority of the students participating in the campaign, KTH from the Inside, are men still the holistic approach and social values dominate in the campaign. This narrative breaks with the tradition to label technology foremost as hard sciences and thing-orientation, which is why technology historically is associated with masculinity. The break with gender patterns also communicates that boys do not need to be thing-oriented. The emphasis on a holistic approach and generic skills confirm the

[11] But one of the project groups (in the first phase of the campaign) are studying in a Bachelor programme in engineering

subject position that Berget et al. (2019) calls a contemporary technologist, a construct based on a discourse that upheld social aspects of engineering and generic skills, e.g., communication skills and creativity. This ideal is clearly portrayed in the material produced by the students, where the students 'confess' to a subject position confirming such skills.

Faulkner (2000) argues engineering work using a holistic approach, i.e., seen in the projects displayed in the campaign, KTH from the Inside, is associated with the 'soft' side of the soft-hard dichotomy, which is associated with engineering work associated with women engineers. Also, classroom studies of technology classes in compulsory school that girls to a higher degree than boys use a holistic approach (Kimbell et al., 1996; Murphy, 1991).

Interestingly, only some of the abilities associated with the contemporary technologist is present in the study of upper secondary school pupils' views regarding engineering students. What is present is the importance of being self-managed lifelong learning. More prominent is the discourse of traditional technologists (cf. Berge et al., 2019) emphasised in statements putting forward the importance of being knowledgeable and confident in mathematics, technology and physics. This result confirms Eccles' research where she examines factors influencing students' choice of major in science. One of these factors is that the individual needs to be confident in his/her ability to do well in the course(s) required to consider it. This factor is very prominent in the results of sub-study one.

When the upper secondary school pupils speak of what engineers do at work, they emphasise that engineers lead and

control. They also say that engineers do calculations, work with technology and solve problems, however these remarks are few in number. There are two variants of this position according to Berge (2019). One, is associated with an interest in nuts and bolts. This is associated with BSc students. The second variation is associated with a theoretical interest in technology. This variation is associated with MSc students.

The position of the traditional technologist is similar to what (Schreiner, 2006) calls the selective boy, or what (Dunteman et al., 1979) calls a thing-oriented individual. This position is upheld to a higher degree in sub-study one than in sub-study two. Interestingly, the upper secondary school pupils do not gender engineering education as male or female (other than the one exception, a statement saying good-looking wife). Still the subject constructed in the recruitment campaign, KTH from the Inside challenge norms on masculinity to a higher degree than what upper secondary school pupils do.

6.3 A socially and physically active student

The recruitment campaign, KTH from the Inside confirms prior results by Schreiner (2006) regarding the selective girl, a girl who values self-realisation, and shaping a fit body, and wants to work with humans. Consequently, the campaign communicates that it is possible to lead an active life without putting your education at risk. Many of the activities that the students are engaged in are also social activities. This result confirms (Berge et al., 2019) analysis of technical universities websites where the students also are young, sporty and socially active (without putting their education at risk). This sporty and socially active student stands

out, in opposition to the image of the geeky engineering student, so often seen in the discourse.

6.4 A student guided by ideals and aspirations of success

In both sub-studies, the importance of being personally successful is omnipresent in the subjects produced. In study one, this point of view is put forward in statements suggesting that engineers are likely to receive a high income, a leading position in working life and high social status. Engineering education is not for everyone, as concluded in the results of study one, you need to be intelligent, confident and willing to work hard to study engineering in HE.

Interestingly, the theme of success in terms of a well-paid job and a high social status is not perceptible in the recruitment campaign KTH from the Inside. In its place, having the 'right' attitude is endorsed as far more important than being intelligent to succeed in your studies. The right attitude in this context is a willingness to work hard (studying) and a willingness to ask for help when needed (study together with friends). The students in the recruitment campaign do not appear to be motivated by a high income. Instead, they speak of the abundance of carrier opportunities that a degree in engineering will give them and the opportunity to get a job aligned with their interests or a job that allows them to make a difference. This way of talking about education implies that every individual is responsible for making themselves attractive on the job market, and is with the discourse of entrepreneurship and neoliberal mentalities (cf. Berge et al., 2019). Although the results differ in this aspect,

both sub-studies reproduce the discourse of entrepreneurship and neoliberalism. A student guided by a cosmopolitan ideal.

