Inspiring children and teenagers to pursue science and technology

A study in methods, activities, and toys that could potentially make technology and science interesting to children and teenagers

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Abstract

This is a study in what motivates children and teenagers to pursue science and technology as future career choices. The subject is of relevance due to the increasing dependency on technology and the decline in engineering applications. Due to children and teenagers being the most susceptible targets for learning, they are the focal point in this study. The aim of this study is to identify what can create an interest in science and technology as well as to study to what extent a toy, game, or physical object can inspire children and teenagers (for product development purposes). The main research method in this study is a survey that has been filled in by 184 engineers. In addition to this, other research methods include interviews and a literature review. A majority of the respondents are from IKEA as this study has been conducted in collaboration with them. However, the result is intended to be used on a general level as the research questions are: ‘What can be used to create an interest in science and technology among children and teenagers?’ and ‘To what extent can a toy, game, or any other physical object inspire children and teenagers to pursue careers within the fields of science and technology while being gender neutral?’ Through analysing the collected data, it is evident that inspirational objects, inspirational people, and blended learning can be used to create an interest in these subjects. Furthermore, toys, games, and other physical objects can create an interest, however, the extent is decided based on how satisfied the child or teenager feels by interacting with the object.

Keywords: STEM, science, technology, engineering, children, teenagers, interests, motivation, toys, creation, playing
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1 Introduction

This chapter briefly introduces this thesis project. To facilitate this, a background of the project area is summarised as well as the main problem this thesis is centred on. Furthermore, the project’s purpose and limitations are mentioned, as these form the framework of this study.

1.1 Background

The value of education varies depending on who is describing it. However, one fact is certain: without education, the future development of the world will become limited and erratic (Gray, 2014). Most jobs in developed countries—and these days, in developing countries as well—require some form of a degree, especially professions that involve societal and technological development, such as engineering, medicine, teaching, and so on (Rose, 2013). Though this creates a need for education, the interest in academic degrees is gradually growing smaller and the number of people applying to universities is dropping, particularly in the western world. Jones-Berry mentions how fewer people are applying to nursing programmes (2017), Bhattacharjee discusses how 47% of all American institutes for tertiary education have fewer international students applying (2004), and Casey stresses the hypothesis that Asia will be where a majority of the world’s engineers originate in the near future (2007).

Due to recent recessions, young adults tend to prefer working over applying for a degree. Furthermore, many western universities deal with drop-out students as this is a growing concern (Zotti, 2016). However, when dividing people based on cultural background, it has in many cases been evident that education is seen as more valuable among Asians. This applies to both Asians living in western countries as well as those who never migrated (Baumann et al., 2011). This means that the western world could be falling behind as technology advances further (Baker, 2005).

In addition to the drop in applications for academic degrees, there is also a growing decline in interest in technology, particularly in engineering. All fields within technology will eventually have to rely on outsourcing if this pattern continues (Bryant, 2006). Simultaneously, engineering also lacks diversity. While this does not necessarily have to be a problem, it is evident that women are less interested in this field (Cadaret et al., 2017). Therefore, engineering is facing two issues: a decline in applications and a lack of interest in the western world, particularly among women.

1.1.1 Problem

As the interest in science and technology is declining, vocational interests among young adults are growing (Vock et al., 2013). A common and constantly growing dream among today’s young adults is to be an entrepreneur rather than studying for an academic degree (Hickie, 2011). In contrast to this, the dependency on technology is increasing as the Internet continues to expand (North et al., 2008). The combination of these factors also inspires young adults to pursue careers which are shrouded in uncertainty (Lechner et al., 2016). For instance, a large number of teenagers all over the world are trying hard to create online personas on various social media, one example being YouTube, and this is growing into a career choice for many (Humphrey, 2015). Being a YouTuber is only one of many such vocational dreams. An additional example which has caused many debates in Sweden is the fact that more people apply for ‘R-rated’ (sexually explicit) reality TV-series in comparison to people applying for a teaching programme (Expressen, 2014). However, the growth of careers that do not require education is not guaranteed to be profitable for everyone (Stein, 2013). Furthermore, these jobs demand technology (Miranda et al., 2012).

If the interests of the younger generation shift towards practical careers or visionary ideas while they are still dependent on technology, there could be issues in the future (Liedtke et al., 2015). With fewer entering scientific and technological fields, a shortage in engineers will be inevitable (Sedgwick, 2015). This could mean that the future demands may have to be fulfilled via engineer outsourcing or offshoring (Dolgui et al., 2013). Today, this is already the case at several companies as software engineering is often offshored from developing Asian countries (Williams, 2011). While
offshoring can be beneficial, there are potential problems that can arise from this (Bradbury, 2005). One example is the cultural clash where different values result in a lack of convergence (Meeussen et al., 2014). Another example is the lack of diversity. If a majority of all engineers are outsourced or offshored from one place, a homogenous mindset can emerge. This could mean that the potential that comes from the combination of different mindsets—diversity—is lost (Ellemers et al., 2016).

1.1.2 Research topic
It is evident that the lack of interest in science and technology is problematic, especially in the field of engineering (Brown, 2005). Young adults—who are the next in line to continue developing the world—aspire to other careers, some of which require no education (Maguire et al., 2012). Furthermore, there is an absence of diversity among existing engineers (Wulf, 2001). Due to this, there is a need for creating an interest in science and technology, especially among women (Machina et al., 2015). As it appears that the younger generation is the group with a diminishing interest in field, it is of importance to highlight the integral roles of science and technology to people at an early age (Hibbert, 2013). Children and teenagers make the most susceptible targets for knowledge due to their learning capacities. Hence, there is more potential for inspiration among them (Siegler, 2005).

Considering the aforementioned issues, the main focus of this study will be on children and teenager’s attitudes towards science and technology. The topic is therefore concerning how to inspire children and teenagers to pursue careers in such fields as this age group is most prone to learning and often determines the future career paths of a person (Ödman, 2009). Therefore, the research questions are the following:

- What can be used to create an interest in science and technology among children and teenagers?
- To what extent can a toy, game, or any other physical object inspire children and teenagers to pursue careers within the fields of science and technology while being gender neutral?

1.2 Research framework
This study is conducted at the Linnaeus University in Växjö in collaboration with IKEA. It is a thesis, part of an interdisciplinary programme which involves business, engineering, and design. While this project is mainly within the field of engineering, it is influenced by these factors. In order to keep the study in line and to not deviate from the research topic, it has been kept within a framework consisting of a purpose and limitations.

1.2.1 Purpose of study
The purpose of this study is to combine theoretical and empirical research in order to come to a conclusion which can answer the project’s research questions. By accomplishing this, the intention is to create a foundation primarily for IKEA, but also other organisations that work with products related to children, upon which projects involving inspiring children and teenagers to pursue careers within science and technology can be conducted. One example of this is toy development. The long-term purpose is to have more engineers within the local area (where the shortage is most evident) as well as greater diversity among them.

1.2.2 Limitations
This project had to be limited in order to reach its final stage within the space of one Swedish university semester. While time was the major obstacle, the study was also limited due to several choices that were made throughout the project’s development, such as:
• **Data collection methods:** due to the data collection being limited to the selected methodology, other possible data collecting methods had to be excluded, some examples being focus groups and ethnographies.

