



CHALMERS
UNIVERSITY OF TECHNOLOGY

Infusing entrepreneurship in engineering education

Perceptions across campus

Master's thesis in Learning and Leadership

ELINA PALMQUIST
SOFIA TOIVONEN

MASTER'S THESIS 2017:140

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Department of Applied Information Technology
CHALMERS UNIVERSITY OF TECHNOLOGY
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ABSTRACT

The number of educational change processes aiming to infuse entrepreneurship in engineering education is increasing. Since these initiatives are a relatively new trend, it is interesting and necessary to understand different perceptions of entrepreneurship, especially among the central participants of the educational process. Accordingly, the aim of this study is to, through a qualitative method, investigate the existing perceptions of entrepreneurship as well as of entrepreneurship in engineering education among teachers and students from the bachelor programmes Bioengineering and Engineering Mathematics at Chalmers University of Technology.

Eight semistructured interviews - four with teachers and four with students - were conducted and analysed using an inductive thematic approach. On the basis of these interviews, four different themes emerged: 1) entrepreneurship is associated with traits ascribed to a certain type of personality, 2) entrepreneurship is associated with the initial phase of starting up businesses, 3) entrepreneurship is associated with process management, and 4) entrepreneurship and basic research are perceived as hard to unify.

The ability to learn how to become more entrepreneurial within the existing engineering education appears to depend on one's view of entrepreneurship. The most decisive factor for this is the perceived attainability of one's own image of the entrepreneur. Additionally, teachers and students do not seem to have a very clear image of how entrepreneurship is learnt, independent of one's view of entrepreneurship.

All in all, there exists a lot of different - and sometimes strong - perceptions of entrepreneurship and what entrepreneurship in engineering education is or could be. These perceptions will unavoidably influence the initiatives of infusing entrepreneurship in engineering education. In order to fully understand the preconditions for such educational change processes, these perceptions are an important factor to consider.

Keywords: perceptions, entrepreneurship education, entrepreneurship, engineering education, educational change, Chalmers University of Technology, learning entrepreneurship.

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1 INTRODUCTION

This chapter presents the master's thesis work, beginning with an introduction of the trend of infusing entrepreneurship in engineering education along with some aspects of change within higher education. This is followed by the aim of the study, research questions and delimitations, ending with a description of the thesis layout.

The speed of change in the current business environment has never been greater and affects all types of organisations (Todnem, 2005). This can be seen as a societal challenge which has increased the demand for people becoming more innovative. In order to meet this demand, infusing entrepreneurship into all levels of education has been a high priority among policymakers during the last decades (Lackéus, Lundqvist, Williams Middleton, 2016; Kyrö, 2015; Walter & Block, 2016). In Europe, the EU has set a goal aiming for every single student to be exposed to entrepreneurship education throughout their studies (EACEA Eurydice, 2012), since it is regarded as valuable for employment as well as strengthening democracy and active citizenship (Kyrö, 2015).

Also, in engineering education, educational change processes involving infusion of entrepreneurship is a trend (Duval-Couetil, Shartrand & Reed, 2016). Although the engineering curricula has for a long time emphasised technical content, recently engineering graduates are also considered to need a broad range of skills beyond the technical (Dabbagh, 2006; Duval-Couetil et al., 2016). Specifically, it is argued that engineers need entrepreneurial skills (Dabbagh, 2006) and entrepreneurship in engineering education is showing potential of increasing creativity, student engagement as well as the perceived relevance of courses (Ohland, Frillman, Zhang, Brawner & Miller, 2004; Bilán, Kisenwether, Rzasa & Wise, 2005). However, there is so far no common framework of defining entrepreneurship in education, which is an initial challenge for this type of initiatives (Lackéus et al., 2016; Kyrö, 2015).

Especially, the teacher's interest and perceptions of entrepreneurship is considered to be a challenge (Teerijoki & Murdock, 2014). In line with this, Wertsch (1998) states that faculty members need to create an understanding of the entrepreneurial terminology in order to feel ownership of the educational change. With this in mind, and since technical competencies may seem far away from entrepreneurship, it is interesting and important to study the existing perceptions among the central participants involved in the educational change. Thus, this will be the focus of this study.

Despite that there is no common framework of defining entrepreneurship in education, there are generally two distinct approaches - a narrow and a broad (Lackéus et al., 2016). The narrow approach refers to entrepreneurship in the form of business entrepreneurialism which enables students to experience and learn about business start-up and management (Lackéus et al., 2016). The broad approach regards entrepreneurship as a group of general competencies enabling students to be more entrepreneurial, e.g. flexible, creative and adaptable (Lackéus et al., 2016). Also, a prominent question regarding the purpose of infusing entrepreneurship in education

is whether the students are to 1) expand their knowledge *about* entrepreneurship, 2) prepare *for* entrepreneurship by becoming entrepreneurs/more entrepreneurial, or if they are to 3) learn *through* enacting entrepreneurial behaviors or *in* a business context (Mäkimurto-Koivumaa & Belt, 2016; Pruett & Sesen, 2017). Depending on both the approach and purpose of infusing entrepreneurship in education as well as the educational context, supposedly the extent of the change may vary. For example, an infusion of entrepreneurship in more theoretical engineering programmes such as Engineering Mathematics and Bioengineering may require a larger change than in engineering programmes closer to social sciences such as Industrial Economy.

Educational change processes are to start with a project phase initiating a long-term and sustainable improvement process (Malmqvist, Bankel, Enelund, Gustafsson, & Knutson Wedel, 2010). In order to achieve a sustainable education development, it is important that all individuals involved in a change share a vision (Lissack & Roos, 2001; Svanström, Palme, Knutson Wedel, Carlson, Nyström & Edén, 2012). Without a coherent and sensible vision, a change process can easily dissolve into a list of confusing initiatives resulting in the process proceeding in the wrong direction or nowhere at all (Kanter, Stein & Jick, 1992; Kotter, 1995; Luecke, 2003). When initiating change, Burnes (1996) argues that

“successful change is less dependent on detailed plans and projections than on reaching an understanding of the complexity of the issues concerned and identifying the range of available options” (p.13).

Furthermore, Lewin - the founder of planned change - also emphasises the importance of understanding the complexity (Lewin, 1946) as well as facilitating learning and enabling involved individuals to understand and restructure their perceptions of the world around them (Burnes, 1996).

Particularly in higher education, including engineering education, the power structure is often more complex than in other organisations (Holmberg, Lundqvist, Svanström & Arehag, 2012). The main challenges when initiating change concern how to best respect and deal with faculty members' high degree of autonomy (Lundqvist, 2016) and how to create engagement and involvement among faculty (Holmberg et al., 2012). If this is not successfully considered, changes tend to be something that is in everybody's interest but is nobody's responsibility (Holmberg et al., 2012). Another challenge are the strong traditions that faculty itself carries along (Holmberg et al., 2012; Sund, 2014). These collective customs enable teachers to act in complex situations, but may also constitute obstacles when doing change (Sund, 2014). For example, new goal settings may be interpreted to fit within old frameworks, resulting in hardly noticeable changes in practice (Sund, 2014). Also, students within engineering education tend to form a culture with conceptions regarding educational content, which may be very hard to transform (Edvardsson Stiwne & Roxå, 2009). These existing structures and traditions within higher education are mentioned to be especially tough to break when striving for faculty-wide change around the perceptions of entrepreneurship in engineering education (Teerijoki & Murdock, 2014)

1.1 AIM OF STUDY & RESEARCH QUESTIONS

Since the infusion of entrepreneurship in engineering education is a relatively new trend, it is interesting to understand different perceptions of entrepreneurship in general and entrepreneurship in engineering education in particular. In the center of all educational processes are the teachers and the students (Pruett & Sesen, 2017), hence, it is necessary to have a better understanding of what these central participants believe. In general, there is only nascent research, mainly based on the teachers' perspectives, regarding perceptions of entrepreneurship in education. The few existing studies regarding the students' perceptions are mostly quantitative.

In this light, the thesis' aim is to, through a qualitative method, investigate teachers' and students' perceptions of entrepreneurship as well as of entrepreneurship in engineering education. This, in order to fill this gap of research and to contribute to an understanding of the preconditions for initiatives aiming to infuse entrepreneurship in engineering education. To support the thesis' aim, the following research questions are investigated:

RQ1 Which perceptions regarding entrepreneurship exist among teachers and students in engineering education?

RQ2 Which perceptions regarding entrepreneurship in engineering education exist among teachers and students in engineering education?

In order to answer these research questions, the perceptions of teachers and students from the bachelor programmes in Bioengineering and Engineering Mathematics at Chalmers University of Technology are studied.

1.2 DELIMITATIONS

The study does not deeply narrate how theory defines entrepreneurship and/or entrepreneurship in engineering education. Instead, the main focus is to investigate the perceptions regarding these concepts.

Although, it exists a master programme in entrepreneurship at Chalmers University of Technology, this study only considers undergraduate levels of higher education. No other levels of education, such as high school and PhD studies, nor extra-curricular activities are included in the thesis work. Data are gathered from no other programmes than the bachelor programmes Engineering Mathematics and Bioengineering at Chalmers University of Technology.

The research is done in the context of an educational change project (the ENG-project) with the purpose to infuse entrepreneurship in engineering education at Chalmers University of Technology. However, the thesis work is not a part of the ENG-project. Hence, the work has not focused on producing change, but is rather focused on creating a better understanding of the preconditions of infusing

entrepreneurship in engineering education. In example, qualitative interviews are used, not as means to affect people's perceptions or interest, but as a scientific method to uncover the interviewees' views. Further, the thesis work will not aim to promote the definition of entrepreneurship formulated by the ENG-project group.

Since educational change is a complex process, the study does not aim to provide a full set of instructions for how to initiate infusion of entrepreneurship in engineering education. Rather, it aims to give access to the specific aspect of perceptions regarding entrepreneurship and entrepreneurship in education in order to give some general guidelines and recommendations for how this aspect might be considered in such an educational change process. This, since each university as well as educational area or programme are different and therefore needs to adapt the conclusions in this thesis to their particular situation and context.

1.3 THESIS LAYOUT

This section describes the content of the thesis.

1. Introduction

This chapter presents the master's thesis work, beginning with an introduction of the trend of infusing entrepreneurship in engineering education along with some aspects of change within higher education. This is followed by the aim of the study, research questions and delimitations, ending with a description of the thesis layout.

2. Introduction to entrepreneurship in engineering education

In this chapter, a literature review regarding entrepreneurship in engineering education, including aspects of its purpose, content and realisation, is given. The chapter begins with a brief background about engineering education and ends with an exposition of research about students' and teachers' perceptions regarding the concept of entrepreneurship and its relation to education.

3. Empirical context

This chapter describes the context of the data collection, i.e. Chalmers University of Technology and the ENG-project. Previous and/or simultaneous change projects are briefly considered as well.

4. Method

In this chapter the method used is explained, starting with a brief description of the research layout. A more thorough description of the different phases of the data collection and analysis is then presented, ending with a section concerning how validity is regarded in this study.

5. Result

This chapter presents the result of the thesis work including four themes regarding perceptions of entrepreneurship as well as of entrepreneurship in engineering education. Each theme is introduced with a visualisation depicting the essence of the theme along with three central quotes. The visualisations are followed by an elaborative representation of each theme.

6. Discussion

In this chapter the perceptions of entrepreneurship as well as of entrepreneurship in engineering education along with their possible implications for the educational change process are discussed. This is followed by recommendations for infusing entrepreneurship in engineering education and suggestions for future work, ending with a discussion of limitations related to the method used in this study.

7. Conclusion

This chapter summarises the thesis work as it presents the main conclusions.

2 INTRODUCTION TO ENTREPRENEURSHIP IN ENGINEERING EDUCATION

In this chapter, a literature review regarding entrepreneurship in engineering education, including aspects of its purpose, content and realisation, is given. The chapter begins with a brief background about engineering education and ends with an exposition of research about students' and teachers' perceptions regarding the concept of entrepreneurship and its relation to education.

All fields of engineering education have one thing in common, namely the focus on technical content including a foundation in science, engineering principles and analytical capabilities (Crawley, Malmqvist, Östlund, Brodeur & Edström, 2014). This technical focus has been the tradition of engineering education for a long time. However, students in the 21st century also need to acquire knowledge within the cross-sections of different sciences such as physical-, life- and information sciences (Crawley et al., 2014). Also, engineering students must develop a range of skills and knowledge beyond the technical (Dabbagh & Menascé, 2006), such as an understanding of business processes as well as sustainable development and how to live and work as global citizens (Crawley et al., 2014).

As a consequence, engineering education has and is changing as the role of the engineer is expanding (Duval-Couetil, Shartrand & Reed, 2016). Within this changing educational environment, matters of infusing entrepreneurship in the engineering education are suggested, with arguments such as the one of an entrepreneur named George Berbeco:

“If an engineer is not an entrepreneur, [s/he] is just a tool” (cited in Dabbagh & Menascé, 2006, p.154)

2.1 ENTREPRENEURSHIP

There is no agreement of a common definition of the concept of entrepreneurship (Moroz & Hindle, 2012). One description of entrepreneurship is given by the BusinessDictionary (2017), in which it is described as:

“The capacity and willingness to develop, organise and manage a business venture along with any of its risks in order to make a profit. The most obvious example of entrepreneurship is the starting of new businesses.”

Further, Gartner (1988) suggests entrepreneurship to be organisational emergence, Shane and Venkataraman (2000) suggests it to be about the seizing of present opportunities in order to create economic value, while Bruyat and Julien (2001) highlights entrepreneurship as the process of creating different types of value.

2. INTRODUCTION TO ENTREPRENEURSHIP IN ENGINEERING EDUCATION

Moreover, the title of the entrepreneur is elusive as well (Gartner, 1988). Except from discovery, assessment and exploitation of opportunities (Shane & Ventkataraman, 2000), creativity and risk-taking are two features that characterizes ‘the entrepreneurial spirit’ (Pruett & Sesen, 2017). Further, Peterman and Kennedy (2003) bring up that some early researchers hypothesised that entrepreneurs are not as well educated as the general population, though, they further explain that more recent research claims that entrepreneurs have a higher level of education than previously thought. According to statistics, the typical entrepreneur in Sweden - in the sense of self-employment - is a high school graduated male consultant in his 40s who runs his own local business with a yearly turnover of less than half a million SEK (SCB, 2008).

As it seems, there is a stereotype image of the entrepreneur. Despite this image, the wide range of existing entrepreneurs and the diversity of entrepreneurial motivations, desired outcomes and definitions of success, imply that there is no one type of entrepreneur (Neck & Greene, 2011). One example of an alternative image of the entrepreneur could be the so called intrapreneur, i.e. acting entrepreneurially within already existing organisations (Hytti & Heinonen, 2013).

2.2 APPROACHES TO ENTREPRENEURSHIP IN EDUCATION

Entrepreneurship in education in general and entrepreneurship in engineering education in particular are new fields of research (Kuratko, 2005). This can be seen when comparing the years of publication of articles from these fields with for example articles from the field of engineering education. Since entrepreneurship has no generic definition (Moroz & Hindle, 2012) and since there is a definitional unclarity about what entrepreneurship in education is (Lackéus et al., 2016; Kyrö, 2015), this affects the conceptualisation of what entrepreneurship in engineering education is as well.

The unclarity is also mirrored by the circulation of similar labels with somewhat different meanings, e.g entrepreneurial education, entrepreneurship education as well as entrepreneurship in education, see for example Erkkilä (2000) and Hytti and Heinonen (2013). The challenges of creating a unanimous definition may not only originate from the fact that entrepreneurship is a rather new field of research, but may also be due to the existence of different conceptions concerning education (Kyrö, 2015). Here, an example of a conceptual contrast is the traditional education on the basis of objectivism (teacher centered) and the progressive education on the basis of subjectivism (student centered) (Lackéus et al., 2016; Kyrö, 2015).