Social and cultural values are in the focus of the student's projects to a higher degree than technological value in the recruitment campaign KTH from the Inside. The effect of this is that the subject is constructed as an autonomous cosmopolitan – an individual guided by will/striving to improve the environment and society at large, not only for themselves but for everyone. In the discourse of technological progress, social progress is argued to be dependent on technological progression (Berge et al., 2019). Thus, what we see in the recruitment campaign, KTH from the Inside, is an intersection of sustainability and technological progression. The outcome of this is a rationale that makes engineers responsible for fixing the environmental problems with technology. Together with the lack of problematising technological progress in itself, in the recruitment campaign, KTH from the Inside presents the rationale that societal development is dependent on technological progression as the 'truth'.

Interestingly, Berge et al. (2019) find only a few examples in their study where students 'confess' to a position that suggests that they are responsible for solving the world's environmental or societal problem, while, in the recruitment campaign, KTH from the Inside, this appears to be what motivates the engineering students. The aspiration to better the world promulgated by the campaign KTH from the Inside, is in line with a desire shared with a group of young people called selective girls in study of Norwegian youth interest or no interest in STEM subjects (Schreiner, 2006).

The selective girl says that she might consider studying STEM subjects (even if science is not their favourite school subject). *The selective girl* is engaged in environmental issues and in medical research. She also expresses that she wants to work with humans. She values self-realisation and shaping a fit body (Schreiner, 2006). These aspirations fit with the narrative and the message communicated in the campaign, KTH from the Inside. The construct of a person-oriented engineering student subject invites those with interests and aspirations generally associated with humanities and medicine. The person-oriented engineering student breaks with an historical and cultural pattern that has associated technology /engineering with hard sciences and masculinity. Despite the fact that most of the students represented in the campaign, KTH from the Inside, are male, the focus on person-orientation challenges the masculinity norm.

6.5 Who is invited to study at technical universities?

The upper secondary school pupils' views produce a subject position of a traditional technologist- an individual confident in mathematics, physics and technology. The participants of sub-study one also associates the engineering student with success, e.g., they describe an individual who is good at studying and learning, self-managed, and in working-life, they receive a high income and high social status. The air of elitism associated with the subject the engineering student, most likely invites the most confident students - those who trust they can live- up to the demands and ambitions attached to this subject. The essence of an elite is that it is a small group, excluding many people.

The recruitment campaign KTH from the Inside, produces a subject position of a contemporary technologist, an individual with cosmopolitan aspirations who strives to better the world. It does not represent students at BSc programmes (other than in one student project in the first phase). Nor does it represent students who study at any of KTH campuses located in the suburbs of Stockholm. Upper secondary school pupils neither define nor differentiate between students at MSc programmes or BSc programmes. However, my results support the view there is a strong perception that that engineering studies lead to positions in working life where you lead, solve problems, and receive a high income. Engineers with a degree from advanced engineering programmes generally have a higher status. Consequently, success is associated with the more advanced engineering students and programmes.

7 Methodological reflection

This thesis delivers a result regarding several different possible subject positions of engineering students and an analysis of how these subject positions relate to discourses surrounding engineering and engineering education. Thus, it seems valid to say that the methodological framework has filled its purpose.

A benefit with the post-it note method applied in study one was that it enabled one researcher to gather 1200 remarks on but only six occasions. The small space on the post-it notes made the statements shallow. I Identified this as a risk when developing the study design. Which was why I made room for the groups to discuss the remarks that were made by the members in each group. I recorded 18 of these group discussions. When listening to the recordings, it became clear

that the participants did not develop their thoughts further during this time. Therefore, I say that this method works best when the aim is to get a general idea of the discourse that renders the subject. When developing this method further, I recommend using a combination of methods. One alternative could be to apply this method in a pre-study, and use the results in a second study, in semi-structured interviews with the same participants or with some of them. Nevertheless, the method provided 'a big picture', and it can likely do so also in other studies.

The merit of this study is the study design, the combination of two studies exploring two perspectives on the subject matter. I find that this has made the power struggle between the traditional discourse and the contemporary discourse surrounding engineering education explicit.

In connection to sub-study two, I became aware of an ethical question when contacted by a student who participated in the campaign. The student seen in a video and cited in the paper, *The cosmopolitan engineering student: an analysis of a recruitment campaign for KTH Royal Institute of Technology in Stockholm* (Kingdon, 2018). argued that I had misunderstood him and asked me to remove the citation. Naturally, it is not possible to change an already published paper. I did what I could to put it right by writing a correction in the publication *International Journal of Technology and Design Education* where the article was published, also published in the thesis immediately after paper two (See also Kingdon, 2021). This experience made me aware of the importance of having at least one person your analysis checked carefully by another person. I believe that this could have prevented me from making this mistake.