• **Location:** the data collection was conducted within travel distance, among colleagues, and among well-known companies in order to gather data as fast and efficiently as possible. The respondents, however, did not necessarily have to be nearby. This means that the data was gathered from a Swedish company with a Swedish work culture.

• **Respondent age:** all respondents in the data collection methods were adults. This was due to the fact that the study needed people who had already made career choices to participate in it. However, the study is aimed at creating interest in children and teenagers and it can be difficult to remember one’s childhood as an adult, especially particular details.

• **Language:** this study involved using material in both Swedish and English which required translation. By translating information, some details can potentially be lost in translation due to language barriers.
2 Methodology

This chapter includes theoretical descriptions of the methods that have been applied in this study. Each description is followed by a motivation intended to emphasise the relevance of the methods.

2.1 Abductive reasoning

Abductive reasoning combines induction and deduction and is a type of logical inference (Mirza et al., 2014). In deduction, empirical research is compared to theories (Fellows et al., 2015). Induction is the opposite and involves creating theories based on empirical research (Somekh, 2005). This study uses theoretical research to create a framework for empirical research. However, the empirical research is designed to be used for further theoretical studies, especially in the field of product development (in case there is a physical object that can stimulate children and teenagers to find interest in STEM-subjects). Due to this, the logical inference used in this study is abduction.

2.2 Hermeneutics

Hermeneutics is a theory as well as a methodology which involves interpreting and understanding. The central idea in this concept is to treat the subject of interest subjectively rather than the opposite (Lawless, 2014). In this study, the research topic involves interpreting children and teenagers and their interests as well as engineers reflecting on their choices. Therefore, this study is deeply rooted in hermeneutics.

2.3 Literature studies

Literature studies involve studying theoretical concrete findings and explaining them through relevant summaries (Aveyard, 2010). The literature can be described terminologically where reoccurring and specific terms are reiterated in a concise manner as well as in a literature review where the findings are analysed based on relevance and summarised through various perspectives (Martínez et al., 2018; McGhee et al., 2007). In this study, terminology has been added to explain certain concepts that are relevant for understanding the research. A literature review has been included as well in order to summarise research within the same area which can help preventing repeating existing studies.

2.4 Data gathering

This section focuses on the data gathering methods that have been relevant in the empirical research of this study. All data gathering has been conducted anonymously except in cases where respondents have been willing to provide their names, e.g. interview with a specific person. Anonymity has been respected throughout the entire study in order to maintain an ethical approach.

2.4.1 Surveys

Surveys are sets of questions that are designed for specific data gathering. The questions are usually connected to a central research subject and are answered accordingly. Respondents are given a certain amount of time after which the researcher collects the surveys and summarises the data (Chaudhuri et al., 2005). Surveys can have different types of question designs depending on how the data should be analysed. There are quantitative surveys as well as qualitative. The latter often contains open questions where respondents are allowed to express immeasurable opinions while the former involves questions with measurable answers (Willis, 2005). In this study, the aim is to find motivational factors, especially through physical objects. Since motivation is unique to each person, the surveys in this study contain a mixture of both qualitative and quantitative questions, i.e. there are both open and closed questions. The qualitative questions are connected to motivation while the quantitative questions are for creating statistics about specific subjects.
2.4.2 Interviews

Interviews are similar to surveys as they involve asking questions to respondents. However, in interviews, the process happens orally through direct contact in conversations (Miller et al., 2014). Interviews can be structured, semi-structured, and unstructured depending on how much control the researcher needs (Fontana et al., 2007). A structured interview contains a fixed set of questions that are organised in a specific order that are usually designed to test a hypothesis (Gillham, 2005). A semi-structured interview has a fixed set of questions as well but does not need a specific order (Roulston, 2011). An unstructured interview lacks both order and fixed sets of questions. Therefore, unstructured interviews are common in early stages of research when the study is still in need of narrowing down (Merriam, 1998). Focus groups are an alternative method for interviewing and involve gathering either specific types of people or a random selection for an open discussion where a certain subject is the focal point of the discussion (Greenbaum, 1998).

In this study, semi-structured and unstructured interviews have been of relevance. The unstructured interviews were needed at early stages which involved casual discussions with people in order to conclude how to progress at certain stages. Semi-structured interviews were necessary for internal data gathering from employed engineers. The semi-structured interviews were more relevant for answering the research questions while the unstructured interviews affected the research’s development overall.

2.5 Data analysis

This section focuses on how the gathered data was handled and analysed throughout the research. The data in question is part of the empirical research only.

2.5.1 IR

IR is an abbreviation for information retrieval and refers to the act of collecting the data or information from a collection of sources, e.g. retrieving data from a survey after it passes its due date (Spink et al., 2005). This method involves creating statistics based on relevance and uses logical algorithms for sorting the information (Zhang, 2008). Two of the most common algorithms in this method are precision and recall (Markey, 2015). Precision is applied to evaluate how relevant to the query the retrieved data is while recall evaluates how relevant the retrieved data is at all (Monika et al., 2016).

In this study, IR was necessary to analyse whether the gathered data was relevant to the research questions. The precision algorithm was important for identifying what data coincided with the research topic in terms of relevance in a Boolean manner, i.e. true or false, as explained in Formula 1 (Preneel et al., 2008). The formula shows the relation between the relevant data within the total amount of data (mathematical intersection) divided by the total amount. This division fraction creates a value that is the precision and can be used to describe how valid the data is (Piwowarski et al., 2007).

\[
\text{Precision} = \frac{|\{\text{relevant documents}\} \cap \{\text{retrieved documents}\}|}{|\{\text{retrieved documents}\}|}
\]

Formula 1: Precision illustrates how relevant the data is to the query, which in this case is the research topic, by calculating how many answers were relevant in contrast to the total amount of answers. This is presented in a percentage (Sclay, 2012).

2.5.2 Chi-squared

Chi-squared is a statistical testing method that involves an algorithm in which a hypothesis is tested by comparing said hypothesis with collected quantitative data (Gorroochurn, 2016). The algorithm involves a formula in which the difference between the expected value (E) and the observed value (O) is compared, as explained in Formula 2. The output of the formula is the collected data’s value. This value can be compared to a critical value, i.e. the expected value which
is the hypothesis. Due to the possibility of erring, a degree of freedom has to be taken into account when making a comparison (Rokach et al., 2008). Depending on how large the difference between the test’s Chi-squared value and the hypothesis is, the significance of the result can be established (Beh et al., 2014).

\[ x^2 = \sum \frac{(O - E)^2}{E} \]

**Formula 2:** Chi-squared test equation that compares a result to a hypothesis in order to establish the consistency of the hypothesis or the variation scale of the collected data (Saunders, 2007).

In this study, there are no precise hypothesis values to compare to. However, there are assumptions based on theoretical findings, e.g. the literature review. For instance, if the theory claims that a certain statement is true or common, the hypothesis will be a high percentage. If the collected data represents values that contradict proven statements, the data will either be foundations for new studies, variations, or errors.