Despite the lack of definitional clarity, there are two distinct approaches to entrepreneurship in education - a narrow and a broad approach - both applicable in engineering education (Lackéus et al., 2016). The narrow approach is by Lackéus et al. (2016) described as entrepreneurship in the form of business entrepreneuri-

2. INTRODUCTION TO ENTREPRENEURSHIP IN ENGINEERING EDUCATION

alism which enables students to experience and learn about business start-up and management. The broad approach, on the other hand, regards entrepreneurship as a group of general competencies enabling individual students (as well as organizations, communities, societies and cultures) to be more entrepreneurial, e.g. flexible, creative and adaptable, in their everyday life.

Regardless of how the two main approaches above are considered - narrow, broad or a combination of both - the purpose of infusing entrepreneurship in education diverges in several ways. A common question regarding the purpose of infusing entrepreneurship in education is whether the students are to 1) expand their knowledge *about* entrepreneurship, 2) prepare *for* entrepreneurship by becoming entrepreneurs/more entrepreneurial, or if they are to 3) learn *in* a business context or *through* enacting entrepreneurial behaviors (Mäkimurto-Koivumaa & Belt, 2016; Pruett & Sesen, 2017). Depending on both the approach and the purpose, the content of entrepreneurship in education may vary.

According to Teerijoki & Murdock (2014) the concept of the entrepreneurial mindset is an increasingly used concept in research of entrepreneurship in education, which can be defined as:

“the ability to rapidly sense, act, and mobilize, even under uncertain conditions.” (McGrath & MacMillan, 2000, p. xv)

The entrepreneurial mindset intends to boost self-confidence, creativity and curiosity among students and suit explorative and brave individuals having the drive to work as future innovators (Teerijoki & Murdock, 2014; Mäkimurto-Koivumaa & Belt, 2016). Another new approach of entrepreneurship in education, is to teach and learn entrepreneurship as a method, i.e. *for* or *in/through* entrepreneurship, which exceed knowledge *about* entrepreneurship (Neck & Greene, 2011). Besides these approaches, entrepreneurship in education can be seen as teaching and learning to create value for others (Lackéus et al., 2016). Shortly, the word value can refer to all sorts of values, e.g. an economic, social, environmental or cultural value.

Also, there is no unambiguous idea of how to infuse entrepreneurship in education and, depending on both purpose and content, the level of extent may vary. For example, the embedding of entrepreneurial activities in the existing education may be favorable over electable courses or whole entrepreneurship programmes if the aim is to extend entrepreneurship coverage (Teerijoki & Murdock, 2014). On the other hand, if aiming for an exclusive entrepreneurial elite, whole entrepreneurship programmes should be considered (Teerijoki & Murdock, 2014).

2.3 PERCEPTIONS OF ENTREPRENEURSHIP IN EDUCATION

To become an entrepreneur, research has found that it is important to first identify oneself with entrepreneurs (Hytti & Heinonen, 2013). If this is also the case when learning to become more entrepreneurial, *about* or *in/through* the context of entrepreneurship, is not clear. However, perceptions generally influence people's intention and the way people act (Teerijoki & Murdock, 2014) and thereby also the learning process. Below, research about perceptions of entrepreneurship and entrepreneurship in education among students and faculty members (including teachers) are presented.

Two statistical studies about perceptions regarding entrepreneurship and entrepreneurial intention among students and teachers have recently been made by Shinnar, Pruett and Toney (2009) and Pruett and Sesen (2017). Shinnar et al. (2009), collected data from 317 students and 87 faculty members at an American 4-year university and Pruett and Sesen (2017) collected data from 3037 students and faculty members in the USA, China, India, Turkey, Belgium and Spain. In both studies, many of the students were from business departments, but also students from engineering sciences as well as communication and art constituted a part of the samples. The studies inform that the views of entrepreneurship often differ significantly between students and teachers (Shinnar et al., 2009; Pruett & Sesen, 2017). For example, regarding students occupational aspirations, where students to a larger extent than perceived by most of the teachers, aspired for working within public administration or in their own business, and not only in industry (Shinnar et al., 2009). Also, students, despite varying educational orientation and current year of study as well as cultures and economies, consistently claim to be more entrepreneurial than faculty believe them to be (Pruett & Sesen, 2017). Further, from a list of 16 possible motives, both faculty and students rank desire for personal independence and the chance of implementing one's own ideas as the top two motives for starting up one's own business (Shinnar et al., 2009). On the other hand, from a list of 20 supposed barriers, students see the excessive risk, lack of capital, one's current economic situation, competence, and knowledge as the top five barriers for why not to engage in starting up a business.

Only a few studies regarding students' perceptions of entrepreneurship in education have been made. Although, Peterman and Kennedy (2003) writes about an increasing student desire for participation in entrepreneurship education programmes in general. On the other hand, Dabbagh and Menascé (2006) states that engineering students perceive engineering as a purely technical field, suggesting that they may not be very open and/or interested in an addition of entrepreneurship within the existing education. Concerning this matter, it is important to distinguish between students' lack of knowledge about how entrepreneurship could be relevant to their career goals and a lack of interest among students, which Teerijoki and Murdock (2014) bring up as easily confused.

2. INTRODUCTION TO ENTREPRENEURSHIP IN ENGINEERING EDUCATION

Hytti and Heinonen (2013) have, through the study of seven written learning diaries from postgraduate life science students, found that there is a perception of the entrepreneur as a certain type of heroic personality. Here, the heroic entrepreneur is seen as a unique and powerful person who has inherited entrepreneurial traits and has a high status (Drakopoulou Dodd & Anderson, 2007). Some students found it hard to identify themselves with this personality and instead found it easier to identify themselves with entrepreneurs being “mere mortals” and telling their own stories about their difficulties when starting up a business (Hytti & Heinonen, 2013).

According to Neck and Greene (2011), entrepreneurship has historically been taught with a very narrow approach, resulting in students seeing:

“entrepreneurship as a box in which they either fit or do not.” (p.58)

This way of seeing is based on perceptions of having or not having certain characteristics of the entrepreneurial personality (Neck & Greene, 2011). In close connection, Pruett and Sesen (2017) also mention lacking of confidence as the biggest influencer on entrepreneurial interest.

The perceived lack of confidence seems to exist among teachers as well, which is described in a study by Teerijoki and Murdock (2014) regarding perceptions of entrepreneurship among teachers undergoing a process of introducing entrepreneurship in engineering sciences. The lack of confidence, for example constituted by the teachers being outside their comfort zone, lacking previous experience and/or knowledge within the area, creates a negative attitude towards teaching entrepreneurship (Teerijoki & Murdock, 2014). Teerijoki and Murdock (2014) conclude that this may arise from what the teachers in their study overwhelmingly express as a lack of connection between the engineering sciences and entrepreneurship. The teachers also claim that engineering education should aim at developing technical knowledge and therefore is the wrong learning environment for entrepreneurial skills. Additionally, they already feel that there is a short amount of time within the existing courses, leaving no room for additions.

Teachers’ perceptions of entrepreneurship in education are divided between being broad or narrow (Teerijoki & Murdock, 2014). For example, there are teachers thinking that there are many ways of being entrepreneurial, and that entrepreneurship in education does not have to involve starting a new businesses (broad approach). The teachers having a narrow understanding of entrepreneurship in education perceive a lack of relevance of infusing this in engineering education. Some teachers merely see start-ups as a way out for students remaining unemployed after graduation (Teerijoki & Murdock, 2014). Gibb (2011) also brings up an adverse resistance among teachers regarding teaching anything labelled “entrepreneurship”, since the word contains an undertone of capitalism and commercialisation. In contrast, the same teachers see some competencies, such as creativity, initiative taking and autonomy, which is often strongly associated with the entrepreneur, as desirable for all students (Gibb, 2011).

3 EMPIRICAL CONTEXT

This chapter describes the context of the data collection, i.e. Chalmers University of Technology and the ENG-project. Previous and/or simultaneous change projects are briefly considered as well.

Chalmers University of Technology (Chalmers) is a big organisation including many individuals and groups of individuals who affect or are affected by educational changes. In order to concentrate the thesis work, it is important to understand the complexity of the whole context (Burnes, 1996) as well as with good reason narrow down to chosen parts of the organisation. Therefore, this chapter contains a quite detailed description of Chalmers’ organisational structure related to the purpose of educating engineering students.

Chalmers provides degrees in both Master and Bachelor of Science in Engineering (Holmberg et al., 2012). The approximately 12,000 students are distributed between several different disciplines, such as chemical, physical, mathematical, mechanical and electrical engineering, as well as programmes within the fields of Architect and Teacher (Holmberg et al., 2012).

The organisational structure of Chalmers, see Figure 1, is constituted as a matrix consisting of horizontal processes, describing the main purposes of the university, and vertical lines, within which all members of staff are employed. There are three processes (educate, research and utilize), each one governed by different Vice Presidents. These processes together supports eight different areas of advance, all of which is governed by an additional Vice President. The lines are divided into 17 departments and several units of operational support, such as administration and service (Chalmers University of Technology, 2017).

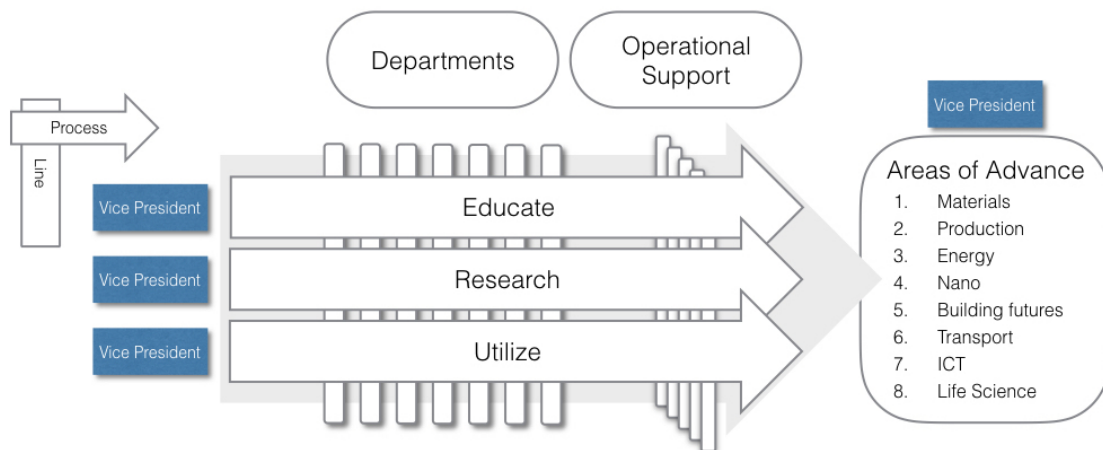


Figure 1: *The organisational matrix of Chalmers, including three horizontal processes and vertical lines, inspired by a pdf from Maria Knutson Wedel (personal communication, 13 February 2017).*

3.1 THE PURPOSE TO EDUCATE

In order to carry out the process of educating students, the undergraduate organisation cooperates with both the departments of the university and student associations (Chalmers University of Technology, 2017 & Chalmers Student Union, 2012a). To illustrate the process, a simplified organisational chart is presented in Figure 2. The undergraduate organisation is divided into four educational areas (KFM, EDIT-I, MATS, ASAM) and is lead by a management group consisting of the Vice President of the process to educate and each Head of Educational Area (HEA) among others. Each educational area includes several bachelor programmes, each one governed by the Head of Programme (HP), and a number of master programmes which, respectively, are lead by the Head of Master Programme (HMP). Both the HP and HMP are assisted in their work to develop and secure the quality of the programme by a Program Board consisting of teachers, students and representatives from business among others (Chalmers Student Union, 2012b).

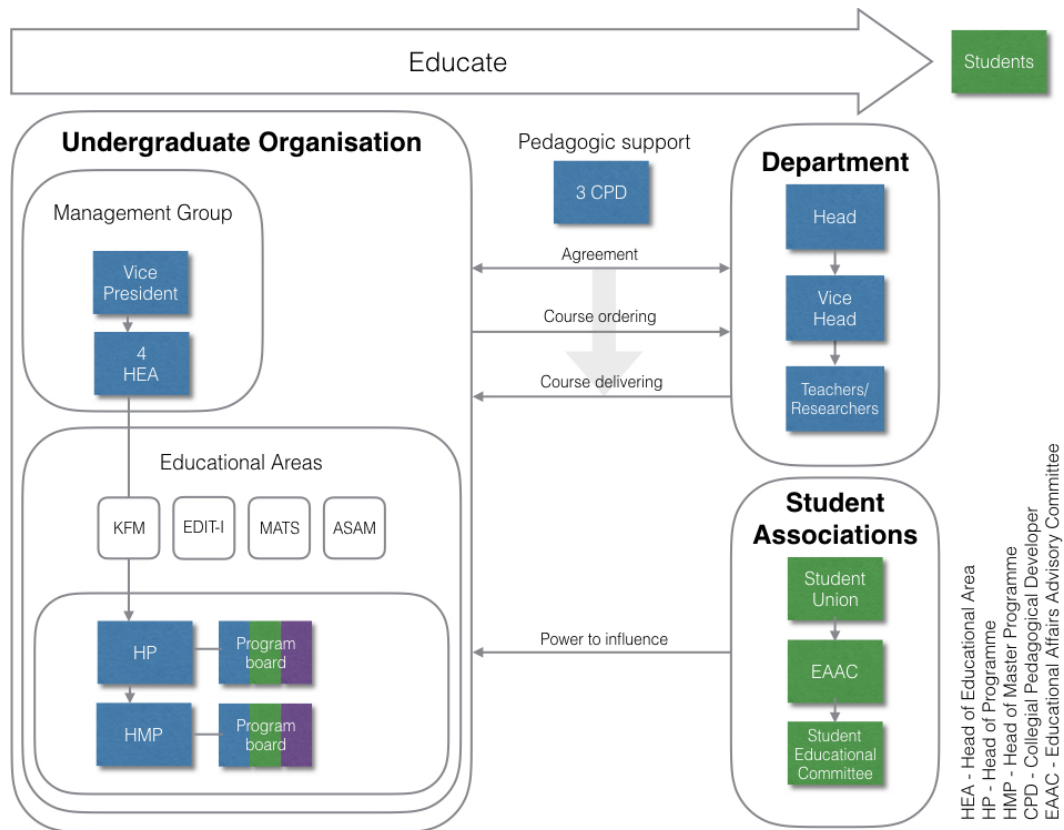


Figure 2: *The organisational structure for the process to educate at Chalmers, visualising the cooperation between the undergraduate organisation, the departments and student associations. Members of the faculty are represented in blue, students are represented in green and other externals (e.g. business partners) are represented in purple.*

Further, the cooperation between the educational areas and the departments, mainly involving a yearly agreement of course ordering and course delivering, is assisted by

three Collegial Pedagogical Developers (CPD) (Chalmers University of Technology, 2015). Finally, the Student Educational Committee which is a part of the Educational Affairs Advisory Committee (EAAC) and thereby the Student Union has power to influence the education (Chalmers Student Union, 2012a).

The goal of the process to educate, is divided into two main parts - disciplinary knowledge and personal characteristics. This goal is fully described by Chalmers (2017) as:

“Chalmers’ alumni have deep disciplinary knowledge combined with the ability to take on leading roles when it comes to the development, implementation and operation of technical systems, processes and services. Chalmers’ alumni can collaborate with experts from other professions and contribute a solid technical foundation to the resolution of complex societal problems.

Chalmers’ alumni have developed personal characteristics such as curiosity and courage, as well as the self-knowledge that generates the ability to continually develop their own competence and to take on challenges within new areas. Chalmers’ alumni use a value-creating mindset and an ethical approach, and have the ability to see their own in-depth theoretical knowledge in a broader context.”

Since, historically, most of the focus has been on the first part of the goal - disciplinary knowledge - several initiatives to broaden the education in line with the second part of the goal have been and/or are implemented. Examples of such initiatives are sustainable development (HU), societal relations (MTS), ethics, and cooperation (aiming e.g. towards increasing cooperation between different departments of the university as well as integration of external actors in courses and whole programmes). The latest addition to this list of educational change processes at Chalmers is the ENG-project, further described in the following section.