The experience also made me aware of the importance of writing, more clearly that focus is on what the discourse does and how it functions. I have also learnt to use citations restrictively.

8 Concluding remarks

The main contribution of this study is the result showing that the notion of elitism is very present in the making of the subject the engineering student. We also learn that the upper secondary school pupils view of the engineering students are strongly in line with what Berge et al call a traditional technologist, those who strive to be successful (high social status and high income), while the subject constructed in the recruitment campaign invites the viewer to become a contemporary technologist, those with ambitions are to improve the world. This engineering student is person-oriented to higher degree than the traditional technologist, who is thing- oriented to a higher degree. In summary, it appears to be a power struggle between a discourse of the traditional technologist and the contemporary technologist, but the notion of the elite appears to be stable within both these discourses.

The campaign, KTH from the Inside foremost, invites the most advanced students. I argue that this calls for a discussion regarding if engineering education aims to broaden the recruitment of new student groups. I ask: are technical universities serious about their ambition to increase the recruitment of new student groups? If the answer is 'Yes', technical universities, i.e., KTH that is in the focus of this study, should ask themselves if the subject positions produced in

recruitment activities invites all these students. If the answer is 'No' there is no need for change.

9 Future work

This study explores two of many contexts of the discourse surrounding recruitment to technical universities. There are many more contexts of interest to examine to enrich our understanding of this subject matter. It could be interesting to explore if there are apparent differences between universities in large cities and colleges in medium-sized towns in industrial areas The results from such inquiries could be of interest to compare with the results of this study and other studies with the same objective, e.g., Andrée and Hansson's articles (2013, 2014) and Berge et al. (2019). It would also be interesting to examine if teachers in Technology and Natural Sciences produce the same or a similar subject, engineering student as the upper secondary school pupils. Moreover, it would be interesting to examine messages communicated in recruitment campaigns for other universities, not necessarily only technical universities.

References

Adams, R., Evangelou, D., English, L., Dias, A., Figueiredo, A. D. d., Mousoulides, N., Pawley, A., Schifellite, C., Stevens, R., Svinicki, M., Trenor, J. M., & Wilson, D. (2011). Multiple Perspectives on Engaging Future Engineers. *Journal of Engineering Education*, *100*, 48-88. https://doi.org/10.1002/j.2168-9830.2011.tb00004.x

Andrée, M., & Hansson, L. (2013). Marketing the 'Broad Line': Invitations to STEM education in a Swedish recruitment campaign. *International Journal of Science Education*, *35*(1), 147-166. https://doi.org/10.1080/09500693.2012.695880

Andrée, M., & Hansson, L. (2014). Recruitment Campaigns as a Tool for Social and Cultural Reproduction of Scientific Communities: A case study on how scientists invite young people to science. *International Journal of Science Education*, *36*(12), 1985-2008. https://doi.org/10.1080/09500693.2014.888598

Archer, L. (2003). Higher Education and Social Class: Issues of Exclusion and Inclusion [Elektronisk resurs]. In M. Philip, M. Hutchings, & A. Ross (Eds.), *Higher Education and Social Class: Issues of Exclusion and Inclusion [Elektronisk resurs]* (pp. 5-20). Routledge.

Archer, L., & Hutchings, M. (2000). 'Bettering Yourself'? Discourses of Risk, Cost and Benefit in Ethnically Diverse, Young Working-Class Non-Participants' Constructions of Higher Education. *British Journal of Sociology of Education*, *21*(4), 555-574. http://www.jstor.org.focus.lib.kth.se/stable/1393382

Archer, L., Philip, M., Hutchings, M., & Ross, A. (2003). *Higher Education and Social Class: Issues of Exclusion and Inclusion [Elektronisk resurs]*. Routledge.

Badran, I. (2007). Enhancing creativity and innovation in engineering education. *European Journal of Engineering Education*, *32*(5), 573-585. https://doi.org/10.1080/03043790701433061

Beck, U. (1992). *Risk society : towards a new modernity*. Sage.