2.5.3 Independent samples T-test

A T-test is a statistical tool that is used to compare values from test results (Creswell, 20011). There are many variants of this test, however, in this study, the independent samples version was applied. This version focuses on comparing two sets of data that are identical but independent and separate. The result of this test can be used to illustrate the statistical significance of the main test subject. The independent samples T-test is a common tool in Likert scale analyses (Treiman, 2009). This is due to the simplicity of the tool as it only requires mean values, standard deviations, and sample sizes of the two data sets (Lehmann et al., 2005). The sample size refers to the amount of data there is. In this study, this refers to the number of respondents from the data gathering. The mean values and standard deviations can be calculated using Formulae 3 and 4.

\[ \mu = \frac{\sum x_n}{N} \]

**Formula 3:** Formula for calculating mean value where \( x_n \) is each value in the set, \( N \) is the total amount of values, and \( \mu \) is the mean value (Lang, 1988).

\[ SD = \sqrt{\frac{\sum |x_n - \mu|^2}{N}} \]

**Formula 4:** Formula for calculating SD, the standard deviation. This value is, in most cases, the error margin (Schmuller, 2013).

2.5.4 Aggregation

Aggregation is the act of combining data from different resources in order to find significant values in a large collection of data (Xu et al., 2012). In this study, data from different resources has been gathered due to the fact that many opinions and target groups were of relevance. However, in order to find a general solution, connections between all the data had to be found. As a result of this, aggregation has been a prevalent method throughout this project.

2.5.5 Hierarchical clustering

Clustering is an analysis method where collected data is categorised according to similarity. These clusters are later studied based on different factors depending on what type of study the data is intended for (Abu Jamous, 2015). In this study, hierarchical clustering was used in order to categorise open-ended questions containing qualitative data.

Hierarchical clustering is a simple clustering method that requires categorising the collected data by making similarity connections. Each cluster can be analysed either by division or agglomeration,
i.e. top down or bottom up. By doing this, connections can be made between each cluster which can be used for generalisation purposes (Nowak et al., 2008).

2.5.6 Visualisation

Data visualisation refers to presenting gathered data in a form that can be interpreted and studied. This can mean arranging data in tables, creating graphs, and so on. The visualisation can be designed for the researcher in order to simplify exploration but also for presentations (Chen et al., 2008). In this study, various digital tools have been used to visualise the gathered data in graphs both for presentations and for analysis purposes. The visualisation was arranged to be relevant and according to the research topic.

2.5.7 Ethical aspects

Ethics refer to a critical reflection of morality, i.e. what is considered to be correct or incorrect (Kromrey, 1993). In this research, several ethical aspects had to be considered such as:

- **Anonymity of respondents**: not revealing any information that could harm the integrity of the respondents
- **Confidentiality with companies**: conducting research in collaboration with a company without exposing sensitive data that could harm the company
- **Generalising or stereotyping people**: avoiding generalisation of people to ward off prejudice by only using collected data to make any connections

2.6 Data verification

This section contains methods that involve the verification of the data used in the study. These methods affect the future aspects of the project.

2.6.1 Validity

Validity refers to how valid a research is in terms of achievements. If the study answers a research question as intended, it is valid. In other words, validity can be explained as how well a study corresponds its original intent to the real world (Litwin, 1995). Validity can be separated into internal, external, and theoretic validity (Skar, 2013). Internal validity refers to how well the study’s result coincides with the main underlying research topic (Langbein et al., 2006). To ensure internal validity, triangulation can be applied which means that other people connected to the topic confirm the validity of the research (Wilson, 2006). External validity refers to how generalisable the research is, i.e. whether or not it is applicable in similar problem areas, disregarding variation (Avellar et al., 2016). Theoretic validity implies relevance in terms of theoretical research, i.e. how relevant and useful the theory of the study has been. If the theory has not been operationalisable, the theoretical validity is low (Gubrium et al., 2012).

The result of this study is not only intended for children and teenagers on a local level but on a global level. This research is intended to be used in countries where a shortage in engineers is prevalent and a problem. Furthermore, IR is used to calculate how valid the research is. Due to this, the external validity of the research is high. The internal validity is also high as the end results are the answers to the research question and the fact that all method applications were designed to be in line with the research topic. The theoretic validity of the research is high as the analysis is built on the combination between the theoretical research and the empirical research. Overall, the validity of the research is high but could be higher if the data gathering was larger.

2.6.2 Reliability

Reliability refers to the iteration rate of a study, i.e. to what extent it can be repeated (Keller McNulty et al., 2006). This means that the study is reliable when it can be applied in a similar scenario with minimal variation (Raheja et al., 2012). As this study is intended for children and teenagers in general, especially in countries suffering from an engineer shortage, the result needs
to be reliable. Due to this, the study has been designed to be as general as possible in order to reach a wider target group. The result can be studied further for the sake of variation, however in this study, it is intended for broad use.
3 Theoretical research

This chapter includes the theory that is relevant for this study, such as terminology, market research (state of the art study), and a literature review. The theoretical research is meant to create a broad view on existing research within the subject as well as a foundation for the empirical research of this project.

3.1 Terminology

This section includes descriptions of terms that recur throughout this study. Each explanation is based on theories from mainly primary sources, e.g. scientific articles. These terms are relevant for the study as they are all connected to the research topic.

3.1.1 STEM

STEM is an acronym for ‘Science, Technology, Engineering, and Maths’ and is a part of many schools’ curriculums. The acronym is considered to be growing in terms of importance due to the decline in these subjects among children and teenagers in the western world (Froschauer, 2015). The reason why these subjects are grouped together is that they are considered necessary to solve the many problems of the world, also known as ‘real problems’. These problems involve the development of the world while fulfilling its future (Nurse et al., 2015). Thus, many schools implement special programmes or methods to encourage students, especially children, to find interest in STEM (Gamoran, 2016).

3.1.2 Didactics

Didactics is the theory of teaching as a methodology. It is not connected to any specific subject and only refers to how the teaching is conducted (Holmqvist Olander, 2016). As it is becoming more evident that people have unique learning abilities and can reach the same point through different forms of schoolings, didactics is a growing as a subject (Grevholm, 2013).

3.1.3 Blended learning

Blended learning is an educational method for teaching which involves both traditional classroom-based classes and digital material (Sharma, 2010). In the world of technology, this has gradually grown to be a major teaching method due to the evolution of digitisation (Hockly, 2018). Technology is complex and not often easy to convey through conventional classroom-based education. Digital platforms where users can apply practical learning are necessary to create an insight into the industry at an early stage of education. Furthermore, digital platforms also allow flexibility for the user as they can plan their education freely instead of being tied to any form of schedule (van Niekerk et al., 2016).

While digitisation is happening rapidly, blended learning has been proven to be an effective educational method for many students, especially among engineers (Chen et al., 2018). There are several subjects in engineering where the application of software has not only simplified the process, but also created practical knowledge which makes the engineer more valuable on the market (Cheng et al., 2016). Due to this, blended learning has slowly been seeing the light in education below university level as well, e.g. secondary school, primary school, and so on (Skellas et al., 2014).

Schools that are focusing on improving and increasing children and teenagers’ knowledge in STEM-subjects are implementing blended learning to engage the younger generation in what the world of technology means (Kotadaki et al., 2016). One example of this is the Swedish project ‘Mot Nya Höjder’ (translation: Towards New Heights), which involves engaging the younger generation in STEM-subjects. The aim of the project is to create an interest in these subjects among children and teenagers in order to meet the future demands of the job market. This involves different events, projects, meetings, and practical activities that are both educational and entertaining, e.g. makerspace events where children can create toys or meeting famous scientists such as astronauts.
By applying blended learning in a curriculum, there is not only a possibility to create more insight into STEM-subjects, but also to empower students as they can be part of the subjects too (van Meeteren et al., 2010).