3.2 THE ENG-PROJECT

An initiative to infuse entrepreneurship in engineering education was started at Chalmers in 2015, which led to the formation of the ENG-project (where ENG stands for entrepreneurship in undergraduate education). The project goal within five years, is to offer entrepreneurial experiences as a part of the education to at least half of the undergraduate students at Chalmers (Henricson Briggs, 2016). Currently, an inventory situation analysis is conducted by the project group, in order to understand which are the already existing entrepreneurial features in the undergraduate education.

The ENG-project defines an entrepreneurial experience as an activity that consists of three components: 1) create value for others, 2) ideas and opportunities and 3) abilities and courage (Henricson Briggs, Faxheden, Kjellberg, Lackéus, & Hagvall Svensson, 2017). The definition is based on research by Bruyat and Julien (2001) and Sarasvathy (2001) and the three components of the definition is visualised in Figure 3.

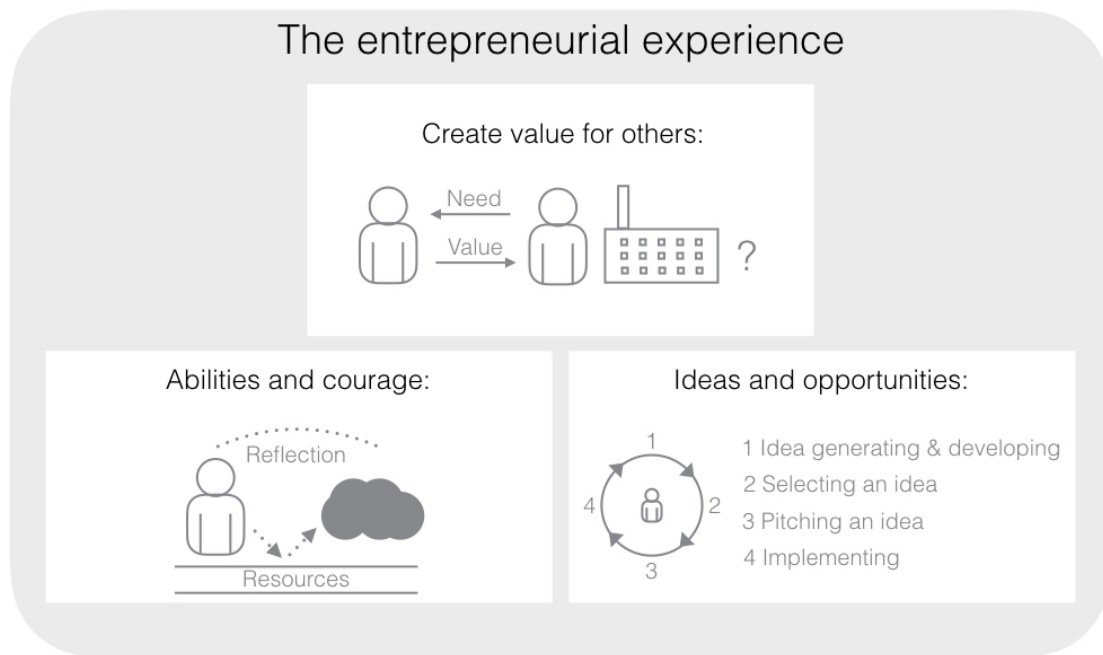


Figure 3: *The three components of an entrepreneurial experience. Inspired by the ENG-project's definition.*

Each illustration in Figure 3 is further described in the list below:

- **Create value for others:** Through interaction with others, students engaging in the illustration of creating value for others, will gain an understanding of others' needs and based on these needs create something of value for them. Here, the word value may refer to many types of values, further explained in Chapter 2.
- **Abilities and courage:** The illustration of abilities and courage demonstrates the ability to identify, combine and use own and other's resources, and the courage to in a reflective way deal with uncertainty.
- **Ideas and opportunities:** The illustration of ideas and opportunities summarises an iterative process involving idea generation, selection and pitching of one idea as well as implementing this idea in a relevant context.

This is merely a brief description of what an entrepreneurial experience can be, out of the perspective of the ENG-project. These experiences can be reached through different types of educational events, however to investigate in this further does not lie within the scope of this thesis work.

Entrepreneurship in education, in the eyes of the ENG-project, links entrepreneurial experiences and entrepreneurial competencies via entrepreneurial learning, i.e. being reflective, see Figure 4. Though, the ENG-project give no promise of developing entrepreneurial competencies among students engaging in an entrepreneurial experience. Instead, the aim of the project is rather to focus on the offering of such experiences. The role of the project group is to support teachers interested in incor-

porating entrepreneurial experiences within their courses and to create opportunities for discussion regarding entrepreneurship at Chalmers among colleagues.

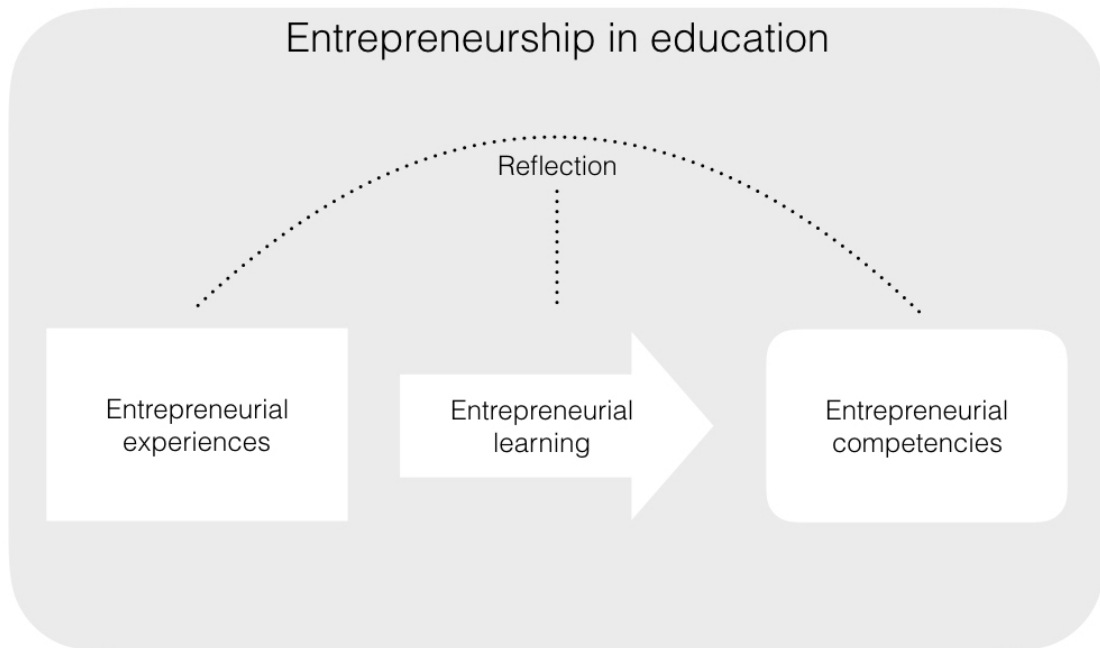


Figure 4: *The ENG-project relates entrepreneurial learning to entrepreneurial experiences and entrepreneurial competencies.*

In order to understand the complexity of the context for this thesis, it is relevant to investigate the stakeholders of the ENG-project. Bryson (2004) emphasizes that doing a stakeholder analysis, i.e. an investigation of any group or individual who can affect or is affected by the achievement of the project's or organisation's objective, is a way of reaching this kind of understanding. Further, Bryson (2004) also argues that nowadays this is more important than ever, because of the interconnected nature of the world and since these investigations often are valuable for the projects. Also, since it is hard to fulfill the wishes of all stakeholders it is common to identify and focus on the key stakeholders, i.e. the ones thought of as most important (Bryson, 2004).

In Figure 5, a mapping of the ENG-project's stakeholders is shown. The framework divides stakeholders into three main areas depending on if the stakeholder is affecting, is affected by or is both affecting and affected by a project (Chevalier & Buckles, 2008). Further, each area is divided in a three dimensional scale - most, moderately and least. The mapping was done by the writers of this thesis together with Kristina Henricson Briggs, leader of the ENG-project group, and should be seen of as a snapshot of the stakeholders' influence in the initial phase of the project. Arguments for the mapping position of each stakeholder is presented in Appendix B.

3. EMPIRICAL CONTEXT

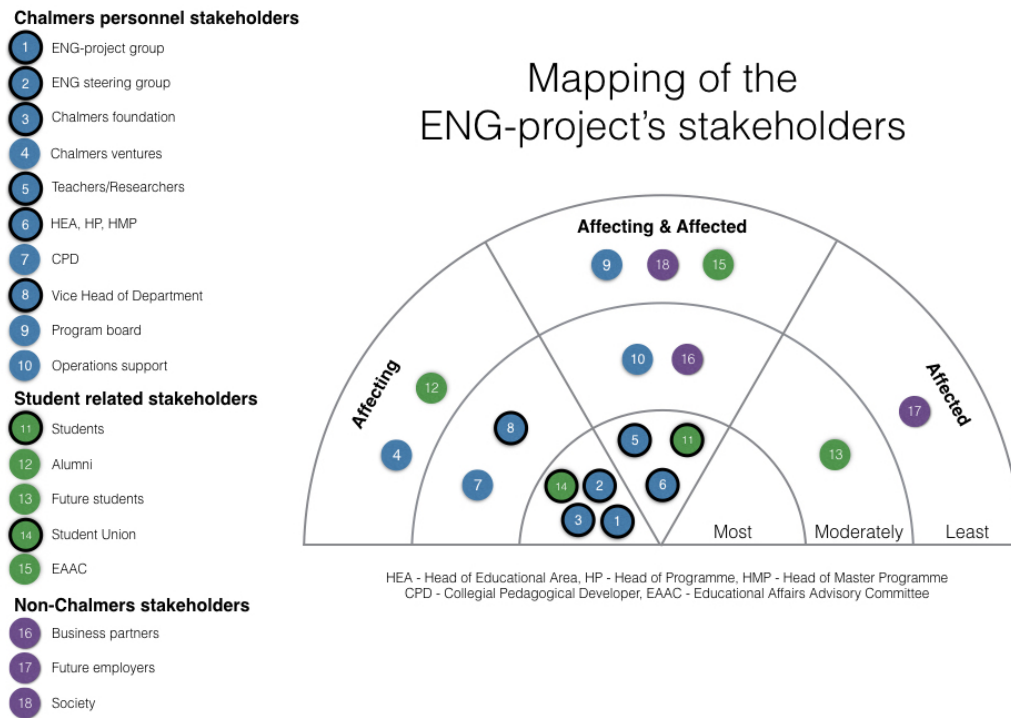


Figure 5: A mapping of the stakeholders of the ENG-project, using a framework inspired by Chevalier and Buckles (2008), where the stakeholders having a bold frame are key stakeholders.

4 METHOD

In this chapter the method used is explained, starting with a brief description of the research layout. A more thorough description of the different phases of the data collection and analysis is then presented, ending with a section concerning how validity is regarded in this study.

4.1 RESEARCH DESIGN

In order to investigate the research questions of this thesis, i.e. studying the perceptions of entrepreneurship as well as of entrepreneurship in engineering across campus, a qualitative study was used. A study of this type is focused on the participants' points of view and is preferable when aiming for a deep and nuanced understanding of people's perceptions (Bryman, 2008; Malmqvist, 2012). The main goal with the study is to describe how two phenomena - entrepreneurship and entrepreneurship in engineering education - are perceived from a second-order perspective, i.e. people's perceptions and experiences of the world (Marton, 2014). This, in contrast to the first-order perspective which describes the world itself.

By using a qualitative approach, a profound analysis of the existing perceptions regarding entrepreneurship in relation to higher education is enabled. This, in contrast to studies with a quantitative approach, e.g. Peterman and Kennedy (2003) and Pruett and Sesen (2017) who use questionnaires of predefined perceptions with belonging scales. Kvale and Brinkmann (2014) contrast these two approaches in the following way:

“The precision of the qualitative interview's description and stringency in the interpretation of the meaning corresponds to the accuracy of the quantitative measures.” (p.47)

Since the area of entrepreneurship in engineering education is a relatively new research area and related perceptions are not well-known, a qualitative approach is a particularly useful method since it provides a rich, yet complex, description of the entire data set (Braun & Clarke, 2006). Likewise, due to this background it is important to let the data within this study inductively speak for itself, e.g. by identifying and representing themes within the data (Braun & Clarke, 2006). To discover existing perceptions, an inductive and thematic analysis (Braun & Clarke, 2006) is considered to be the best option and is therefore used. Here, a theme represents some level of patterned response or meaning within the data set and needs to capture something important about the data in relation to the research questions (Braun & Clarke, 2006).

The intention for the research process was to begin with an introductory and exploratory phase, and to move on to a second in-depth phase. In order to explore the context of the thesis work and to better understand some aspects of how one can conceptualize entrepreneurship in education within the context, the exploratory phase

was broken down into two parts: 1) an initiation part including meetings with people knowledgeable in the area, reading of introducing literature and a stakeholder investigation of the ENG-project, 2) a workshop involving thoughts and group discussions regarding entrepreneurship and entrepreneurship in engineering education. The in-depth phase was in turn broken down into two parts: 1) a literature review including reading and synthesising literature about entrepreneurship and entrepreneurship in education as well as change process theories related to higher education, and 2) interviews with four students and four teachers. A conceptualisation of the method can be seen in Figure 6.



Figure 6: *The research process was divided into two phases: beginning with an exploratory phase moving on to an in-depth phase.*

Since the thesis work has been a learning process in itself and the knowledge has been growing throughout the project, an iterative approach to each part of the method has been applied. For example, the literature review can be thought of as an iteration of the initiation part and the literature review has been iterative in itself as well. This, since most of the texts read have been read and synthesised several times at different stages of the work. Also, the data of the workshop gave input to the interviews and, in a similar way, the interviews gave a deeper understanding of the data from the workshop.

In this study, the perceptions of people from the bachelor programmes Bioengineering and Engineering Mathematics are investigated, which are included in the educational area KFM. This, since the bachelor programmes provides a larger scope of people, rather than the master programmes on Chalmers. Also, the bachelor programmes are in some way placed above the master programmes, e.g. HP is superior to HMP, see Figure 2. Finally, Bioengineering and Engineering Mathematics are especially interesting to study due to the programmes' theoretical nature and the fact that the writers of this thesis has attended one programme each.

Furthermore, to access perceptions from people that have a direct impact on the possible infusion of entrepreneurship in education, the study mainly focuses on two groups; students and teachers. Firstly, these groups are also both belonging to the key stakeholders from the stakeholder investigation, see Figure 5, and both groups are strongly affected by changes within education and/or possess a big power of influence. Secondly, these two groups of key stakeholders distinguish from the others since they are both large groups, which facilitates the selection of participation and the assurance of anonymity in the study. Thirdly, most from these groups have not been introduced to the ENG-project and are therefore in a way unaffected prior to the study. Lastly, since teachers and students are central participants when it comes to educational changes, a deeper understanding of the existing perceptions from these two groups could be beneficial for people in charge of infusing entrepreneurship in engineering education in general and at Chalmers in particular.

The method of the workshop and the interviews as well as how validity has been regarded in this study are described more in detail in the following sections.

4.2 WORKSHOP

Focus groups are advantageous when exploring, for the participants, unfamiliar topics, since they allow for discussion (Bryman & Bell, 2007). Therefore, a 45 minutes long workshop regarding perceptions of entrepreneurship in engineering education was conducted at a cooperation meeting at the educational area of KFM, including i.a. representatives from the programmes Engineering Mathematics and Bioengineering. The data from the workshop mainly functioned as input for the preparations of the interviews.