Berge, M., Silfver, E., & Danielsson, A. (2019). In search of the new engineer: gender, age, and social class in information about engineering education. *European Journal of Engineering Education*, *44*(5), 650-665. https://doi.org/10.1080/03043797.2018.1523133

Bergström, K. (2009). *Nyfiken på naturvetenskap och teknik [Elektronisk resurs] : en kartläggning av initiativ som syftar till att öka barns och ungdomars intresse för ämnena*. Teknikdelegationen.

http://www.teknikdelegationen.se/Bazment/teknikdelegationen/sv/publikationer.aspx
Berner, B. (2003). Kvinnor i ingenjörsarbete. In B. Berner (Ed.), *Vem tillhör tekniken? : kunskap och kön i teknikens värld* (pp. 175-200). Arkiv.
Berner, B. (2004). *Ifrågasättanden : forskning om genus, teknik och naturvetenskap*. Tema Teknik och social förändring, Linköpings universitet.
Bradley, H. (2016). *Fractured identities : changing patterns of inequality*. Polity.
Bøe, M. V., Henriksen, E. K., Lyons, T., & Schreiner, C. (2011). Participation in science and technology: young people's achievement-related choices in late-modern societies. *Studies in Science Education*, *47*(1), 37-72. https://doi.org/10.1080/03057267.2011.549621
Case, J. M., & Light, G. (2011). Emerging Research Methodologies in Engineering Education Research [https://doi.org/10.1002/j.2168-9830.2011.tb00008.x]. *Journal of Engineering Education*, *100*(1), 186-210. https://doi.org/https://doi.org/10.1002/j.2168-9830.2011.tb00008.x
Cockburn, C. (1996). Hushållsteknik: askungen och ingenjörerna. In E. Sundin & B. Berner (Eds.), *Från symaskin till cyborg : genus, teknik och social förändring*. Nerenius & Santérus.
Dakers, J. R., Dow, W., & McNamee, L. (2009). De-constructing technology's masculinity. *International Journal of Technology and Design Education*, *19*(4), 381. https://doi.org/10.1007/s10798-009-9099-3
Dick, T. P., & Rallis, S. F. (1991). Factors and Influences on High School Students' Career Choices. *Journal for Research in Mathematics Education*, *22*(4), 281-292. https://doi.org/10.2307/749273
Dreyfus, H. L., & Rabinow, P. (1983). *Michel Foucault : beyond structuralism and hermeneutics*. Univ. of Chicago Press.
Dunteman, G., H., Wisenbaker, J., & Taylor, M. E. (1979). *Race and Sex. Differences in College Science program Participation*. (RTI-22U-1570). R. T. Institute. https://files.eric.ed.gov/fulltext/ED199034.pdf
Eccles, J. (2009). Who Am I and What Am I Going to Do With My Life? Personal and Collective Identities as Motivators of Action. *Educational Psychologist*, *44*(2), 78-89. https://doi.org/10.1080/00461520902832368
EU. (2004). *Increasing Human Resources for Science and Technology in Europe: Report of the High-Level Group on Human Resources for Science and Technology in Europe*. EU.

EU. (2005). *Europeans, Science and Technology- Special Eurobarometer No. 224*.

Fagrell, P., & Geschwind, L. (2020). Engineering Academisation: The Transition of Lower Level Engineering Education from Upper Secondary School Level to Higher Education. In L. Geschwind, A. Broström, & K. Larsen (Eds.), *Technical Universities. Past, present and future [Elektronisk resurs]* (pp. 191-210). Springer Netherlands. http://kth.diva-portal.org/smash/get/diva2:1474992/FULLTEXT01

Faulkner, W. (2000). The Power and the Pleasure? A Research Agenda for "Making Gender Stick" to Engineers. *Science, Technology, & Human Values*, *25*(1), 87-119. http://www.jstor.org.focus.lib.kth.se/stable/690201

Faulkner, W. (2001). The technology question in feminism: A view from feminist technology studies. *Women's Studies International Forum*, *24*(1), 79-95. https://doi.org/https://doi.org/10.1016/S0277-5395(00)00166-7

Faulkner, W. (2007). 'Nuts and Bolts and People': Gender-Troubled Engineering Identities. *Social Studies of Science*, *37*(3), 331-356. http://www.jstor.org.focus.lib.kth.se/stable/25474523

FEANI. (2005). *Competence of Professional Engineers/EUR ING* http://www.feani.org/site/index.php?id=21.