3.1.4 VARK

VARK refers to a model which can be used to identify different learning methods among children and teenagers (Othman et al., 2010). The model emphasises that anyone can reach the same level if they are taught in a way that stimulates them (Prithishkumar et al., 2014). The different learning methods that are mentioned in the model are: visual learning, auditory learning, read or write learning, and kinaesthetic learning, VARK (Moazeni et al., 2013).

Visual learning is a method where the student learns through graphic teaching such as charts, diagrams, maps, and images (Wadham, 2015). Auditory learning refers to students who learn through listening to lectures, sounds, conversations, and so on (Kraus et al., 2015). Read or write learning is connected to traditional classroom education and refers to the act of learning through reading or writing. This can mean rewriting teachers’ notes as well as reading different types of material (Benison, 2015). Kinaesthetic learning is the act of learning through physical activity such as performing tasks, problem solving, practical activities, and so on. This type of learning is strongly linked to blended learning and is a growing subject in the world of technology, especially engineering (Mobley et al., 2014).

3.1.5 Gender neutrality

Gender neutrality means the absence of feminine or masculine connection to a subject (Gonsalves, 2014). When a subject or an object of interest has masculine or feminine traits, it is often considered to be gendered and designed to appeal primarily to a certain gender (Rafi, 2015). An example of this is the toy industry where it is common to see dolls marketed as toys for girls. This is usually accomplished by having girls playing with the toys in the advertising as well as the use of the colour pink (Auster et al., 2012). With the recent growth in feminism, many claim that society has created a norm where there are masculine and feminine sides to things and that this is why people tend to avoid exploring subjects and objects designed for the opposite sex (Brescoll, 2016).

When a majority of the people using an object consists of one gender due to the marketing methods and societal norms, homophily arises among the users which can mean that minorities feel unwelcome (Kovanen et al., 2013). Homophily often results in gender stereotypes which means that the user of a certain object is someone predictable due to other users being similar. This can lead to outsiders being misled to believe that all users of the object are identical (Bordalo et al., 2016). The previous doll example can be applied in this case as well. It is not common to see boys playing with dolls as this is seen as a toy for girls (Ulrich et al., 2016).

As gender often also has integrity-related implications, e.g. manliness, sexual orientation, and so on, many choose to not try an object as it could hurt their integrity (Rabelo et al., 2014). Children are often not aware of gender implications and think in a gender neutral manner (Jadva et al., 2010). However, many parents choose to not give their children toys that are catering to the opposite sex due to them wanting their children to be seen as the gender they are born as. For instance, most parents do not buy dolls for their boys even though the boys are not capable of understanding the implications of gendered toys (Endendijk et al., 2014).

3.2 Literature review

This literature review focuses on summarising scientific articles that are connected to keywords that relate to this study’s research topic. The main keywords are: motivating children and teenagers, inspiring children and teenagers, technology and toys, interest in STEM, and educational activities. There are many articles involving these keywords, however, only a few select are summarised. The
selection has been made according to relevance, recency, and reference count (how many times the article’s authors have been referred to).

In a study by Campbell and Jane (2012), motivation is described as either intrinsic or extrinsic. According to this research, intrinsic motivation is what creates the feeling of satisfaction in people when they manage to accomplish something desired, e.g. solving a problem. The researchers use this idea as a foundation for their experiment which involves engaging children in technology-related activities that will trigger intrinsic motivation. The main activity as well as research method of this study was make children create a recycling device through technology. Throughout the design process, the children were monitored via log writing where their thoughts and ideas were written. After completing the product, the children were asked to evaluate the results. Many children were too engaged in the activity and could therefore not finish their logs. The researchers summarised the results of the activity and concluded that allowing children to engage through creative processes increased their motivation, i.e. kinaesthetic learning. More children claimed to feel satisfied with their result in comparison to children claiming to enjoy the activity. Therefore, the researchers concluded that children do not necessarily need to have fun in order to feel interested in technology; it is satisfaction that motivates this interest. Due to this, Campbell and Jane emphasise the importance of intrinsic motivation.

Andersen (2013) studied why very few young adults aspired towards STEM-related occupations. In this study, motivation was analysed through a model of expectancy value of achievement-related choices. The model was based on a study in motivation by Eccles et al. (1983). This model illustrates how choices are made based on five contributing factors: self-efficacy, attainment value, utility value, interest or enjoyment value, and cost. Self-efficacy refers to a person’s confidence in being able to successfully accomplish a task, attainment value indicates how important or relatable the subject is to the person, utility value means how useful the result of a task could be in the future to the person, interest or enjoyment value describes how much a person is interested in or is enjoying the subject, and cost implies relational costs such as time spent with people during a certain task and the future consequences of these interactions (Andersen, 2013).

In Andersen’s study (2013), the conclusion is that children do not know the values of STEM-related occupations. By applying Eccles et al.’s model (1983), Andersen realised that children lack a connection with the occupations, even if they are aware of STEM-subjects. The subjects are taught in school, but children seldom recognise their importance or how to apply them. Therefore, Andersen suggests that parents allow children to interact with areas that are strongly rooted in the STEM-subjects more often, and that children and teenagers need to be encouraged more to pursue careers related to these subjects.

Similarly, Eccles et al. (2016) emphasise the role of parents and family. In their study, thousands of students were surveyed in order to identify what motivates people to choose careers in mathematics and science. According to their result, females are more connected to their families’ values in comparison to males. If STEM-occupations are not encouraged within the family, it does not become a priority for the woman. While women appeared to be affected by family values and roles, the study indicated that men were not influenced by family at all. One of the major reasons discussed in this article is that women are under the impression that they cannot fulfill altruistic and non-STEM-related interests if they choose certain careers. Therefore, Eccles et al. emphasise that these occupations must be encouraged in a way that illustrates that one can have a proper career in a STEM field while still living a normative life.

Upitis (2001) also focuses on gender in terms of technology in a study in toys, however, in this article, the central area of interest is school and didactics. While Andersen and Eccles et al. accentuated the influence from the family, Upitis claims that many activities in schools that could encourage children and teenagers to pursue careers in technology are pandering towards boys. One of the many examples in the study is project-based learning or kinaesthetic learning. According to
Upitis, many technical projects that involve both boys and girls have different gender-based results despite the projects being conducted by both. Girls are generally praised for design aspects and are encouraged to pursue creative careers while the boys are praised for the technical aspects, regardless of who actually contributed to what in the project. Several other examples are mentioned that have similar outcomes in this study. The researcher also conducts observations as an experiment to see how children react when they are asked to design their own toys and games using technology without interference from the outside.

As a result of the observations and an analysis of different school scenarios with different didactic methods, Upitis (2001) concludes that motivation can be created in children and teenagers as long as other people’s opinions do not interfere. Children and teenagers are affected by opinions and a harmless suggestion based on gender stereotypes can lead to lack of interest in STEM-subjects even when there is potential. Upitis’ study also stressed the fact that students must be allowed to have equal access to all types of activities in order to develop motivation and any kind of encouragement from the school must be gender neutral. For instance, in an observation in Upitis’ study, girls and boys were equally interested in making computer games when both were allowed to choose freely.