In order to gather each individual's initial thoughts and perceptions, the 20 participants - Head of Programmes, Head of Master Programmes, students, Vice Heads of departments, Collegial Pedagogical Developer and administrative staff - did not know about the topics of discussion prior to the workshop. In this way, the participants couldn't discuss the topics in advance and thereby get influenced by others. Additionally, in order to access both individual and collective understandings of the topics, the discussions during the workshop was done according to the think-pair-share-method (Dyer, 2012, 15 November). This method begins with the conductor asking a question and each participant writing down their own thoughts. Then, the participants pair-up in small groups discussing their thoughts and ideas. Lastly, all groups get time to share their topics of discussion with the whole group. This method enabled the workshop participants to write down their own thoughts before discussing them with other participants.

According to ethical guidelines the participants were informed about the aim of the master thesis, the setup of the workshop including observation, confidentiality and matters of participation prior to the workshop (Kvale & Brinkmann, 2014; Vetenskapsrådet, 2002). The participation was voluntary and the participants also had the right to withdraw their participation at any time.

4.2.1 SETUP

The workshop had the following setup:

1. Three sessions of think-pair-share (Dyer, 2012, 15 November) in four self deployed groups of five. During the sessions the groups created so called think-pair-share-trees, see Figure 7, with the help of post it notes and big white charts. The following questions were thought of and paired during the sessions:
 - (a) **Session 1** - What is entrepreneurship? What are entrepreneurial competencies/traits?
 - (b) **Session 2** - For teachers: If you would like to help a student to become entrepreneurial, how would you do that in your teaching? For students: If you as a student would like to become entrepreneurial, how would you like to be helped by your teacher?
 - (c) **Session 3** - What possibilities do you see? What are your storm clouds?
2. A presentation round where one member of each group got one minute to share their think-pair-share-tree.
3. A short presentation of the ENG-project and their definition of entrepreneurship in education followed by comments and questions.
4. Feedback given by the observer to the participants.

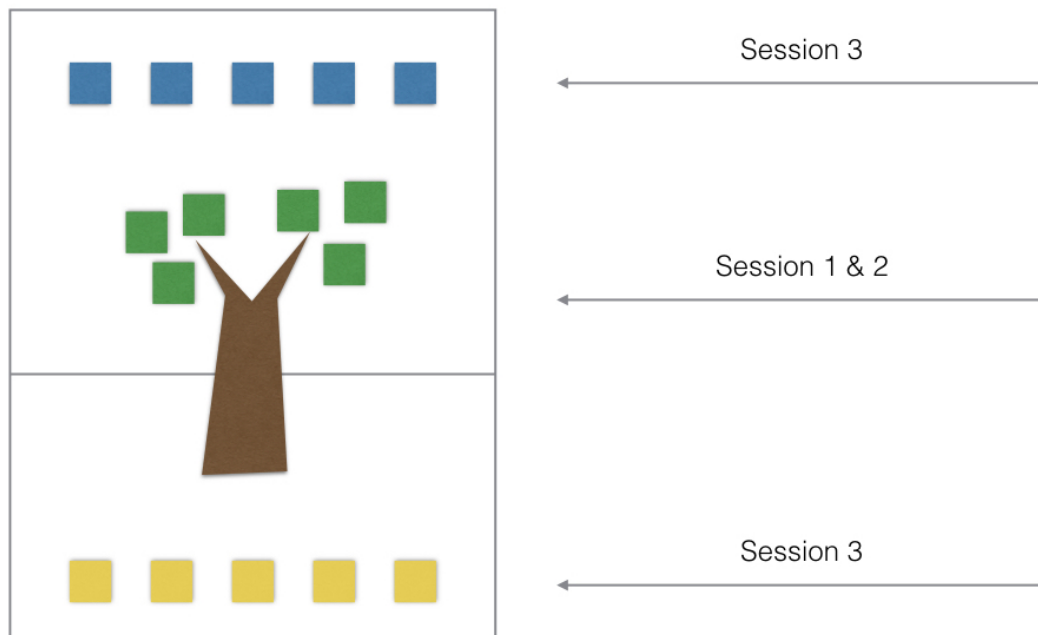


Figure 7: *The think-pair-share-tree, where the blue, green and yellow squares represent the post it notes.*

4.2.2 OBSERVATION

Making sure that the workshop was well observed, the observation was of the first order, i.e. the observer wasn't involved in the workshop and focused only on the observation (Björndahl, 2005), see Figure 8. Consequently, the workshop was held by one of the writers of this master thesis and observed by the other.

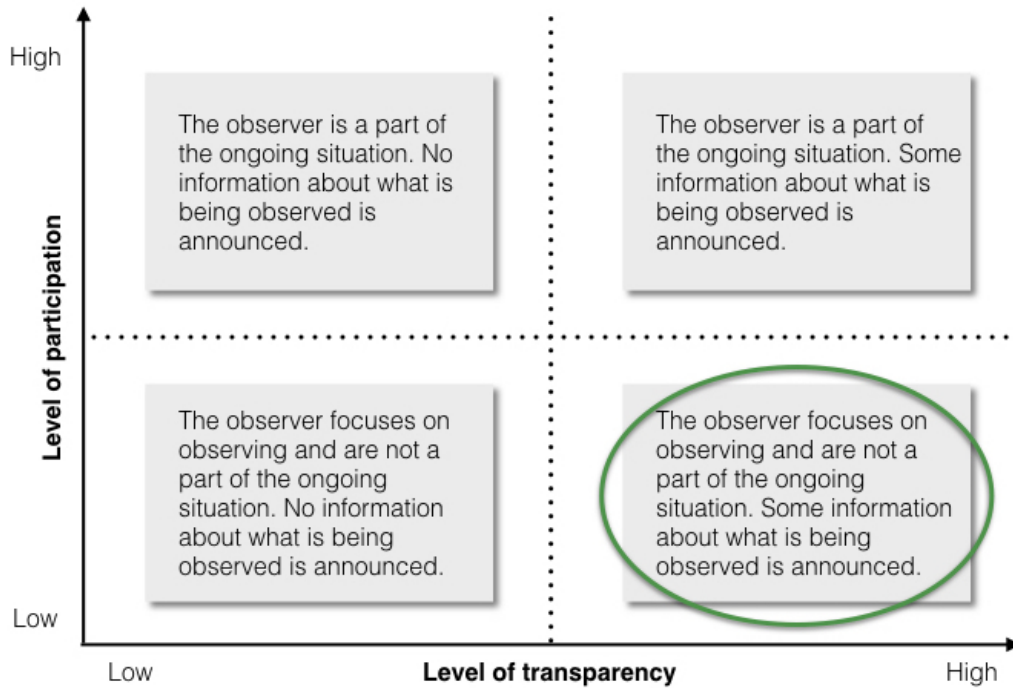


Figure 8: *Four possible roles of an observer, inspired by Björndahl (2005). The green circle marks the position of our observation, i.e. a high level of transparency and a low level of participation.*

To facilitate a rigorous gathering of data, the observation was structured, meaning that the observer used an observational template for notations throughout the whole workshop (Hermerén, 2011), see Table 1. To enable a closer contact with the participants, the template was filled in using paper and pencil.

Table 1: *The observational template used during the workshop, inspired by Björndahl (2005). The interpretation column was filled in after the workshop.*

	Description What is said/done?	Behaviour Reactions/emotions?	Interpretation Why did they say it?
Session 1			
Session 2			
Session 3			

4.2.3 ANALYSIS OF DATA

In order to recollect the totality of the observational data and to obtain trustworthiness, an initial analysis, based on the observational template, was made immediately after the workshop. The initial interpretation and summation were reached by dialogical intersubjectivity (Kvale & Brinkmann, 2014), i.e. through rational dialogues between the observer and the one holding the workshop ensuring concurrence. During this step the interpretation column in the observational template was filled in, see Table 1.

To reach a deeper understanding of the data from the workshop, a more detailed analysis on the basis of the general inductive approach, described by Thomas (2006) and Braun and Clarke (2006), was performed, using the steps described in the list below:

1. Summing each think-pair-share-tree
2. Summing of each session and thematising of post it notes
3. Aligning with initial analysis
4. Detecting patterns including reducing overlaps in themes
5. Cumulating interesting aspects

4.3 INTERVIEWS

Aiming to understand the interviewees' world of experience (Marton, 2014), eight semi-structured interviews were conducted (Kvale & Brinkmann, 2014; Ryen, 2004). Further, trying to reach a deep understanding of the interviewees, the interview position as an explorer (Kvale & Brinkmann, 2014) was striven after, see Figure 9. The interviews were approximately one hour long.



Figure 9: *Three possible interview positions - the pollster, the explorer and the attender, inspired by Kvale and Brinkmann (2014). The green circle marks our position.*

4.3.1 SELECTION OF INTERVIEWEES

Trying to obtain a varied set of data, a strategic approach for the selection of interviewees was used (Trost, 2010). This strategic approach was an attempt to get a set of data that covers a wide scope, which is often the aim when doing a qualitative research, rather than to get a set of data that is representative in a statistical matter (Trost, 2010; Braun & Clarke, 2006). Teachers and students from the bachelor programmes in Bioengineering and Engineering Mathematics were selected based on the variables seen in Table 2 and 3.

4. METHOD

Table 2: *The selection criterias for teachers, inspired by Trost (2010), with the variables grade and type of course.*

Teachers at the bachelor programmes Bioengineering and Engineering Mathematics				
Grade	1		3	
Type of course	Theoretical	Applied*	Theoretical	Applied*
Sample	Teacher A	Teacher B	Teacher C	Teacher D

Table 3: *The selection criterias for students, inspired by Trost (2010), with the variables grade and type of bachelor thesis (for third year students only).*

Students at the bachelor programmes Bioengineering and Engineering Mathematics				
Grade	1		3	
Bachelor thesis			Theoretical	Applied*
Sample	Student A	Student B	Student C	Student D

* The sectioning of applied regards that the course/thesis contains some practical elements, e.g. applied laborations and/or programming. This, since most of the courses and the bachelor theses at the bachelor programmes Bioengineering and Engineering Mathematics are of theoretical nature.

Besides these variables, the interviewers were not supposed to know the interviewees (Trost, 2010). Additionally, to ensure a high level of teaching engagement among the teacher interviewees, teachers with involvement throughout whole courses were preferred, e.g. teachers who both give lectures and are in charge of some examining events. All of the interviewees were contacted via e-mail, except for the two first-year students who volunteered after being approached during a lecture.

4.3.2 SETUP

According to ethical guidelines the interviewees were informed prior to the interviews about the aim of the master's thesis, the setup of the interview including recording, confidentiality and matters of participation (Kvale & Brinkmann, 2014; Vetenskapsrådet, 2002). The participation of the interviewees was voluntary and they also had the right to withdraw their participation at any time. An informed consent was signed by everyone involved in the interviews.

Semi-structured interview guides, one for the teachers and one for the students, were created and used during the interviews. To ensure the relevance of the suggested interview questions - with aspect to the research questions and the aim of the study - the creation of the guides started with a mapping of interview topics against RQ1 and RQ2. This was followed by a brainstorming session of interview questions for each topic. The guides were not used as questionnaires, but rather functioned as lists of specified interview topics with suggestions of questions (Trost, 2010).

In order to obtain an open and easy-going atmosphere and to avoid biasing the interviewees' answers, all questions asked were as short and simple as possible (Kvale & Brinkmann, 2014; Trost, 2010). Also, both introductory, open and exploratory as well as follow-up questions, e.g. exemplifying questions, were asked. Finally, as suggested by Trost (2010), questions starting with "why" were avoided.

To achieve a richer set of data and to enable a deeper understanding during the upcoming analysis, the interviews were conducted by two interviewers. Thus, one of the interviewers could focus on the agenda of the interview guide and the other on taking notes using a template, see Table 4, and thereby reach both a more focused interview and observation. To be able to dig deeper than what is explicitly said, the observational template included both a column for what was said and done as well as a column for reactions and emotions. This made it possible to write down notations about the participants being uncertain regarding some of the interview topics. To test each interview guide, prioritise the questions and estimate an approximate time frame for the interviews, two pilot interviews were conducted prior to the interviews. A foundation of the interview guide can be seen in Table 5 in Appendix A

Table 4: *The notation template used during the interviews.*

	Description What is said/done?	Behaviour Reactions/emotions?
Entrepreneurship		
The entrepreneur		
Entrepreneurial interest		
Entrepreneurial learning strategies and outcomes		
Engineering education and entrepreneurship		

4.3.3 ANALYSIS OF DATA

In order to recollect the entirety of the data and to obtain trustworthiness, an initial analysis, based on the notation template, was made immediately after each interview. The initial interpretation and summation were reached by dialogical intersubjectivity (Kvale & Brinkmann, 2014) between the two interviewers.

To reach a deeper understanding of the whole data set from the interviews, a data-driven inductive approach of thematic analysis, described by Thomas (2006) and Braun and Clarke (2006), was made. The steps of the analysis was divided into three main parts - reducing data, demonstrating data and sense-making of data (Ryen, 2004), see Figure 10.

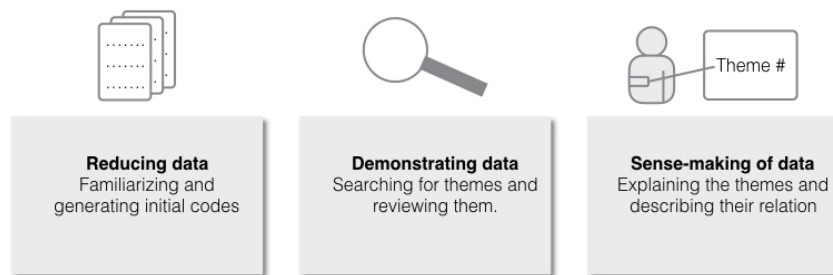


Figure 10: *The three main parts of the analysis - reducing data, demonstrating data and sense-making of data - inspired by Ryen (2004).*

A full description of the steps of the analysis is presented below:

Reducing data:

1. Familiarizing yourself with your data
 - (a) Noting down initial ideas directly after the interview
 - (b) Transcribing, anonymising and initial reading
2. Generating initial codes
 - (a) Identifying specific text segments

Demonstrating data:

3. Searching for themes
 - (a) Reorganising and labelling the segments of texts to create themes
4. Reviewing themes
 - (a) Reducing overlap and redundancy among themes
 - (b) Ensuring that the themes explain the entire data set

Sense-making of data:

5. Defining themes
 - (a) Explaining each theme
 - (b) Describing relation between themes

In order to stay open for some comparison between the interviews with the students and the interviews with the teachers, the generation of initial codes (step 2) was made separately for the students and the teachers before they were merged together. To ensure that the themes explained the entire data set (step 4b), the data from the workshop was considered after the joint analysis of the interviews with the teachers and student. Though, since the level of depth of the answers in the workshop was lower than the topics discussed during the interviews, no aspects from the workshop that was not further explained by the interviewees were used in the search for themes and explanations of them.

4.4 VALIDITY

Kvale and Brinkmann (2014) defines validation as the process of controlling, theorizing and questioning to make sure that the study answers the intended research questions. Throughout the thesis work, the following four questions, suggested by Kvale and Brinkmann (2014), concerning validity was regarded.

Is the study trustworthy?

In order to ensure a high level of trustworthiness, one of the main aspects to consider is researcher bias (Kvale & Brinkmann, 2014). To decrease this type of bias, the workshop functioned as a pre-study and as a mean to explore the perceptions within the context of the study, rather than perceptions on the basis of our own thoughts or the ones presented in literature. To maintain the relevance for both the participants in the study and the study itself, the use of think-pair-share-method during the workshop secured that each individual was heard.

Another way of decreasing researcher bias was the used setup for both the workshop and the interviews, where one had an observing role and one was focusing on the conduction. One down-side of the chosen setup for the interviews, being two persons to interview a single interviewee, is that the interviewee may feel as an underdog (Troost, 2010). With this in mind, the choice of semi-structured interviews was made in strive for enabling the interviewees to speak freely and reveal their own thoughts. However, an advantage of being two persons doing the thesis work together is that it enables dialogical intersubjectivity, which according to Kvale and Brinkmann (2014) increases the consistency of the study.