Fejes, A. (2006). *Constructing the adult learner : a governmentality analysis*. Linköping University, Department of Behavioural Sciences. http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-6231

Fejes, A., & Dahlstedt, M. (2013). *The confessing society : Foucault, confession and practices of lifelong learning*. Routledge.

Foucault, M. (1983). The subject and power. In H. L. Dreyfus & P. Rabinow (Eds.), *Michel Foucault : beyond structuralism and hermeneutics* (pp. 208-226). University of Chicago Press.

Foucault, M. (1993). *Diskursens ordning : installationsföreläsning vid Collège de France den 2 december 1970* (M. Rosengren, Trans.). B. Östlings bokförl. Symposion.

Foucault, M. (2000). Security, Territory and Population In P. Rainbow (Ed.), *Essential works of Foucault, 1954-1984 Vol 1. Ethics : subjectivity and truth* (Vol. 1, pp. 67-72). Penguin.

Foucault, M. (2010). *The archaeology of knowledge and the discourse on language*. Vintage books.

Fröberg, M. (2010). *Teknik och genus i skapandet av gymnasieskolans teknikprogram : Översättningar och gränsarbete på tre nivåer* (Publication Number 511) [Doctoral thesis, monograph, Linköping University Electronic Press]. DiVA. Linköping. http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-54518

Giddens, A. (1991). *Modernity and self-identity : self and society in the late modern age*. Polity Press.
Hall, S. (2001). Foucault: Power, Knowledge and Discourse. In M. Wetherell, S. Taylor, & S. J. Yates (Eds.), *Discourse theory and practice : a reader* (pp. 14- 28). Sage.
Henwood, F. (1996). WISE Choices? Understanding Occupational Decision-making in a Climate of Equal Opportunities for Women in Science and Technology. *Gender and Education*, *8*(2), 199-214. https://doi.org/10.1080/09540259650038860
Hultqvist, K. (2006). The future is already here – as it always has been. The new teacher subject, the pupil and the technologies of the soul. . In T. S. Popkewitz & K. Hultqvist (Eds.), *The future is not what it appears to be" : pedagogy, genealogy and political epistemology : in honor and in memory of Kenneth Hultqvist* (pp. 20-61). HLS förlag. http://www.fsys.se/gfxliborg/9176566234.jpg
Högskoleverket. (2002). *Tekniskt sett, högskoleingenjörer- kartläggning och enkätstudie* (Högskoleverkets rapportserie 2002: 27 R, Issue. https://www.uka.se/download/18.12f25798156a345894e2936/1487841892560/0227R.pdf
Joseph, J. (2010). The limits of governmentality: Social theory and the international. *European Journal of International Relations*, *16*(2), 223-246. https://doi.org/10.1177/1354066109346886
Kimbell, R., Stables, K., & Green, R. (1996). *Understanding practice in design and technology*. Open University Press.
Kingdon, P. (2013). The successful student: a study examining how young Swedish people represent engineering students discursively. In I.-B. Skogh & M. J. d. Vries (Eds.), *Technology teachers as researchers : philosophical and empirical technology education studies in the Swedish TUFF Research School* (pp. 199–222). Sense Publishers.
Kingdon, P. (2018). The cosmopolitan engineering student: an analysis of a recruitment campaign for KTH Royal Institute of Technology in Stockholm. *International Journal of Technology and Design Education*, *28*, 787-802. https://doi.org/10.1007/s10798-017-9405-4
Kingdon, P. (2021). Correction to: The cosmopolitan engineering student: an analysis of a recruitment campaign for KTH Royal Institute of Technology in Stockholm. *International Journal of Technology and Design Education*, *31*(1), 199-200. https://doi.org/10.1007/s10798-019-09539-z
Krige, J. (2000). NATO AND THE STRENGTHENING OF WESTERN SCIENCE IN THE POST-SPUTNIK ERA. *Minerva*, *38*(1), 81-108. http://www.jstor.org.focus.lib.kth.se/stable/41821156