The study by Upitis (2001) also showed that blended learning is a didactic opportunity to introduce children and teenagers to technology in a manner that creates interest or enjoyment value (Eccles et al., 1983). This is also supported in a study by Young et al. (2012) where the researchers study the effect of blended learning where video games are involved, especially educational games connected to STEM-subjects. There is a focus on kinaesthetic learning as a didactic method and popular games used in various schools. The conclusion of this study is that educational games are too new to be evaluated from a scientific standpoint in terms of accuracy in facts. However, video games have stimulated children and teenagers to learn more and have created interest in the subjects of interest. The researchers recommend that teachers and schools enter partnerships with researchers in order to design games that will improve learning processes.

In addition to video games, educational toys are also experimental subjects in terms of inspiring children and teenagers to pursue careers in technology through kinaesthetic learning. In a study by Granerud (2005), children and teenagers were introduced to a famous building block set where they were given the task to build and program a robot out of it. Granerud observed the children and categorised the results according to age and gender. What was evident was that both girls and boys were equally as capable of building robots, however, the interest in the task was vastly higher among the teenage boys. Age-wise, the children were more enthusiastic because toys were involved, however, they mostly copied each other with their solutions because they were afraid of being different from others. The teenagers were not enthusiastic as they felt that they were too old for the activity but had no issues being expressive in their solutions.

Granerud’s (2005) conclusion is that technology is gender neutral but that boys appear to have more interest in it. One of Granerud’s thoughts about this was that boys were often pressured by societal norms to be more interested in technology since they did not seem to excel in their solution in comparison to the girls. Granerud also accentuated that age made a difference as children are too young to have their own identity. Children are likely to mimic others. However, due to this, projects aimed at young children can interest both girls and boys equally as much.

What Granerud (2005) and Upitis (2001) discovered coincides with an article by Bursky (2002). This article emphasises that females lack interest in STEM-subjects in general and that the decline in engineering could be a consequence of this. Bursky addresses the fact that many universities have had a rapid growth in subjects unrelated to STEM, such as life sciences. He also mentions that these growing subjects are what females are encouraged to study and how this means that the future demands may not be fulfilled. Bursky discusses engineering companies expanding and
current engineers retiring while there are not enough young engineers to fill the empty seats. He stresses that this shortage can impede progress for the world’s future.

3.2.1 Summary of literature review

Summarising these articles shows that males and females are equal in terms of capacity and qualities but are influenced and encouraged differently by their surroundings. Due to this, men and women with the same qualifications are likely to choose different careers. Furthermore, with the growth of other subjects (non-STEM), many choose to pursue careers that cannot fulfil the future demands of the world’s technological growth, especially women. For progress to avoid impeding and instead advancing, new engineers are needed. It is evident that there is a need to invest in didactic methods involving blended learning in order to allow children and teenagers to experience the satisfaction of kinaesthetic learning, e.g. educational activities, interactive learning, problem solving, and so on.

3.2.2 Key factors for empirical research

Based on the literature review, it is evident that the key factors that need to be studied empirically are how children and teenagers are encouraged in their homes as well as in school. Furthermore, it is necessary to study what kind of learning engineers preferred when they were in the learning process (at young age). An additional point of interest is to examine whether or not engineers were stimulated by activities that triggered kinaesthetic learning, such as certain toys, games, activities, media, and so on.
4 Empirical research

This chapter includes the methodological aspects of this study, i.e. applied methods and field research (practical approaches). The empirical research only contains how the practical approaches were conducted. The results of this research are described in a later chapter.

4.1 Test survey

In the earliest stage of this project around January 2018, a test survey was designed. This survey contained general questions that were assumed to be relevant to the topic. This was arranged in a third party questionnaire client called Google Forms. Through this client, the survey could be distributed and analysed digitally as Google Forms features a built in statistics visualiser.

Designing the survey involved creating questions relating to the research topic, with both quantifiable answer options as well as open questions for qualitative data collection. None of the questions were marked as mandatory so users could opt out of answering certain questions. Another reason for having optional questions was to see if there were any questions that respondents tended to ignore or find difficult to answer.

The survey was never intended to be a significant part of the project and was only designed to test a set of questions. Therefore, the survey was created in Swedish and was only distributed among acquaintances who were working within the field of technology and science. The survey was distributed via social media channels containing a total of 300 users. A week after initial distribution, the survey had 46 answers which meant that the participation rate was 15.33%.

4.2 Survey

Based on the results from the test survey, the questions that had most answers were carried over into a new survey. This survey was designed to be used as the main survey of this study. The questions were translated into English for distribution at IKEA where many employees cannot speak Swedish due to there being more than 50 nationalities represented among them. Some questions from the test survey were removed as their answers added no value to the study due either to irrelevant data or inapplicability for people who did not grow up in Sweden.

In addition to the recycled questions, a few new questions were added that were based on the theoretical research. Through the literature review, it became evident that the test survey was lacking in substance and focused on the research topic in a shallow manner. Due to this, in-depth questions were added that could bring out data not only for answering the research questions, but also for creating a foundation for future studies, i.e. recommendations. Each question of the survey was accompanied by a hypothesis. In the recycled question, the test survey result was used as a hypothesis. In the case of new questions, existing analyses were used for comparative reasons. These hypotheses were included for statistical analysis purposes with focus on the Chi-squared test and the T-test (as mentioned in chapter 2). However, there were two exceptions in the survey. The qualitative questions did not have any hypotheses. This was due to the fact that qualitative data is subjective.

The finalised survey was distributed on the 15th of March, 2018 to approximately 300 respondents. Its due date was set to be the 30th of April, 2018. However, the due date was not publicised as it existed only for efficient planning. The respondents were teachers at the Linnaeus University (Växjö, Sweden), engineers among personal contacts, and engineers at IKEA of Sweden. The reason behind this choice were availability and resources.

The first question of the survey was designed to create quantifiable data relating to gender (with emphasis on biological sex) representation within the field. The options were ‘Male’, ‘Female’, and ‘Prefer not to say’. The question was limited to this in order to create generalisable data, however, due to there being individuals identifying as other genders, a third option was added as seen in Figure 4.1. In a national analysis conducted by Nelson & Rogers (2003) where the gender
distribution of several STEM-subject programmes is analysed, average values for different engineering fields were presented, as seen in Table 4.1. By adding these values together, a mean value can be calculated. This mean value was used as the hypothesis for this question. Therefore, the expected result was male 77%, and female 23%. However, due to the question containing a third option for respondents who may not want to reveal their gender, the hypothesis was adjusted to include this option without changing the values significantly. For this reason, the final expected values were 76% ‘male’, 23% ‘female’, and 1% ‘prefer not to say’.