Additionally, in an attempt to remain neutral throughout the whole thesis work, the choice to not be a part of the ENG-project was made.

Is the design of the method relevant for the aim of the thesis work?

As mentioned in beginning of this chapter, since the area of entrepreneurship in engineering education is a relatively new research area and related perceptions are not well-known, a qualitative approach is a particularly useful method since it provides a rich, yet complex, description of the entire data set (Braun & Clarke, 2006). Likewise, it is important to let the data speak for itself, e.g. by identifying and representing themes within the data, which supports the choice of using an inductive and thematic analysis (Braun & Clarke, 2006).

In order to explore the context of the thesis work, the study began with an introducing exploratory phase, including an initiation part and a workshop. Further, to better understand some aspects of how one can conceptualize entrepreneurship as well as entrepreneurship in engineering education, the study moved on to a second in-depth phase, including interviews and a literature review.

Are the results from the workshop and the interviews reliable?

A risk when doing an inductive analysis, is the fact that themes may emerge out of the researchers head rather than from the data itself (Braun & Clarke, 2006). This, because it is impossible to neglect the active role of the researcher even if the position of the researcher is neutral (Taylor & Usher, 2001). To make sure that the themes actually emerged from the data itself, the analyses, both of the workshop and the interviews, included iterative steps, where the entire data sets were revised multiple times.

Does the report give a valid review for the main results of the study?

To give a valid review for the main results, the presentation of the themes are in a clear way based on thoughts and claims to one or several quotes, together with the interviewee who said them. To give the reader a full representation, all of the quotes supporting the themes and the conclusions are presented in Appendix C. Also, to help the reader to easily receive the main result as well as the report as a whole, visualisations and conceptualisations are used to support the reader.

5 RESULTS

This chapter presents the result of the thesis work including four themes regarding perceptions of entrepreneurship as well as of entrepreneurship in engineering education. Each theme is introduced with a visualisation depicting the essence of the theme along with three central quotes. The visualisations are followed by an elaborate representation of each theme.

The following themes are the result of the analysis of eight interviews - four with students (Student A-D) and four with teachers (Teacher A-D). The first three themes give descriptions of different perceptions of entrepreneurship along with perceptions of entrepreneurship in engineering education, while the last theme highlights the perceptions of entrepreneurship related to basic research. All quotes supporting the themes are presented in Appendix C.

5.1 THEME 1 - ENTREPRENEURSHIP AND PERSONALITY

This theme captures an aspect of entrepreneurship emerging from the interviews, namely that entrepreneurship is closely connected to the personality of individuals. Both teachers and students associate entrepreneurship with traits ascribed to a certain person, i.e. entrepreneurship lies in the personality. One does not necessarily have to be born an entrepreneur, however, if trying to learn entrepreneurship this requires changes in one's personality. This is also one of the reasons why entrepreneurship is considered hard to learn. A visualisation including three central quotes for this theme can be seen in Figure 11.

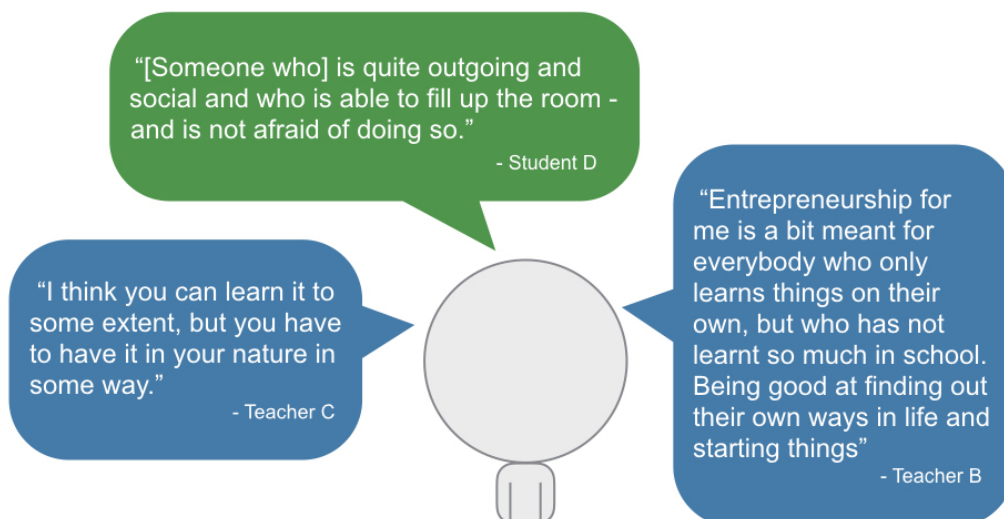


Figure 11: *Three central quotes for the theme of entrepreneurship and personality.*

Entrepreneurship is something that is hard to put into words, according to Teacher B, who also thinks entrepreneurship is a work of art where the entrepreneur has an artistic function. Some interviewees claim that entrepreneurship runs in the veins (Teacher C) and suits quite few (Teacher A). Among whom, Teacher B states that entrepreneurship requires another type of ‘bildung’ than what is given by the school system. This teacher even expresses it as a chance for those who do not learn so much in school but are naturals at finding their own ways in life by starting new things.

Furthermore, several interviewees characterise the entrepreneur with certain traits, such as being an idea generator, a socialiser and a communicator. For example, Teacher B, explains that new ideas are generated by just popping out, in an irrational way, in the mind. Also, several interviewees link idea generation with a trait of being creative. Both Student C and D describe the entrepreneur as a socialiser, meaning a person that is outgoing, networking and who is not afraid to fill up the room. The entrepreneur is described as good at communicating her/his ideas and visions (Teacher D) and as a person good at inducing belief and thereby also actions (Teacher B). In summary, these traits seem to paint an image of the entrepreneur as a certain type of personality that is hard to develop and live up to.

Some students express that their interests of becoming an entrepreneur are limited, since they do not identify themselves with some of the traits, e.g. being outgoing (Student C and D) or creative (Student A). Another consequence of this perception of entrepreneurship lying in the personality, is described by i.a. Student C who states that it is hard to affect or learn, since personality is driven by many factors. However, according to Student A changes in the personality, such as being more creative, can be made over many years.

Since entrepreneurship, by Teacher B is seen as a work of art with idea generation as a main component, the learning objective of entrepreneurship in education is suggested to be about being able to use a new mindset. In this mindset, Teacher B further includes breaking existing patterns and combining solutions that have not been combined before. The mindset is not spoken of as necessarily being a way to “truly” become an entrepreneur, rather, it is described as a feature of a role you may adopt. Also Teacher C and Student B touch the idea of learning a new way of thinking in order to become more entrepreneurial. This type of learning can occur by actively letting go of structures provided by a coursebook (Teacher C) as well as passively getting inspired by entrepreneurs (Student B), e.g. alumni, guest lecturers or available entrepreneurs at Chalmers.

Despite that some interviewees express entrepreneurship as hard to learn and suits quite few, they are at the same time somewhat positive to the existence of entrepreneurship at Chalmers - for those students who are interested. The same interviewees suggest that entrepreneurship should be offered by Chalmers as electable courses. Although, to avoid missing out on suitable students, whom may become interested in entrepreneurship if only introduced to it, Teacher C also advocate that this should be a mandatory part of the bachelor programmes.

5.2 THEME 2 - ENTREPRENEURSHIP AS STARTING A BUSINESS

In this theme, entrepreneurship and learning to become entrepreneurial is brought up in relation to starting up businesses. Here, the central part is the initial phase of starting something. Some illustrative examples are presented in Figure 12.

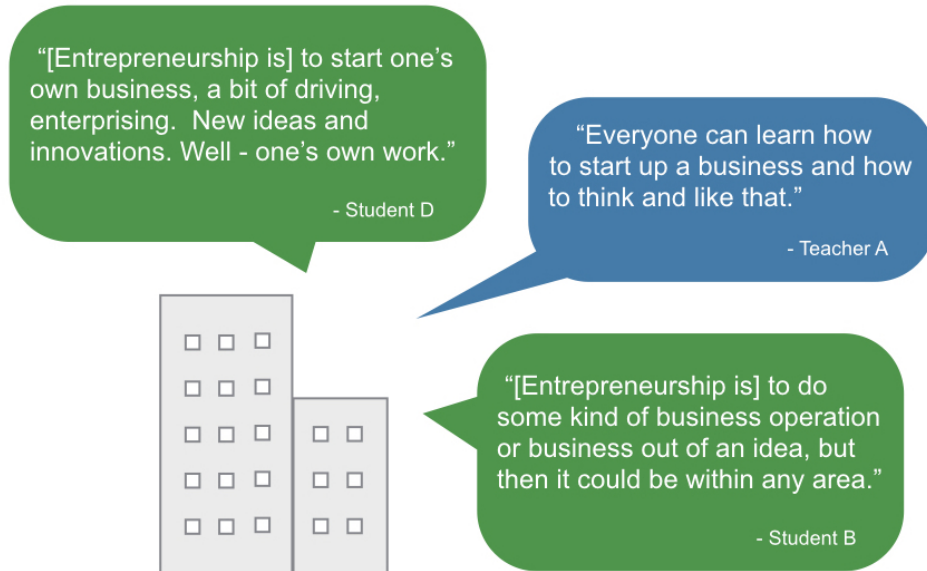


Figure 12: *Three central quotes for the theme of entrepreneurship as starting a business.*

Entrepreneurship is, among several students and teachers, associated with self-employment and start-ups. Specifically, Teacher D links entrepreneurship to profit-driven businesses where innovation is at the core. Some of the interviewees exemplify the entrepreneurial process as creation and execution of ideas - being in the context of starting up and initially running a business.

In close connection to the idea execution process, the entrepreneur is among some students and teachers thought of as a hard-working executor with abilities to initiate applications of ideas as well as to organise the execution (Student D) and solve problems along the way (Student B). Some students clearly identify themselves with an executor role and these students are also interested in learning how to start up a business.

Since entrepreneurship in this theme is regarded as starting up businesses, this is also interpreted as the main learning outcome of entrepreneurship in education. Among the interviewees there is a unanimity about the fact that it is possible to learn how to start up businesses, although some teachers mention that they are uncomfortable teaching entrepreneurship viewed in this way due to lack of this type of experience. Despite the unanimity, the suggested learning process differs among the interviewees. For example, Student D speaks about active hands-on-experiences including continuous guidance from teachers. Another example is Student C, who

suggests listening to concrete examples from entrepreneurs who have the experience of starting and pushing through large projects.

This view of entrepreneurship, i.e. starting up businesses, seems to divide the interviewees when it comes to the relevance of infusing entrepreneurship in engineering education. It appears to exist a rift regarding whether this type of entrepreneurial features belong within engineering education at Chalmers.

Among those being more positive towards the infusion of this kind of entrepreneurship in the engineering education at Chalmers, the importance of a broad engineering education is brought up. Also, some general knowledge about starting up a business is considered valuable for all students no matter where they end up (Student D) and the connection to working life is also thought to be reinforced (Student B). Entrepreneurship in education is also by Teacher C regarded as important since Chalmers is responsible for highlighting all types of possible career choices for engineering students - not only within academia or industry, but also within the public sector and entrepreneurship. Student C believes many students are afraid of starting something, but this fear is thought to decrease by taking this kind of courses and getting familiar with the concept of being entrepreneurial.

Those being more negative towards the infusion of this kind of entrepreneurship in the engineering education at Chalmers, state that it takes focus from the essential parts of the education and undermines the major field of study. Among those people, Teacher A thinks that it already exists a lot of elements that are squeezed into the engineering education at Chalmers, e.g. bachelor thesis work, societal relations (MTS), sustainable development (HU) and ethics. Even those with a generally positive attitude towards the infusion, emphasise that it may be hard to introduce the practical features of starting up a business within some subjects that are clearly theoretical, since it creates such a contrast to the already existing education.

5.3 THEME 3 - ENTREPRENEURSHIP AS MANAGING PROCESSES

This theme entails a view of entrepreneurship as the managing of processes, not necessarily within a business context. The processes may be big or small, but when learning entrepreneurship smaller processes are seen as more manageable. Therefore this view of entrepreneurship seems easier than other perspectives of entrepreneurship to infuse in engineering education. Three central quotes representing the theme can be seen in Figure 13.

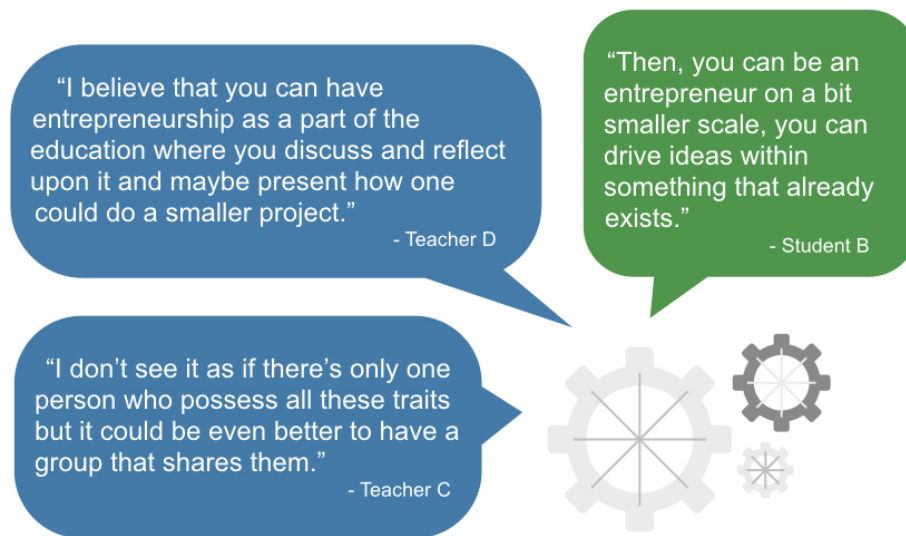


Figure 13: *Three central quotes for the theme of entrepreneurship as managing processes.*

Student C talks about entrepreneurship as the running of a business, focusing on the driving process. Here, the business could be of any type, e.g. non-profit or profit-driven, and the driving of ideas could be on different levels within a business. For example, Student B mentions development within an already existing structure. Some students express an interest in this view of entrepreneurship, rather than in entrepreneurship as focusing on starting up new businesses.

One teacher thinks of the entrepreneur as a driver of new projects and ideas (however not in the context of starting up a whole new business), much alike an executer. Also, according to Teacher C, the entrepreneur does not have to possess all entrepreneurial traits or abilities oneself, and that it could be beneficial if these are distributed over a team. Another teacher talks about an entrepreneurial ability, which includes to discover possibilities for cooperation and to put together a team accordingly.

In regards to learning outcomes and approach, our interpretation is that the learning objective of entrepreneurship in education is to be able to carry out processes on a smaller scale. The strategy to reach this objective, is by Teacher D suggested to include discussion and reflection about entrepreneurship and also presentation of possible ways and tools for carrying out smaller projects. Some students also mention that they can learn by given examples and by studying the contributions of other members during a group work or discussion. Thus, it is not seen as necessary to practise in order to learn about how to execute smaller processes, which enables for more time efficient entrepreneurial activities.

5.4 THEME 4 - ENTREPRENEURSHIP AND BASIC RESEARCH

This theme is specific for the teachers, since they tend to, when talking about entrepreneurship, relate it with basic research. It appears to exist a rift between entrepreneurship and basic research and some examples of this are presented in Figure 14.