Layton, D. (1993). *Technology's challenge to science education : cathedral, quarry or company store?d David Layton*. Open University Press.
Margolis, J., & Fisher, A. (2002). *Unlocking the clubhouse : women in computing*. MIT Press.
Mellström, U. (1999). *Män och deras maskiner*. Nya Doxa.
Murphy, P. (1991). Gender differences in pupils' reaction to practical work. In B. E. Woolnough (Ed.), *Practical science* (pp. 112–122). Open University Press.
Nye, D. E. (2004). *America as second creation : technology and narratives of new beginnings*. MIT.
OECD. (2004). *OECD Science, Technology and Industry Outlook 2004*. https://doi.org/doi:https://doi.org/10.1787/sti_outlook-2004-en
OECD. (2008). *Encouraging Student Interest in Science and Technology Studies*. https://doi.org/doi:https://doi.org/10.1787/9789264040892-en
OEEC. (1960). *Forecasting manpower needs for the age of science : [papers*. Office for Scientific and Technical Personnel, Organisation for European Economic Cooperation.
Olsson, U. (1997). *Folkhälsa som pedagogiskt projekt : bilden av hälsoupplysning i statens offentliga utredningar*. Univ.
Osborne, J., & Dillon, J. (2008). *Science Education in Europe: Critical Reflections: A Report to the Nuffield Foundation*. https://www.nuffieldfoundation.org/wp-content/uploads/2019/12/Sci_Ed_in_Europe_Report_Final1.pdf
Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, *25*(9), 1049-1079. https://doi.org/10.1080/0950069032000032199
Ottemo, A. (2008). *Rekryteringssarbete och genusmönster i rekryteringen till Chalmers utbildningar på EDITZ-området: Genus delprojektet inom EDITS- översynen*. Chalmers Universitiy.
Ottemo, A. (2015). *Kön, kropp, begär och teknik : passion och instrumentalitet på två tekniska högskoleprogram* [Gender, body, desire, and technology: Passion and instrumentality in two technical university programs]. Acta universitatis Gothoburgensis. http://hdl.handle.net/2077/39621
Petersson, K., Olsson, U., Popkewitz, T. S., & Hultqvist, K. (2007). Framtiden som styrning: En genealogisk betraktelse av det utbildningsbara subjektet och pedagogisk teknologi under det tidiga 2000-talet. In K. Johansson & S. Lövgren (Eds.), *Viljan att*

styra : individ, samhälle och välfärdens styrningspraktiker (pp. 272).
Petersson, K., Popkewitz, T. S., & Olsson, U. (2006). The Future Is not What It Appears To be Pedagogy, Genealogy and Political Epistemology: An introduction In T. S. Popkewitz, K. Petersson, U. Olsson, & J. Kowalczyk (Eds.), *"The future is not what it appears to be" : pedagogy, genealogy and political epistemology : in honor and in memory of Kenneth Hultqvist* (pp. 10-19). HLS förlag.
Popkewitz, T. (2004). The Alchemy of the Mathematics Curriculum: Inscriptions and the Fabrication of the Child. *American Educational Research Journal*, *41*(1), 3-34. http://www.jstor.org.focus.lib.kth.se/stable/3699383
Popkewitz, T., S. (2003). Governing the child and pedagolisation of the parent. In M. N. Bloch (Ed.), *Governing children, families, and education : restructuring the welfare state* (pp. 35–61). Palgrave Macmillan.
Popkewitz, T. S. (2008). *Cosmopolitanism and the age of school reform : science, education, and making society by making the child*. New York: Routledge. http://www.loc.gov/catdir/toc/ecip0715/2007014025.html
Popkewitz, T. S., Olsson, U., & Petersson, K. (2006). The Learning Society, the Unfinished Cosmopolitan, and Governing Education, Public Health and Crime Prevention at the Beginning of the Twenty-First Century. *Educational Philosophy and Theory*, *38*(4), 431-449. https://doi.org/10.1111/j.1469-5812.2006.00203.x
Powell, A., Dainty, A., & Bagilhole, B. (2012). Gender stereotypes among women engineering and technology students in the UK: lessons from career choice narratives. *European Journal of Engineering Education*, *37*(6), 541-556. https://doi.org/10.1080/03043797.2012.724052
Rose, N. (1996). Governing 'advanced' liberal democracies. In A. Barry, T. Osborne, & N. Rose (Eds.), *Foucault and political reason : liberalism, neo-liberalism, and rationalities of government* (pp. 37–64). The University of Chicago Press.
Rose, N. (1999). *Powers of freedom : reframing political thought*. Cambridge University Press.
Sahin, M. (2010). The impact of problem-based learning on engineering students' beliefs about physics and conceptual understanding of energy and momentum. *European Journal of Engineering Education*, *35*(5), 519-537. https://doi.org/10.1080/03043797.2010.487149