![Sex](image)

**Figure 4.1:** Question 1 from survey

<table>
<thead>
<tr>
<th>Field</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer science</td>
<td>72.3%</td>
<td>27.7%</td>
</tr>
<tr>
<td>Chemical engineering</td>
<td>64.3%</td>
<td>35.7%</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>75.5%</td>
<td>24.5%</td>
</tr>
<tr>
<td>Electrical engineering</td>
<td>86.9%</td>
<td>13.1%</td>
</tr>
<tr>
<td>Mechanical engineering</td>
<td>86.1%</td>
<td>13.9%</td>
</tr>
<tr>
<td><strong>Mean value</strong></td>
<td><strong>77%</strong></td>
<td><strong>23%</strong></td>
</tr>
</tbody>
</table>

*Table 4.1: Statistical view of American gender distribution among engineers (Nelson et al., 2003)*

The second question of the survey was also designed to create quantifiable data. This question concerned what kind of area the respondent grew up in, as seen in Figure 4.2. This question was suggested by an examiner as this could contribute to mapping engineering potential. According to a study by Shank et al. (2014), technological presence is measured from a global perspective and it is stated that technology is more prevalent in urban areas. Furthermore, based on an online population mapping course called ‘DSST Environmental Science: Study Guide & Test Prep’ (Study.com, 2018), in 2009, 50% of the global population lived in urban areas. In an analysis in Norwegian migration by Rye (2006), it is stated that 25% of all rural residents migrated to an urban environment during a span of 30 years. Therefore, the expected values for this question are: 50% ‘urban’ and 25% ‘both’. The remaining 25% could be the expected value for ‘rural’. However, due to ‘other’ being an option, this was adjusted to 23% ‘rural’, and 2% ‘other’.
The third question of the survey was also a quantitative question and concerned the age at which the respondent became interested in technology and science, as seen in Figure 4.3. The aim of this question was to study what age would be the best to target for creating interest in technology and whether or not children and teenagers would make an appropriate target group for this matter. The expected result is a majority consisting of children and teenagers and a small amount of young adults and adults. This means roughly 25% children, 50% teenagers, 15% young adults, 5% adults, 4% not remembering, and 1% at later ages. This is due to the fact that children are more susceptible to learning and becoming interested in new subjects compared to adults, as discussed in chapters 1 and 3 (Siegler, 2005; Campbell et al., 2005). The values are, in this case, not based on theory, but on the results from the test survey, as this question is recycled from it.

The fourth question was quantitative and was based on information from the theoretical research. The question involved understanding what kind of learning the respondents preferred. Each learning type was explained in order to avoid confusion, as seen in Figure 4.4. This question allowed multiple choices in case someone could learn better through more than one method. According to the theoretical findings, kinaesthetic learning should be the most common learning type among engineers (Upitis, 2001; Mobley et al., 2014). The expected values of the hypothesis are based on a survey from a case study conducted by Driscoll et al. (2000), where 32% were kinaesthetic learners, 26% auditory learners, 24% read or write learners, and 18% visual learners. This case study was conducted in an American engineering university.
The fifth question was the first to be qualitative. This question was designed to create data for answering the research questions. It was an open question where respondents could fill in anything that inspired them to pursue technology and science, as seen in Figure 4.5. An additional purpose of this question was to evaluate how to conduct interviews as they would be entirely qualitative.

**Figure 4.4**: Question 4 from survey

What inspired you to choose technology and/or science?
You are free to mention many things, e.g. people, specific memories, activities, toys, media, etc.

Your answer

**Figure 4.5**: Question 5 from survey

The sixth question was also qualitative and concerned problems respondents may have experienced due to their choices, as seen in Figure 4.6. This question was based on the theoretical research concerning encouragement.

**Figure 4.6**: Question 6 from survey

Did you experience any problems after choosing your field?
If so, what were the problems?

Your answer

Question seven was a quantitative question designed to measure how encouraged respondents were by the people in their surroundings, as seen in Figure 4.7. This question was meant to illustrate the meaning of families’ opinions on the matter of technology and science. The expected results for this question were 28% positive, 51% positive and encouraging, 12% indifferent, and the remaining options sharing the last 8%. This expectation is based on the literature review in chapter 3 (Eccles et al., 2016). The numbers are based on the test survey results due to this being a recycled question.
Question eight was similar to the previous question as it also involved encouragement, as seen in Figure 4.8. However, in this case, the subject of interest was encouragement from people in school. The reason this was added was the emphasis on schools encouraging students as mentioned in the theoretical research. The question was designed to include a Likert scale where the range went from ‘not at all’ to ‘very much’. The expected value for this is to be equal on extreme values, i.e. 30% on both ‘not at all’ and ‘very much’, and a relatively even distribution of the remaining percentages on the other options. For this question, a Chi-squared test was not the intended analysis method. However, the question still had a hypothesis which was based on a study by Steinberg et al. (1992) where an identical question was asked to 6400 respondents. The mean value and the standard deviation of the answers were 3.67 and 0.59 respectively. These values were used as the hypothesis for this question.

The ninth question was a multiple choice quantitative question involving activities concerning the matter, as seen in Figure 4.9. This question was designed to illustrate whether or not society facilitated or hosted anything that could encourage these subjects. This was also designed to visualise how connected the respondents were to their communities when they were young. The expected result in this case was secondary school as a majority of 45% followed by primary schools and companies around 15% each, and 5% each for governmental units and independent organisations leaving the remaining 15% on the other options. This assumption was based on the literature review in chapter 3 (Young et al., 2012). The values were based on the test survey as this was a recycled question.
The tenth and penultimate question in the survey was a personal quantitative question designed to measure how the respondents valued the importance of technology and science for the future, as seen in Figure 4.10. This question was designed to illustrate whether or not people within the field saw a need for more colleagues based on the demands. The expectations for this question was a result with a majority of 82% claiming that the topics are ‘very important’ with the remaining 18% being close to that. This assumption is based on the fact that the world is becoming more dependent on technology, as mentioned in chapter 1 (Rose, 2013). The values are based on the test survey results as this is a recycled question. While this question was similar to question 8 (Figure 4.8), this was not designed to generate a mean value despite involving a Likert scale. This was due to the fact that it was a recycled question which was repeated within a short amount of time as well as the hypothesis having a uniform result.

Question eleven was the last in the survey and was a quantitative question measuring satisfaction from being in the field, as seen in Figure 4.11. The purpose of this question was to study whether or not there is a possibility for the respondent to change their field even after having started a career in it. The expectations for this question was a totally positive answer of 100% being happy with their choices. This expectation was based on the test survey as this was a recycled question. However, for variation risks, the assumption was changed to 90% ‘yes’, 10% ‘no’ or ‘other’. This assumption was based on the concept of blended learning and kinaesthetic learning where the satisfaction of solving a problem creates motivation, as mentioned in chapter 3 (Andersen, 2013). The variation risk was taken into consideration due to the international backgrounds of the respondents from IKEA.
4.3 Interviews

After receiving a significant number of survey answers, more answers than the test survey generated, i.e. roughly 50, some questions from the survey were selected as key questions. This meant that they had a direct connection to the research topic. The remaining questions were considered to have an indirect connection and were left for analysis in order to find a deeper meaning in their results.

The direct questions were rearranged to be in a coherent order and were rewritten in a less formal style. All questions were designed to be open and qualitative, so some quantitative questions were changed. When this process was finished, the questions were used as a template for interviews. The questions had an order but were not necessarily asked in the planned arrangement. The interviews were semi-structured as they were designed to let the interviewees give input outside the questions’ framework as well.

All interviews took place through in-person meetings. Notes were taken during each interview. However, the interviews were not transcribed directly. Therefore, their results are summaries of each interview rather than a full transcript.

4.3.1 Interview arrangements

Two weeks after the distribution of the survey, 30 answers had been collected. Based on these, it was evident that the respondents were mainly kinaesthetic learners, inspired by either parents or toys, happy by their choices in their fields, and thought that technology and science were important for the future development of the world. It was also evident that most of the respondents became interested during their childhood and that they were encouraged by both their schools and their families.