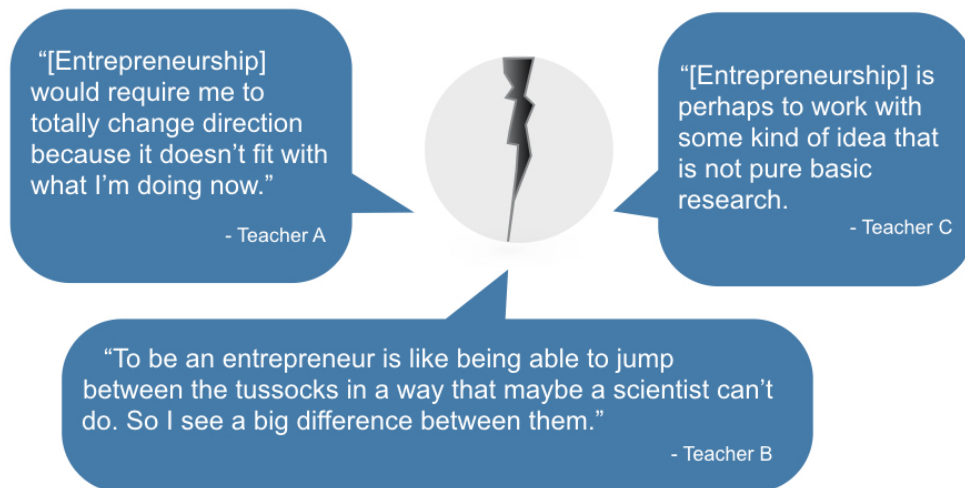


Figure 14: *Three central quotes for the theme of entrepreneurship and basic research.*

Entrepreneurship is by the Teacher C seen as a process of working with an idea that is not related to basic research. Teacher C continues by contrasting entrepreneurship with basic research, and claims that the outcome of entrepreneurship will be directly usable for others, whereas basic research works on a longer time frame to provide research for others to apply. Further, according to Teacher A, basic research has its place in the chain of research but is, unlike entrepreneurship, not disposable for the market. Hence, the level of utilisation seems to distinguish entrepreneurship from basic research. Also, Teacher D describes entrepreneurship as a subset of the larger process of utilisation, where utilisation beyond entrepreneurship includes other ways of doing good, such as exchange and communication of science to the public and its authorities. Some of the teachers express that non commercial ways of working are more in line with their values.

All of the above are examples of the perceived differences between entrepreneurship and basic research. On the same track, Teacher B states that there are differences between entrepreneurs and researchers as well. This teacher explains that entrepreneurs have the ability to broaden their views and jump between the tussocks in a way that is not possible for the researchers, since the researchers need to narrow down their views and focus on the one tussock where they will contribute to science.

Another difference, further explained by Teacher B, is the role of the entrepreneur, aiming to convince people that an idea will work, unlike the researcher, who is tied to

5. RESULTS

ideas that actually work. Consequently, some teachers express that the entrepreneur needs to have wild ideas, leading or (in most of the cases) not leading to success. This is also combined with a, in Teacher B's point of view, somewhat unreflective way of marching forward. Though, there are some parts of being entrepreneurial that researchers find it easier to identify with, such as the ability to seek financial resources. Although, some researchers find themselves financially overshadowed by convincing entrepreneurs that promise a lot but only deliver a tad.

6 DISCUSSION

In this chapter the perceptions of entrepreneurship as well as of entrepreneurship in engineering education along with their possible implications for the educational change process are discussed. This is followed by recommendations for infusing entrepreneurship in engineering education and suggestions for future work, ending with a discussion of limitations related to the method used in this study.

6.1 DISCUSSION OF THEMES

During the interviews the questions asked were formulated in a way so that the title of the entrepreneur did not need to be the central focus of the conversations, but rather the option of talking of entrepreneurial features was given. Despite this, it seems hard for many of the interviewees to think in a different way than linking entrepreneurship to a certain type of person, i.e. the entrepreneur. Although some of the interviewees see the entrepreneur as a certain type of congenital personality, it seems hard to speak of certain entrepreneurial skills, which may be due to the elusive role of the entrepreneur. This may also be an effect of the lack of definitional clarity regarding entrepreneurship, which may make it hard to put entrepreneurship into words - something that was generally noticed during the interviews.

Together, all of the themes represent a diversity of perceptions regarding the role of the entrepreneur. This may be an effect of the non-existing educational certification of the title of the entrepreneur, which makes it possible for anyone to claim to be an entrepreneur. This also makes it hard to understand what being an entrepreneur actually means, which in turn may contribute to the perceptions presented in Theme 1 - that an entrepreneur is something that you are and not something that you become. All of the above affect how people think about entrepreneurship in education and contribute to the image of learning entrepreneurship as something difficult and abstruse.

In Theme 1, unlike Theme 2 and 3, the perceptions are focused on entrepreneurial traits rather than on abilities. Especially, the social and the creative personality is highlighted. The entrepreneur as a social and networking kind of person is particularly interesting since this is something that previous research seems to not mention. These traits depict an image of the entrepreneur, not unlike the heroic image of the entrepreneur having a high (social) status (Hytti & Heinonen, 2013; Drakopoulou Dodd & Anderson, 2007). During the interviews it was both expressed by the interviewees and sensed by the conductors that many of the interviewees felt uncomfortable with their image of the entrepreneur which in turn also gave a feeling of unattainability among them.

Even if some interviewees perceive that entrepreneurial learning involves changes in one's personality, they also believe that it is possible to assimilate an entrepreneurial mindset. This is not necessarily a way to "truly" become an entrepreneur, rather,

the entrepreneurial mindset is spoken of as features of a role you may adopt. Our interpretation of the interviewees responses is that one does not have to fully identify oneself with the entrepreneur in order to adopt this entrepreneurial mindset, it is still possible to imitate the entrepreneur and step into her/his shoes. Earlier research emphasises that to become an entrepreneur you also have to identify with the entrepreneur (Hytti & Heinonen, 2013). However, our study tells us that in order to adopt an entrepreneurial mindset, this requirement is not perceived equally strong.

The mindset, described out of the interviewees' perspective, slightly differs from what is described by McGrath and MacMillan (2000). Our interpretation is that the interviewees' view of this mindset is mostly connected to idea creation and creativity, unlike McGrath and MacMillan (2000) who instead emphasises strategies for management under uncertain conditions. In general, the interviewees link entrepreneurship to idea creation and creativity, thus, it is not strange that they also talk about the entrepreneurial mindset in this way. Uncertain conditions are by the interviewees not particularly mentioned as a part of entrepreneurship and/or the entrepreneurial mindset. Although some speak of bold and wild ideas which indirectly suggests that uncertainty is present. However, uncertainty seems to only be a part of the idea creation process and not as a feature of central attention. Thus, our interpretation is that the interviewees feel uncertain with entrepreneurship in itself, rather than that uncertainty is a central part of entrepreneurship.

Theme 2 brings up a view of entrepreneurship as starting businesses. This, in contrast to Theme 3, which specifically points out the managing of processes - which does not necessarily have to be in a business context. In other words, Theme 2 is in line with what Gartner (1988) describes as organisational emergence and follows what the BusinessDictionary (2017) describes as the most obvious example of entrepreneurship, namely the starting of new businesses. Hence, it is not so strange that a theme like this has emerged from the interviews.

Most interviewees supporting Theme 2 seem to perceive the infusion of entrepreneurship in engineering education as introduction of new content. This stands in contrast to the ambition of the ENG-project, which aims to introduce entrepreneurship mainly as a new approach to teaching existing curricula. Also, some of the interviewees believe it is hard to infuse entrepreneurship in education and that it may intrude on the essential parts of the engineering education. This may emerge from the belief that the events of entrepreneurship in education is something major and demands a lot of time, which seems to induce a feeling of unachievability. For example, Teacher A thinks that it already exists a lot of squeezed in elements in the engineering education at Chalmers. The short amount of time within the existing courses, leaving no room for additions, is also mentioned by Teerijoki and Murdock (2014) as something that increases a negative attitude among teachers when infusing entrepreneurship in engineering education.

Even though not all students themselves are interested in learning entrepreneurship fully, there are - independent of one's view - positivity among students towards entrepreneurship in general. Also, some students are positive to the narrow approach of entrepreneurship as starting of businesses. This positivity may come from the fact that there are a lot of successful entrepreneurs getting much positive attention in society in general as well as in (social) media. Though, related to Theme 2, a clear sense of entrepreneurship as something unfamiliar was registered and in some cases also fear was expressed by students. For example, Student C states that

“to start up something like that - that you've never learnt - and I think that maybe it makes you a little scared of starting up something”.

This can be interpreted as a sign of lack of confidence among the students, which according to Pruett and Sesen (2017) is the biggest influencer on entrepreneurial interest. This may also be a response to uncertainty, previously mentioned when discussing Theme 1, which once again is not explicitly spoken of but can be read between the lines in Student C's quote.

Theme 3 highlights an alternative image of entrepreneurship, namely the managing of processes, and can be interpreted as a toned down version of both views of entrepreneurship in Theme 1 and 2. Also, the interviewees talk about what seems as a less heroic entrepreneur related to this theme. For example, Student B talks about being an entrepreneur on a bit smaller scale, e.g. driving ideas within structures that already exist, which is an example of an alternative identity in line with the so called intrapreneur mentioned by Hytti and Heinonen (2013). This alternative option is by some students expressed as appealing, which may come from being sensed as more attainable. Also teachers seem positive towards entrepreneurship as the managing of processes, since this is not perceived as very time-consuming, and therefore not necessarily something that competes with other content in the existing education. Rather, entrepreneurship in education could be integrated within the education in a way that reminds of teaching entrepreneurship as a method. For example, Teacher D mentions that a possible way of teaching and learning entrepreneurship is through doing small projects. All in all, infusing this type of entrepreneurship in engineering education seems to be perceived as manageable.

Theme 3 also differentiates from Theme 2 since it is not perceived to be such a big contrast to the engineering education. This contrast is explicitly mentioned by Student D and may originate from the fact that the programmes Bioengineering and Engineering Mathematics belong to a mainly theoretical educational area (KFM) at Chalmers. In fact, Theme 4, which describes the difficulties of unifying entrepreneurship and basic research, as a whole may originate from this perceived contrast. Theme 4 is not so much about descriptions of entrepreneurship as of teachers' somewhat negative reactions towards it. Since teachers are also researchers and KFM in particular is very connected to basic research it is not odd that a theme like this has emerged out of the data.

The perception that entrepreneurship is far from basic research is not something entirely new, since in close connection to this, Teerijoki and Murdock (2014) raise that some teachers claim engineering education to be the wrong learning environment for entrepreneurial skills. Moreover, they write that teachers tend to have a negative attitude towards teaching something outside their comfort zone. This is also noticeable in this study, e.g. Teacher D expressing that s/he would refer to somebody that is better equipped for teaching entrepreneurship. This implies a rather weak interest and that some teachers - at least within research oriented educational areas - are expected to decline the task of infusing entrepreneurship in their courses.

Among some of the teachers, entrepreneurship is associated with making money and marching forward in an unreflective way. Between the lines it seems to exist a resistance, probably coming from what Gibb (2011) describes as an opposition towards teaching something that is perceived born out of capitalism and commercialism. Especially, Teacher D states that s/he is not driven by making money, which may imply that her/his view of entrepreneurship does not match her/his core values. During the interviews, a touchable sense of teachers' contempt towards the commercialistic parts of entrepreneurship has been observed. This has not been the case when it comes to the students, where only one of them links entrepreneurship with making money and in that case, it was rather seen as something successful and desirable.

It's reasonable to believe that the teachers find entrepreneurship hard to unify with basic research as a consequence of their view of the concept of entrepreneurship. However, no clear connection between the previous themes (Theme 1, 2 and 3) and this one (Theme 4) has been found. It seems as this is more of a general attitude towards the infusion of entrepreneurship in engineering education. This is supported by Teacher A, who experience that the word 'entrepreneur', at least within the older generation of academia, is associated with negative feelings. This in turn makes us conclude that entrepreneurship is seen as a path lying outside the woods of basic research.

6.2 DISCUSSION OF IMPLICATIONS

It is important to keep in mind, that for each theme there is a scale of how much each interviewee has contributed. In general, each theme is built up from mainly one or two interviewees, but is also enriched by some additions from other interviewees. For example, Theme 1 contains teachers and students perceiving entrepreneurship to fully belong to one's personality and thereby believing it is hard to learn. But also, it contains those who think that only some parts of being entrepreneurial are hard to learn, e.g. becoming creative. With this in mind and since individuals even within the same group of stakeholders have different perceptions, it is important to have a dialogue with individuals and to be responsive to their perceptions. Also, since some of the teachers perceive entrepreneurship as hard to learn, the approach of the ENG-project to direct the focus on interested teachers, is a good approach.

Though many interviewees easily speak about entrepreneurship and entrepreneurship in engineering education, they also express a feeling of uncertainty regarding if their perceptions are the “right” ones. For example, expressions like “this is only based on my personal prejudices” (Teacher B), “now you will hear about my lack of knowledge” (Teacher A) and “the other interviewees, have they answered quite similar or fundamentally different?” (Teacher D). Additionally, all of these expressions have been combined with nervous laughter. Even though these interviewees are expressing themselves as not being acquainted with entrepreneurship, they are indeed conversing the topics. This implies that the interviewees speak out of their own understanding of entrepreneurship which in turn suggests that their words really are perceptions. These perceptions need to be respected and dealt with when infusing entrepreneurship in engineering education. Although, since many of the interviewees appear to be uncertain about their view of both entrepreneurship and entrepreneurship in education, there is an opportunity that they may be receptive for other interpretations if presented to them.

No narrow or broad division related to how the interviewees speak about entrepreneurship in education in general was observed during the interviews. For example, it appears to be no connection between interviewees speaking about content focus of entrepreneurship in education and having a narrow approach, nor between interviewees speaking about entrepreneurial skills and a broad approach. Also, interviewees with a mainly narrow approach sometimes speak in broad terms. This implies that entrepreneurship in education is ambiguous and that some interviewees combine aspects belonging to different themes in their view of entrepreneurship in education. This ambiguity entails that teachers as well as students may be receptive for the ENG-project’s broad approach, but a presentation along with group discussions are needed in order for more of them to feel comfortable with this type of educational infusion. In line with both Malmqvist et al. (2010), Wertsch (1998) and Svanström et al. (2012), it is also important to let the infusion take its time, so that all people - affected and/or affecting - get enough time to digest the educational change.

In the vision of the ENG-project, the concept of an entrepreneurial experience is used. The definition of an entrepreneurial experience is by the ENG-project divided into three parts - create value for other; abilities and courage; ideas and opportunities - where value creation permeates all three parts. During the interviews, the interviewees did not mention the ENG-project and their definition, and none of the interviewees had heard about the ENG-project before (which was asked in the end of each interview). In the following list we will discuss the interviewees’ perceptions of entrepreneurship in engineering education in relation to the three different parts of the ENG-project’s definition of an entrepreneurial experience.

- **Create value for others** is mentioned the least out of the three parts and when it is mentioned it is by teachers having a negative tone relating it to the context of making money. Also, one student relates entrepreneurship with making money, but in this case having a positive tone. In general, both students and teachers seem to talk about value creation and being an entrepreneur for egoistic reasons, in contrast to the ENG-project who rather highlights that value, through entrepreneurship, are to be created for others.
- **Abilities and courage** are not directly mentioned by the interviewees, but our interpretation is that this is something that the students are comfortable with since they believe that they are already practising it, especially during different types of group work. For example, in Theme 3 some students mention that they can learn by studying the contributions of other team members during a group work or discussion. It is also expressed that traits and abilities can be distributed within a team instead of belonging to just one individual. This is in line with the ENG-project's view, although they are exclusively talking about abilities and not about traits. Courage is not mentioned by any of the interviewees.
- **Ideas and opportunities** is out of the three parts of the definition what is concerned the most during the interviews and is often by the interviewees closely related to entrepreneurship in general. In contrast to the ENG-project, the interviewees do not talk about ideas in the form of a chain of idea development, but simply as coming up with ideas and sometimes also pitching them. Though, idea creation is by both teachers and students expressed as hard to learn, see Theme 1. Consequently, the ENG-project should expect that people having a view in coherence with Theme 1 may find it difficult to take on this third part of the definition.