Salminen Karlsson, M. (2003). Hur skapas den nya teknikens skapare? . In B. Berner (Ed.), *Vem tillhör tekniken? : kunskap och kön i teknikens värld* (pp. 145–174). Arkiv Förlag.
SCB. (2010). *Temarapport 2010:2*.
SCB. (2015). Studiedeltagande för befolkningen 16-64 år höstterminen 2014. Kvinnor och män. . In.
Schreiner, C. (2006). *EXPLORING A ROSE-GARDEN: Norwegian youth's orientations towards science: seen as signs of late modern identities* [Doctoral thesis]. University of Oslo. https://www.duo.uio.no/handle/10852/32331
Schreiner, C., Henriksen, E. K., Sjaastad, J., Jensen, F., & Løken, M. (2010). *Vilje-con-valg: Valg og bortvalg av realfag i høyere utdanning*. https://www.naturfagsenteret.no/c1515601/binfil/download2.php?tid=1509698
Schreiner, C., & Sjøberg, S. (2007). Science education and youth's identity construction - two incompatible projects? In D. Corrigan, J. Dillon, & R. Gunstone (Eds.), *The re-emergence of values in science education* (pp. 231–247). Sense Publishers.
Sjögren, F. (2011). *"Kan man särskilja kompetens från personlighet?" [Elektronisk resurs] en genusvetenskaplig studie av kompetens och ideal i fyra IKT-forskningsorganisationer*. Luleå tekniska universitet. http://urn.kb.se/resolve?urn=urn:nbn:se:ltu:diva-26349
Skolverket. (2014). *Ett fjärde år för gymnasieingenjörsexamen*. Retrieved 14 March, 2014 from https://www.skolverket.se/for-dig-som-.../studie--och-yrkesvagledare/gymnasieutbildning/infor-gymnasieingenjor---det-fjarde-aret
Söderlind, J., & Geschwind, L. (2017). More students of better quality? Effects of a mathematics and physics aptitude test on student performance. *European Journal of Engineering Education*, *42*(4), 445-457. https://doi.org/10.1080/03043797.2017.1295921
UKÄ. (2013). *Etableringen på arbetsmarknaden 2011 – examinerade läsåret 2009/10*. https://www.uka.se/download/18.12f25798156a345894e4cca/1487841875901/rapport-2013-12-16-etablering-arbetsmarknad.pdf-
UKÄ. (2015). Universitet och högskolor: Årsrapport 2015. 156. https://www.uka.se/download/18.12f25798156a345894e4ae8/1487841868714/arsrapport-2015.pdf
UKÄ. (2016a). *Kan excellens uppnås i homogena studentgrupper? En redovisning av regeringsuppdraget att kartlägga och analysera lärosätenas arbete med breddad rekrytering och breddat*

deltagande. https://www.uhr.se/globalassets/_uhr.se/publikationer/2016/uhr-kan-excellens-uppnas-i-homogena-studentgrupper.pdf
UKÄ. (2016b). *Universitet & högskolor: Årsrapport 2016*. https://www.uka.se/download/18.12f25798156a345894e4ac9/1487841867894/arsrapport2016.pdf
UKÄ. (2020). *Universitet och högskolor: Årsrapport 2020*. https://www.uka.se/statistik--analys/arsrapport-om-universitet-och-hogskolor/arsrapport-2020.html
Ulriksen, L., Madsen, L. M., & Holmegaard, H. T. (2010). What do we know about explanations for drop out/opt out among young people from STM higher education programmes? *Studies in Science Education*, *46*(2), 209-244. https://doi.org/10.1080/03057267.2010.504549
Vene, E. (2019). *Gymnasieingenjören kommer tillbaka*. Retrieved February 05 from https://www.nyteknik.se/karriar/gymnasieingenjoren-kommer-tillbaka-6407981
Vetenskapsrådet. (2017). *God forskningssed [Elektronisk resurs]* (9789173073523).
Wajcman, J. (1991). *Feminism confronts technology*. Polity Press.
Wetherell, M. (2001). Themes in Discourse Research: The Case of Diana. . In M. Wetherell, S. Taylor, & S. J. Yates (Eds.), *Discourse theory and practice : a reader* (pp. 14- 28). Sage.
Winther Jørgensen, M., & Phillips, L. (2002). *Discourse analysis as theory and method*. Sage.
Ziehe, T., & Stubenrauch, H. (1984). *Ny ungdom og usædvanlige læreprocesser : kulturel frisættelse og subjektivitet*.

Part II