One week after that, the survey was distributed among IKEA staff (engineers) which increased the number of answers significantly. By the 5th of April, 2018, 145 answers had been collected. The new entries did not add many new opinions. However, a few more motivational factors were added such as school subjects, role models, attractive job market, incomes, and desires relating to wanting to change products and the world. Furthermore, with the addition of answers from IKEA engineers, the age during which the respondents became interested shifted from children to teenagers. Lastly, the IKEA engineers’ answers also created a diverse range of answers in all questions concerning encouragement from schools or activities involving science and technology.

Based on the 145 answers, the areas of interest were those where there was most diversity, e.g. age, inspiration, and a few questions concerning school such as questions 8 and 9 from the survey. Furthermore, parents were represented in the survey very often. Because of this, a new type of question was added which involved evaluating the parents’ roles in a family in terms of career inspiration. Due to this, the interview questions were the following (as seen in Table 4.2):
## Questions

<table>
<thead>
<tr>
<th>Questions</th>
<th>Motivation behind question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. At what age did you become interested in science and technology and around what age did you make the choice to pursue a career within the field?</td>
<td>The survey was not clear enough in differentiating between choice and interest. As the study focuses on children and teenagers, this question would clarify whether or not children and teenagers were appropriate target groups.</td>
</tr>
<tr>
<td>2. Do you remember there being any toy, game, or physical object that inspired you towards science and technology?</td>
<td>The survey made it clear that there were inspirational toys, however, with this question, it becomes possible to delve further into the subject. This allows the interviewee to describe the physical object’s attributes and functions which could be valuable data for potential product development. Furthermore, this question is connected to the sub-research question.</td>
</tr>
<tr>
<td>3. If your school encouraged you in any manner, how did you receive the encouragement?</td>
<td>This question goes in depth into how the encouragement is presented to the person while the survey only shows whether or not the respondent was encouraged. The data from this question could help understanding promotional behaviour.</td>
</tr>
<tr>
<td>4. What kind of activities involving science and technology arranged by your school do you remember?</td>
<td>The survey only illustrates the likelihood of activities being arranged while this question investigates the activity itself. This could help understanding what kind of activities are useful and should occur more often.</td>
</tr>
<tr>
<td>5a. What about your family members being in the field inspired you? Did you look into other fields before making your choice?</td>
<td>This question is aimed at people who have family members working in the field, such as parents. Due to many respondents claiming that their parents inspired them, it became important to see what in particular made them want to follow in their parents’ footsteps.</td>
</tr>
<tr>
<td>5b. Why did you choose to go into this field when no one else in your family did? Did you receive any support when you made your choice? How do you feel being the first in your family to have made this kind of career choice?</td>
<td>This question is aimed at people who do not have family members within the field. The purpose of this question is to illustrate possible encouragement methods for children and teenagers who lack a connection to the field through family members.</td>
</tr>
</tbody>
</table>

**Table 4.2:** Interview questions

During each interview, no audio data was recorded. The respondents answered questions in a casual discussion manner and notes were taken to focus on keywords. After each conducted interview, the notes were summarised (as seen in the sections below) and sent to the interviewees.
for reviewing and feedback. Due to the interviews being personal and highly subjective, it was of interest to connect the data to the individual interviewee. For this reason, some details about the respondents were not anonymised, e.g. gender. However, this choice was based on mutual agreements via e-mail or in person during the interviews.

4.3.2 Interview I
On the 12th of April, 2018, the first interview was conducted with an engineer from IKEA of Sweden. He is an engineer who at the time of the interview worked as a core competence manager.

The interview was casual and took place in an open booth. Due to both participants being Swedish, the interview was conducted in Swedish. The beginning involved introducing both parts, e.g. interests, work, and this study. This was followed by the interview questions and ended with a guided tour around IKEA of Sweden’s facilities. The main data from this interview is presented in chapter 5, however, the full result can be found in Appendix I.

4.3.3 Interview II
On the 3rd of May, the second interview was conducted with an engineer at IKEA of Sweden. The interview was conducted in English via a phone call and took approximately 10 minutes.

4.3.4 Interview III
On the 4th of May, the third interview was conducted with an engineer at IKEA of Sweden. The interview involved a short meeting at IKEA of Sweden and the conversations were in Swedish. This meeting lasted approximately 15 minutes.

4.3.5 Interview IV
The fourth interview was conducted directly after the third interview on the 4th of May at IKEA of Sweden. The respondent was an engineer at IKEA of Sweden. The interview was conducted in English and took approximately 15 minutes.

4.3.6 Interview V
The fifth interview was conducted via e-mail with an engineer at IKEA of Sweden. Table 1 from section 4.3.1 was sent in an e-mail to which the respondent sent a reply on the 4th of May. The interview was conducted in Swedish.

4.3.7 Interview VI
The sixth interview was conducted on the 8th of May with a product development engineer at IKEA of Sweden. The interview was conducted in person at IKEA of Sweden and took approximately 30 minutes. The interview started with a brief discussion about the project, the interviewee’s career, and the conversation ended with the interview questions. The interview was conducted in Swedish.

4.3.8 Interview VII
The seventh interview was conducted directly after the sixth interview at IKEA of Sweden, on the 8th of May. This interview was conducted at the same location with a product requirement engineer at IKEA of Sweden. The interview lasted approximately 20 minutes. The interview was conducted in Swedish.

4.3.9 Interview VIII
The eighth interview was conducted on the same day as the sixth and seventh interviews at IKEA of Sweden. The interviewee was a mechanical design engineer at IKEA of Sweden. The interview was conducted in Swedish and lasted approximately 15 minutes.
4.3.10 Interview IX

The ninth interview was conducted via e-mail. The respondent was an engineer at IKEA of Sweden. The respondent received the interview questions via an e-mail and replied on the 16th of May, 2018. This interview was conducted in English.
5 Results

This chapter includes the results from the empirical research. However, this chapter only presents the results that were of importance for the research topic in order to come to a conclusion. The test survey which was used to design the main survey has been neglected in this section. However, it is presented in Appendix II.

5.1 Survey results

By the 30th of April, 2018, 184 survey answers had been collected. The number ceased to increase at that point. Considering that the potential respondents was estimated to be 300, this created a participation rate of 61%. Compared to the participation rate from the test survey (15.33%), this rate was significantly higher. 61% also means that more than half of the respondents participated which is enough to create a majority among the respondents.

The gender distribution was relatively even, however, males formed the majority, as seen in Table 5.1.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>107 (59.1%)</td>
</tr>
<tr>
<td>Female</td>
<td>72 (39.8%)</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>2 (1.1%)</td>
</tr>
</tbody>
</table>

Table 5.1: Gender distribution of survey respondents

Almost half of the participants knew they wanted to pursue science and technology when they were teenagers, as seen in Table 5.2.