Since the way the ENG-project defines an entrepreneurial experience differs from how all interviewees perceive entrepreneurship in engineering education, it may be appropriate to consider the choice of the label entrepreneurship in this case, or alternatively to be very explicit regarding what entrepreneurship at Chalmers means. Otherwise, one needs to be prepared to fight against people's perceptions on this matter. All of this is further complicated by the fact that entrepreneurship as well as entrepreneurship in engineering education is a rather new and yet undefined field of research, which perhaps makes it easier to criticize and question the project.

As described in Chapter 3, Chalmers has a bisectional goal for the process to educate - disciplinary knowledge and personal characteristics. Based on the interviews, it seems like many of the teachers are committed to the first part of the goal, whereas the second part is being somewhat neglected. Among the teachers actually mentioning that the education should strengthen certain personal characteristics, e.g. curiosity and courage, entrepreneurial experiences are not connected with leading to these characteristics. Even though, some of the characteristics mentioned appear to be the same as the ones in literature expressed as entrepreneurial. Consequently, it could be that teachers either do not see a clear connection to the second part of

the goal as they teach theoretical subjects and/or feel that entrepreneurship is not the way to learn these kinds of characteristics.

Though the above may sound a bit hopeless, one should not forget, that it exists a reasonable background to why the educational change of infusing entrepreneurship in engineering education at Chalmers has been taken on in the first place. Included in this background is the benefit of broader skills among engineers (Dabagh & Menascé, 2006; Crawley et al., 2014), which is also brought up as something positive by teachers and students during the interviews. Also, the possibility for employment is by some of the interviewees thought to increase by learning more about entrepreneurship, not only because of having more general skills but also since students will become aware of different career choices as well as increasing their professional network.

Although, the positive teacher interviewees also seem to have a tendency of neglecting infusion of entrepreneurship in their own courses, often stating that they are not experienced enough. However, engineering students seem to find it easier to listen to “mere mortals” lecturing about entrepreneurship than to successful business entrepreneurs, described by Hytti and Heinonen (2013). So, not being as experienced within entrepreneurship could actually be an advantage when trying to reach out to engineering students. Therefore the tendency of having “technical” teachers declining infusion of entrepreneurship in their courses may be an issue for the ENG-project. Further, since the ENG-project is dependent on interested teachers in order to success with the change process, this has the potential of becoming an even larger issue. The teachers’ power to be able to decline is an indicator of the teachers’ autonomy at Chalmers, which simultaneously must be dealt with and respected (Lundqvist, 2016). If this becomes a problem and the goal of the project is seen as crucial, it might then be necessary to use a top-down strategy of leadership, keeping in mind the risk to decrease teacher’s high level of autonomy.

Another explanation for the tendency of unwillingness may be a temporarily exhaustion coming from previous and ongoing change processes within the education. This may call for the importance of not missing out on the opportunity to hook on to other processes of change, mentioned by Lundqvist (2016). However, the exhaustion may not only be due to the change processes in themselves but the problem may be in what they attempt to bring with them. For example, Teacher A describes this tiredness as s/he expresses that

“something that I think is a bit problematic, especially at Chalmers, is that very many mandatory elements are to be pushed into the education [...] After all, it is an education in engineering. Somewhere, the main subject suffers”.

Here, the exhaustion is associated with the perceived lack of relevance regarding entrepreneurship in engineering education and already overfilled courses. This implies that the approach of the ENG-project, to infuse entrepreneurial experiences as a teaching method rather than adding content, is sufficient and in line with what teachers and students desire.

All in all, it exists a lot of different - and sometimes strong - perceptions of entrepreneurship and what entrepreneurship in engineering education is and/or could be. These perceptions will unavoidably influence both students' and teachers' attitudes towards the infusion and thereby will also affect the ENG-project's work.

6.3 RECOMMENDATIONS

To sum up, the recommendations for infusing entrepreneurship in engineering education in general and for the ENG-project in particular are as follows:

- it is necessary to have dialogues and discussions, both individually and in groups, regarding perceptions as well as how the concept of entrepreneurship will be used in this particular context
- it is, based on perceptions noticed in this study, good to have the approach of infusing entrepreneurship as a teaching method embedded in the existing courses
- it is a good strategy to focus on interested teachers, though a top-down strategy might be necessary if the teachers tendency to decline is too strong
- it is not necessarily better to have successful entrepreneurs teaching entrepreneurship, which is why it is suggested to equip the (theoretical) teachers, that today feel uncomfortable, with useful tools
- it is desirable to hook onto other educational changes.

6.4 FUTURE WORK

As entrepreneurship and entrepreneurship in education are relatively new fields of research, there are many things that could be done within these areas in the future. For example, to reach a common definition of what both entrepreneurship in education as well as in engineering education are is needed. If one would want to continue in line with this study, we have a few suggestions presented below.

It would be interesting to investigate perceptions in other universities and/or in other educational areas at Chalmers, e.g. those closer to societal sciences and industry. One could for example compare the results of teachers and students from different educational areas in order to customize the infusion of entrepreneurship in engineering education to the situated context.

Something that this study has not covered is perceptions of how entrepreneurship in engineering education is to be or could be examined. Is there a connection between one's view of entrepreneurship and how one believe entrepreneurship should be examined? This is something that is mentioned as difficult in literature regarding entrepreneurship in engineering education, see for example Lackéus et al. (2016). This examining difficulty was also highlighted during the workshop conducted in this

study. However, this was not further brought up by the interviewees and therefore not deeply investigated.

Since the educational change of infusing entrepreneurship in engineering education is already taking place, it would be interesting to continue to study the perceptions among central participants throughout the change. Are the perceptions changing and in that case - how? How are the perceptions after such an infusion? Also, it would be interesting to investigate how the students are to adapt to this type of infusion. For example, does the teaching of entrepreneurship as a method put a higher demand for responsibility among the students?

6.5 LIMITATIONS OF METHOD

In this section, the focus is to discuss the research methodology as well as reflect upon its effect on the results.

For many scientists used to doing quantitative studies, qualitative research can appear unclear and subjective (Braun & Clarke, 2006). Further, since qualitative research is often based on a small - and in a statistical manner not representative - sample of respondents in a specific context, it is hard to make generalisations. This is important to consider if trying to apply this study in other contexts, including other educational areas at Chalmers as well as other universities providing engineering education.

One of the most important things when doing a qualitative study and having a flexible method of analysis such as the thematic analysis, is to be explicit about what has been done (Braun, 2006). In an attempt to be extensive, the method chapter in this report is quite detailed.

Regarding the collection of data, interviews were the main method used. In total, eight interviews were performed - four with teachers and four with students. The reason for not performing more than eight interviews was to enable such a deep analysis of each interview. This also makes each interviewee have a large impact on the theme(s). Due to the risk of making false generalisations it was decided that no major generalisations comparing students and teachers were to be made. For example, the intention has never been to highlight differences and similarities between students and teachers. One possibility would have been to only focus on investigating either teachers or students. Though, since both students and teachers are central participants in all educational activities, we found it interesting to study both groups' perceptions.

Aside from researcher bias and the interviewers' impact on the interviewees and thereby also the data, there is a risk that the interviewees as well have biased the data by presenting themselves as good as possible. Since entrepreneurship sometimes can be a quite sensitive topic to discuss and since the interviewees were not well acquainted with entrepreneurship, some interviewees initially found it hard to

open up and speak their mind. Although, the length of the interviews as well as the non-judging atmosphere made most of the interviewees lower their guard as the interview proceeded, which made them elaborate upon things that in the beginning made them tense.

In general, there was no problem getting teachers and students to attend the interviews. Though, one teacher decided not to participate stating that s/he saw entrepreneurship as a natural talent - not possible to learn - and therefore felt that s/he had nothing to discuss in an interview. All of the interviewees, except the students in first grade, were personally asked to participate due to their fit in the selection of interviewees. The first grade students were, on the other hand, approached during a lecture, which resulted in two students volunteering. It is reasonable to believe that these two students are especially interested in entrepreneurship or matters concerning education, which in that case would affect the level of variation in the sample. Though, such a special interest was not noticed and the data collected from the interviews with these two first grade students varied a lot.

The explorative phase in combination with doing an inductive analysis, is somewhat an issue. This, since we were primed with concepts within entrepreneurship and entrepreneurship in education as well as the ENG-project's view on the latter and therefore the analysis unavoidably is influenced by this. Thus, this may have made us incapable of entirely letting the data speak for itself, i.e. data-driven, which is the core of inductive analysis. Although, this may not have been entirely negative, since some initial reading brings the possibility of deepen the analysis by facilitating the recognition of more subtle features of the data (Braun & Clarke, 2006). Also, the workshop guided the preparations for the interviews, especially with the formulation of interview topics. In this way, the study has been directed by the context and its perceptions rather than theory lying further away from our situation.

The first intention with the thesis methodology was to perform it linearly. Rather than following this intention, the data from the different parts of the were processed iteratively. Hence, movement back and forth through the different parts of the method was needed. This is a great example of the design paradox of knowing only a little in the beginning of a project when you at the same time have the most power of influencing its direction, illustrated in Figure 15. The iteration process showed to be beneficial because it enabled us to take advantage from what was learnt throughout the whole thesis work.

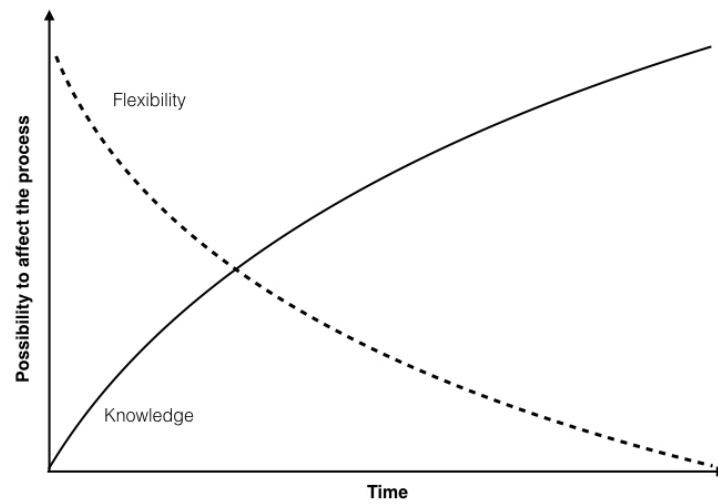


Figure 15: *The designer's dilemma — having the most freedom to make decisions when knowing the least about a project. The graph is inspired by the Lean Enterprise Institute (2004).*

7 CONCLUSIONS

This chapter summarises the thesis work as it presents the main conclusions.

The aim of this study was to, through a qualitative method, investigate the existing perceptions of entrepreneurship as well as of entrepreneurship in engineering education among teachers and students from the educational area KFM at Chalmers. On the basis of eight interviews, followed by an inductive thematic analysis, four different themes emerged: 1) entrepreneurship is associated with traits ascribed to a certain type of personality, 2) entrepreneurship is associated with the initial phase of starting up businesses, 3) entrepreneurship is associated with process management, and 4) entrepreneurship and basic research are perceived as hard to unify.

Entrepreneurship is by some interviewees perceived as being a big contrast to the engineering education, possibly since KFM is a clearly theoretical educational area. The ability to learn how to become more entrepreneurial within the existing engineering education appears to depend on one's view of entrepreneurship. The most decisive factor for this is the perceived attainability of one's own image of the entrepreneur. For example, a person starting up businesses seems hard to attain whereas entrepreneurship as managing of processes is easier to relate to. Additionally, teachers and students are not having a very clear image of how entrepreneurship is learnt, independent of one's view of entrepreneurship.

Since it exists a lot of different - and sometimes strong - perceptions, it is important to acknowledge these when infusing entrepreneurship in engineering education. This, in order to fully understand the preconditions for such educational change processes.

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A Interview guide

The foundation for the interview guide is presented in Table 5, showing the research questions along with related topics as well as suggested questions for each topic.

Table 5: *Interview guide.*

Research questions	Topics for investigation	Suggested questions
RQ 1	Entrepreneurship	<ul style="list-style-type: none"> - What is the first that comes to your mind when you hear the word entrepreneurship? - In your perspective, what is entrepreneurship?
	The entrepreneur	<ul style="list-style-type: none"> - What do you think characterizes an entrepreneur? - What is an entrepreneur good at?
	Entrepreneurial interest	<ul style="list-style-type: none"> - Can you identify yourself with your image of an entrepreneur? - Would you like to become more entrepreneurial?
RQ 2	Entrepreneurial learning strategies and outcomes	<ul style="list-style-type: none"> - Do you think it is possible to learn to become more entrepreneurial? - In your perspective, what do one learn in entrepreneurship in education? - How would you, as a teacher, help your students to learn entrepreneurial skills? - What would you, as a student, do in attempt to become more entrepreneurial?
	Engineering education and entrepreneurship	<ul style="list-style-type: none"> - Do you see any obstacles for instilling entrepreneurship in education at Chalmers? - What are the possibilities of integrating entrepreneurship in engineering education?

B Arguments for stakeholder mapping

Arguments for the mapping of the stakeholders' influence on the ENG-project are presented below. The mapping can be seen in Figure 16.

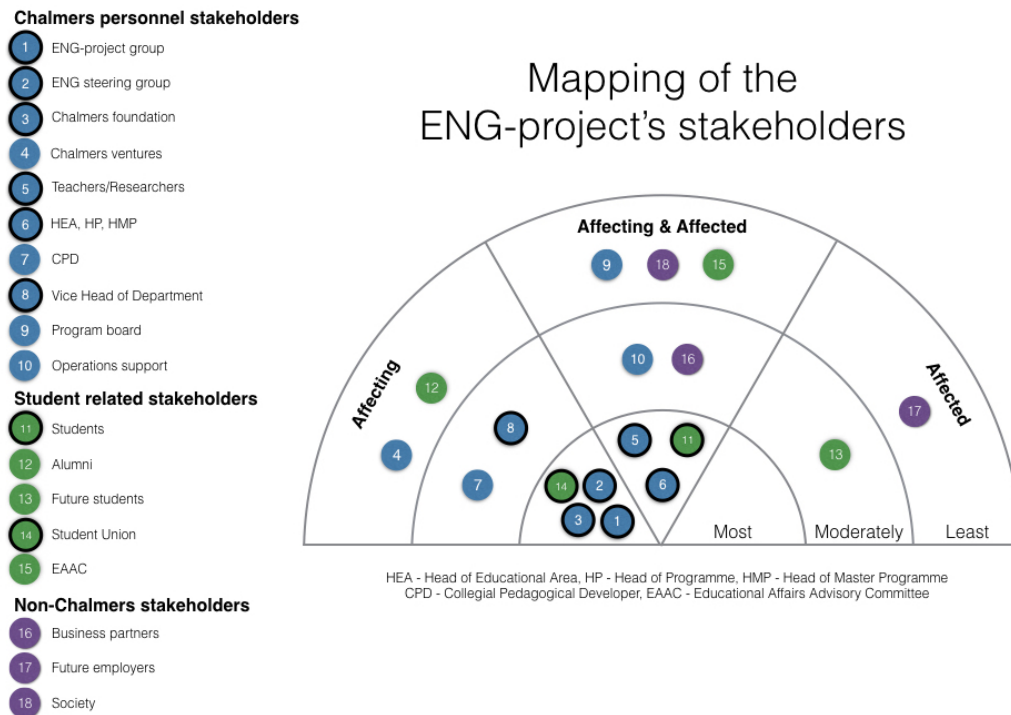


Figure 16: A mapping of the stakeholders of the ENG-project, using a framework inspired by Chevalier and Buckles (2008), where the stakeholders having a bold frame are key stakeholders.

Chalmers personnel stakeholders

1. **ENG-project group** - Has a high influence on the project, but is not recipients of the “end product”.
2. **ENG steering group** - Has a high influence when it comes to decision-making.
3. **Chalmers foundation** - Sponsor of the ENG-project.
4. **Chalmers venture** - Are doing a parallel project regarding entrepreneurship in extra-curricular activities. Are not necessarily having a direct influence, but may affect the project in some ways.
5. **Teachers/Researchers** - Are affected by the top-down decision to start the ENG-project. Are crucial for the intended implementation of entrepreneurial experiences.
6. **HEA, HP, HMP** - Are affected and affecting through their big power in decision-making. Although they have different responsibilities, the stakeholder relation to the ENG-project is the same, and they are outmost responsible for the implementation.

7. **CPD** - Supports the pedagogical development at Chalmers and will thereby affect the work of the ENG-project.
8. **Vice Head of Department** - Has great power of influence - from the department side of the organisation. (Head of Departments are responsible for parts of research and are thereby eliminated as a stakeholder).
9. **Programme board** - Not that much impact on the project initially, but will have increasing power during follow-up.
10. **Operations support** - Leaders of processes and responsible for surveys. Have some indirect power due to their knowledge about the organisation and previous changes.

Student related stakeholders

11. **Students** - Recipients of the “end product” and central in the educational process. Have high power during follow-up. Affects through student organisations and surveys.
12. **Alumni** - Do not have very much direct interest and only affect indirectly through alumni surveys.
13. **Future students** - Will be affected if the education changes and is of importance to Chalmers since they will judge whether an addition of entrepreneurship in engineering education will make Chalmers more choosable compared to other competitive providers of education in engineering sciences.
14. **Student Union** - Has a high power of influence on the project since one of the project members is also a part of the student union.
15. **EAAC** - Consists of study committees from all programmes. Not that much impact on the project initially, but will have increasing power during follow-up.

Non-Chalmers stakeholders

16. **Business partners** - Have high interest. Will affect as well as be affected by involved students.
17. **Future employers** - Are affected by the project. May have a small indirect impact. Some of the future employers will have a high interest in students being more entrepreneurial.
18. **Society** - Affects and are affected indirectly. Has indirectly given rise to the project but is not close to the students or the teaching.

Additional frameworks used for the stakeholder investigation is presented in Figure 17.

B. Arguments for stakeholder mapping

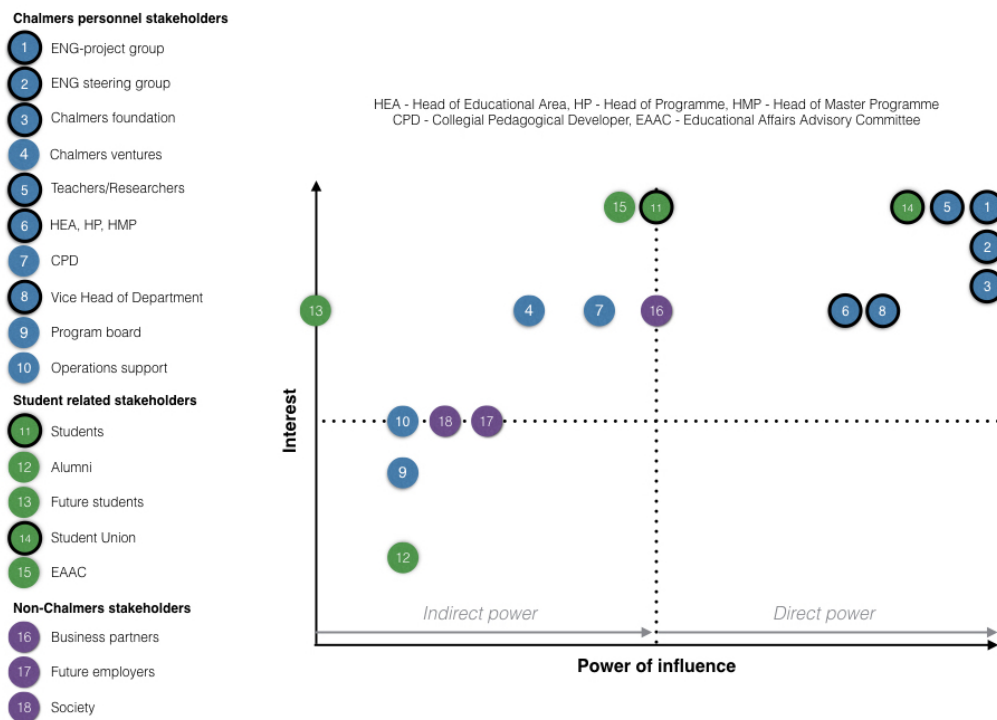


Figure 17: A mapping of the stakeholders of the ENG-project, using a framework inspired by Maylor (2010), where the stakeholders having a bold frame are key stakeholders.

C Full list of quotes from the interviews

Lists of all interview quotes supporting each theme is presented below.

THEME 1 - ENTREPRENEURSHIP AND PERSONALITY

“I think entrepreneurship is something that is hard to put into words. To say that it is this and this and that this is what you should do, it is more of an art [...] It’s more of an artistic function. When you come up with a new idea it requires that no one else has come up with that idea before. Then you have to combine in some irrational way in you head, or just come up with it in a sudden.” (Teacher B)

“A person who has it in his blood. He bubbles over with ideas and such.” (Teacher C)

“An intuitive ability to find new solutions. Being able to combine solutions that no one else has done. Something that of course requires a great ‘bildung’ - but a different type of ‘bildung’ than the school provides.” (Teacher B)

“Entrepreneurship for me is a bit meant for everybody who only learns things on their own, but who has not learnt so much in school. Being good at finding out their own ways in life and starting things” (Teacher B)

“I think an entrepreneur needs to be a bit social, be able to network and spread oneself a bit.” (Student C)

“[Someone who] is quite outgoing and social and who is able to fill up the room - and is not afraid of doing so [...] That part of being really outgoing and really into your own stuff, that part I may feel I can not really identify myself with [...] You have this image of how an entrepreneur is and there are some parts where you feel - "naah, that doesn’t suit me" - and this makes you a bit turned-off.” (Student D)

“I think you should have a high level of social skills and an ability to communicate your thoughts and visions and ideas” (Teacher D)

“The entrepreneur’s role is often to make people believe something will work. So you have to be quite good at persuading, convincing about this idea being correct.” (Teacher B)

“I’m not so creative. No, I do not think I can be a good entrepreneur.” (Student A)

“Yes, to some extent, but I think that quite a lot lies within the personality. And the personality is controlled by very many factors - your childhood and the environment in which you live - so I think it’s probably quite difficult to affect.” (Student C)

“Yes, since the ability to be able to think about new things, to be creative, that you

can learn over a long period of time.” (Student A)

“But to be able to do as an entrepreneur - doing brand new things, breaking old patterns, that is of course something that is really important for engineers and for anyone who is highly educated” (Teacher B)

“But maybe practising more about thinking yourself and not only following what is said in the book, but to think if it is possible to take it one step further.” (Teacher C)

“So I think that if you are inspired by someone else you can definitely learn to think in a certain way or in different ways.” (Student B)

“When you sit in a group and see what the others are doing and hear about their different thoughts and in what perspectives they look at the problem - that may be rewarding and helping.” (Student A)

“I think it’s good that it’s being offered, but I do not think it should be mandatory, but instead offered for those who want to. It’s clear that for Chalmers as a whole it’s really important and the ones who want to and are suited for it, they should have the opportunity to become good entrepreneurs.” (Teacher A)

“But I think it’s the same as with teachers - everyone can take a course in pedagogics, but not everyone can be a good teacher. ” (Teacher A)

“I think you can learn it to some extent, but you have to have it in your nature in some way.” (Teacher C)

“Perhaps this is something we should get into the education for everyone, because I think there are many who do not even think about it.” (Teacher C)

THEME 2 - ENTREPRENEURSHIP AS STARTING A BUSINESS

“To do some kind of business operation or business out of an idea, but then it could be within any area.” (Student B)

“To start one’s own business, a bit of driving, enterprising. New ideas and innovations. Well - one’s own work.” (Student D)

“What I think when I hear the word entrepreneurship is probably just innovation, to create some kind of additional value for an innovation. To create some kind of business that can earn money and run this foundational innovation further until it becomes a more profound product or service on the market.” (Teacher D)

“Problem solving is a very general answer [regarding what is characterising the

entrepreneur] [...] I don't know if I think that the entrepreneur needs to be the one to come up with ideas, but that can see the possibilities for them in every-day life. So, the entrepreneur, the one who suggests how you could move ahead and what to do. " (Student B)

"Yees, that I guess I can image myself becoming [more entrepreneurial/an entrepreneur]." (Student C)

"I think it is the business enterprising in itself. To be a part of that - the systematic, the organising, the planning. To desire - have the ambition of doing things - that I recognise myself the most. " (Student D)

"Everyone can learn how to start up a business and how to think and like that." (Teacher A)

"I think about that master degree in entrepreneurship [Chalmers School of Entrepreneurship] - to actually do it for real. Bring out an idea or service and to receive guidance all the time I think." (Student D)

"I think you need to have a 'hands-on-experience' to be able to know what parts you're good at and what parts others are good at, and then learn from each other [...] [Entrepreneurship] could be a very big contrast to what you're doing I think. You have lots of theoretical stuff, and some programmes have very little practical, and the all of a sudden it comes a part of entrepreneurship." (Student D)

"I don't think it's a huge drawback if you have some of that knowledge, since you get to know more about business enterprising in itself, no matter where you end up later." (Student D)

"It would be if they [teachers] would show a concrete example. Maybe how they themselves have done to run a bigger project from the start." (Student C)

"I would actually in general refer to somebody else that is better equipped than me. Like Chalmers School of Entrepreneurship and mediate the contact to the student. I don't think I'm the right person. It's easy to get it wrong because I have no entrepreneurial experience." (Teacher D)

"We [academia] do think an academic career, industry, entrepreneurship and then there's also more state and municipality, that kind of jobs. I think it's important to bring up that there's other than just industry or to doctorate. " (Teacher C)

"To start up something like that - that you've never learnt - and I think that maybe it makes you a little scared of starting something up [...] people would not be as scared of starting up something, [if] they became more acquainted with what it is to become 'entrepreneur' or to do something that is considered entrepreneurship." (Student C)

“Something that I think is a bit problematic, especially at Chalmers, is that very many mandatory elements are to be pushed into the education. For example 15 credits bachelor thesis work, which they don’t have in Lund. We have HU [sustainable development] which will enter, MTS-stuff [courses linked to Human, Technology and Society], and now ethics on master level. Of course, all these things are good and important, but for example that means that if you don’t take extra courses, you can’t study two courses central for your main subject because they collide. After all, it is an education in engineering. Somewhere, the main subject suffers.” (Teacher A)

“Of course you will have to think about what’s getting missed, if you for example in a master programme include 30 credits entrepreneurship. What’s the right balance in order to still achieve enough knowledge about one’s subject? (Teacher A)

“If the goal is having a start-up business and to buy a nice car or something like that. Then I don’t believe in it. It takes focus from what is essential.” (Teacher B)

“In general I think that engineering education would benefit from being a bit broader in it’s setup. Well, it has already become broader in the last 20 years, but to also open up for questions regarding entrepreneurship since there are many [students] that are interested in it and that may have that image of what they want to do in the future.” (Teacher D)

“It could give an even stronger springboard out into, because somehow it will be a stepping board to how it works like for real, outside of university and school.” (Student B)

THEME 3 - ENTREPRENERUSHIP AS MANAGING PROCESSES

“Then I think about an initiator who begins to run something new, probably a business or some kind of business operation. I mean, it could be a non-profit association or something like that.” (Student C)

“Then, you can be an entrepreneur on a bit smaller scale, you can drive ideas within something that already exists.” (Student B)

“I’m not interested in starting a business myself, but at a workplace where you already work, I’d like to be a part of developing new thoughts and ideas and plans.” (Student B)

“You need to have a good idea, but besides that you also need to be a ‘man of action’. So that you have this ability to realise your thoughts and ideas.” (Student A)

“To be an entrepreneur and to run a project, that’s kind of the same thing maybe.” (Teacher B)

“I don’t see it as if there’s only one person who possess all these traits but it could be even better to have a group that shares them.” (Teacher C)

“An entrepreneur is in a way a person that is good at put together a team of people and sees what you could do together.” (Teacher B)

“I believe that you can have entrepreneurship as a part of the education where you discuss and reflect upon it and maybe present how one could do a smaller project. To actually realise it properly, then perhaps one need to go to the school of entrepreneurship or have a longer time to do it.” (Teacher D)

“So I think that if you get inspired by others you can definitely learn to think in a certain way or in different ways.” (Student B)

“But to sit in a group and see what others do and what different thoughts they have, from what perspectives they look at the problem - that can also be very giving and helps me.” (Student A)

THEME 4 - ENTREPRENEURSHIP AND BASIC RESEARCH

“[Entrepreneurship] is perhaps to work with some kind of idea that is not pure basic research. I myself work with basic research and that is more like something that someone else will utilise to do something. A direct link between what you do, which can be used by other people in a shorter time frame. We hope that what we do in our research will be usable too, but that is more in about 20 years or so. Within entrepreneurship, you can’t really work on a 20-year long time frame.” (Teacher C)

“At my department many wants to go into details about some small thing and they want to understand this thin and don’t do anything else with it. They have their place in the chain of research, but they are not going to sell this to everyone and be out and talk about it.” (Teacher A)

“If it was possible to do any cool application of this [Teacher A’s research], then it would be very fun. But I don’t see that it’s possible at the moment, so I don’t think I have anything to contribute as an entrepreneur.” (Teacher A)

“[Entrepreneurship] would require me to totally change direction because it doesn’t fit with what I’m doing now.” (Teacher A)

“To be an entrepreneur is like being able to jump between the tussocks in a way

that maybe an scientist can't do. So I see a big difference between them." (Teacher B)

"Everyone needs to be visionary, researchers needs that too, but it's only that the very most vision will never work. One will get rid of rather many before you reach something that works." (Teacher B)

"[The entrepreneur is] very optimistic, not always realistic and prepared to work very hard. In that way it's quite similar to researchers. Giving up mustn't be anywhere on the map. It's something that doesn't suit everyone." (Teacher A)

"The role of the entrepreneur is often to make people believe that it will work." (Teacher B)

"Entrepreneurship is something that is present among us all but it is more disciplined within the scientific world. There you can't just fool around. What works works." (Teacher B)

"I'm better at criticising entrepreneurs than helping them. Usually it's always me who says that we can't do that. It won't work." (Teacher B)

"You can have many ideas, but the ideas can be totally weird and not useful for anything, it's not enough to only have ideas. But, you should not be too inhibited either, sometimes it could be many wild ideas that becomes something." (Teacher C)

"Within science I see at this with some skepticism, because entrepreneurs have an ability - within the world of science then - to not be very reflective. They march forward with their own and are so convinced that they're right that they're not always so careful with what they do." (Teacher B)

"Chalmers centrally push very much for entrepreneurship... the theoretical research that we do, of which we can't do any direct applications in industry, we can't bring in any industry money [...] Before, it was much like 'even your science must be able to use in making something'. We try to say that we are doing basic research. We think that basic research has a justification of its existence in itself." (Teacher A)

"Chalmers has a rather big drive towards entrepreneurship, och it's close to this with utilisation." (Teacher D)

"In this with entrepreneurship, it's very much focus on innovation and creating business, while utilisation, which maybe is a closely related concept at least should broader and even include communication och exchange with the public, exchange with policy makers at authorities and the rest of the actor of the society. In this context, I'm usually a bit critical to entrepreneurship and the great importance of innovation for the utilisation." (Teacher D)

"To run a business to make money - I don't think that suits me. I'm not engaged enough in that type of questions." (Teacher D)

C. Full list of quotes from the interviews

“I guess I’m trying to become a bit more entrepreneurial than I have been. But within science as to speak. But that is also about searching for fundings and such.” (Teacher B)

“I belong to the younger generation, I understand that entrepreneurship for Chalmers is large and that if one only can realise that maybe it’s not applicable for just every part, then it’s of course important for Chalmers to work on it.” (Teacher A)

“Within our circles, at least in the older generation, the word entrepreneur has no good ring to it.” (Teacher A)

“ It can easily be the case that the entrepreneur receives very much fundings because it sounds so fantastic, and then it only becomes a thumb of it all.” (Teacher B)