<table>
<thead>
<tr>
<th>Age</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 12</td>
<td>28 (15.5%)</td>
</tr>
<tr>
<td>12 - 18</td>
<td>88 (48.6%)</td>
</tr>
<tr>
<td>18 - 30</td>
<td>55 (30.4%)</td>
</tr>
<tr>
<td>30 - 50</td>
<td>4 (2.2%)</td>
</tr>
<tr>
<td>50 ≤</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Don’t know/remember</td>
<td>6 (3.3%)</td>
</tr>
</tbody>
</table>

Table 5.2: Age around which respondents knew they wanted to pursue science and technology

Most of the participants considered themselves to be kinaesthetic learners, however, there were many who selected other methods too. Three participants did not answer question four. Seven participants added unique answers relating to the presented options. Due to these unique answers being few in comparison to the total amount, they are not represented in this section. Figure 5.1 illustrates this in a bar graph where the number on top of each bar represents the number of respondents choosing the learning method in particular.
Figure 5.1: Learning methods among respondents

A few respondents did not answer question five. The remaining respondents wrote various motivating factors. Some of the factors were similar to others and were categorised and generalised for this section, as seen in Table 5.3.

<table>
<thead>
<tr>
<th>Motivating factor</th>
<th>Number of mentions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest in understanding how things work and problem solving</td>
<td>30</td>
</tr>
<tr>
<td>Enjoying or being interested in STEM subjects</td>
<td>28</td>
</tr>
<tr>
<td>People (family and relatives)</td>
<td>24</td>
</tr>
<tr>
<td>Toys and games</td>
<td>24</td>
</tr>
<tr>
<td>People (friends, teacher, unspecified)</td>
<td>22</td>
</tr>
<tr>
<td>Innovation, art, creativity, construction, and improving the world</td>
<td>20</td>
</tr>
<tr>
<td>Attractive jobs, good incomes, and the idea of a stable future</td>
<td>13</td>
</tr>
<tr>
<td>Media, TV, books, and so on</td>
<td>11</td>
</tr>
<tr>
<td>Performed well in STEM subjects or found them easy</td>
<td>7</td>
</tr>
<tr>
<td>Mechanics in vehicles</td>
<td>7</td>
</tr>
<tr>
<td>Electronics and gadgets (computers, watches, etc.)</td>
<td>5</td>
</tr>
<tr>
<td>Aviation, military, and piloting</td>
<td>3</td>
</tr>
<tr>
<td>Information from schools, pamphlets, prints, and so on</td>
<td>3</td>
</tr>
</tbody>
</table>
People (scientists and celebrities) 2
Lack of interest in other subjects 2
Social status of engineers 2
Robotics 1
Space and exploration 1

Table 5.3: Inspirational and motivational sources for the respondents

Question six received 124 answers, however, a small number of these were not answers to the question itself and were not included in the results. 60 participants did not answer this question which can be interpreted as these respondents not experiencing any problems after choosing their field. In addition to these 60 respondents, 52 people wrote ‘No’ as an answer to the question. Hence, 112 respondents claimed to not have experienced any problems, i.e. a majority. However, several of the remaining 72 respondents brought different problems to light that were categorised for simplicity. Some respondents mentioned more than one problem, as seen in Table 5.4.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Number of mentions</th>
</tr>
</thead>
<tbody>
<tr>
<td>No problems</td>
<td>52</td>
</tr>
<tr>
<td>Difficult subjects</td>
<td>17</td>
</tr>
<tr>
<td>Job does not meet expectations</td>
<td>10</td>
</tr>
<tr>
<td>Finding a job</td>
<td>9</td>
</tr>
<tr>
<td>Attitude towards women</td>
<td>7</td>
</tr>
<tr>
<td>Lack of women</td>
<td>5</td>
</tr>
<tr>
<td>Engineering is too broad</td>
<td>4</td>
</tr>
<tr>
<td>Not enough preparation before university</td>
<td>4</td>
</tr>
<tr>
<td>Income</td>
<td>3</td>
</tr>
<tr>
<td>Not enough free time</td>
<td>3</td>
</tr>
<tr>
<td>Teacher attitudes</td>
<td>3</td>
</tr>
<tr>
<td>Uninteresting subjects</td>
<td>3</td>
</tr>
<tr>
<td>Attitudes from outside</td>
<td>2</td>
</tr>
<tr>
<td>Was not ready to study</td>
<td>2</td>
</tr>
<tr>
<td>Lack of material for studying</td>
<td>1</td>
</tr>
<tr>
<td>Large work teams</td>
<td>1</td>
</tr>
<tr>
<td>People questioning choices</td>
<td>1</td>
</tr>
<tr>
<td>School choices</td>
<td>1</td>
</tr>
<tr>
<td>Study loans</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5.4: Problems experienced after making choice in fields
A large majority of the respondents had positive reactions from people around them when they made their choice in fields, as seen in Table 5.5. However, a small minority was discouraged and there were some respondents who did not remember or know.

<table>
<thead>
<tr>
<th>Reactions of friends and family</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positively and encouragingly</td>
<td>94 (51.9%)</td>
</tr>
<tr>
<td>Positively</td>
<td>51 (28.2%)</td>
</tr>
<tr>
<td>Indifferently</td>
<td>23 (12.7%)</td>
</tr>
<tr>
<td>Negatively</td>
<td>1 (0.6%)</td>
</tr>
<tr>
<td>Negatively and discouragingly</td>
<td>1 (0.6%)</td>
</tr>
<tr>
<td>Do not know/remember</td>
<td>11 (6.1%)</td>
</tr>
</tbody>
</table>

Table 5.5: Reactions of friends and families of the respondents (after making a career choice)

The question regarding encouragement from school had mixed results, as seen in Figure 5.2. The figure illustrates the data from the Likert scale in a bar chart where the left side represents the respondents who did not feel encouraged at all while the right side represents those who were very encouraged.

Figure 5.2: Level of encouragement received from school according to the respondents

Most respondents mentioned that there were science and technology related activities arranged by their secondary schools. However, there were mentions of activities arranged by primary schools, governmental units, and companies as well. Several respondents presented additional options such as museums, activities arranged by clubs, girl scouts, and so on. Some respondents mentioned making an activity out of disassembling toys. The additional entries have been generalised as they were unique, as seen in Figure 5.3. This figure is a bar chart illustrating how many activities there were involving science and technology in the respondents’ lives before they made their career choices. Each bar represents a place or unit that has the potential to arrange activities. The number above the bar corresponds with the number of respondents selecting the option below.
5.2 Interview results

This section has been separated into one subsection per conducted interview in order to simplify the result presentation and to clarify the individual opinions of the respondents. Additionally, this section only contains the answers to the interview questions while Appendix I includes additional data.

5.2.1 Summary of interview I

Answer to question 1: The respondent became interested in science and technology as a child, particularly around the age of ten. However, the choice to pursue these subjects as a career was made during teen years due to the Swedish secondary school programme selection.

Answer to question 2: There were toys, games, and physical objects in the respondent’s childhood that were inspiring. Some examples are building block toys, e.g. LEGO and Meccano which illustrated principles of physics relating to construction such as loads, durability, and so on. The respondent also spent a lot of time drawing during their childhood, e.g. technical drawings and designing products.

Answer to question 3: No encouragement was needed from the school due to the respondent having decided at an early age.

Answer to question 4: The respondent remembers the school arranging field trips that involved science and technology. One particular memory that was brought to light was a visit to Chalmers, an engineering university in Gothenburg. In addition to field trips, there was also printed information such as pamphlets, brochures, catalogues, etc.

Answer to question 5a: The respondent mentioned their father being seen as a handy person. He built a house on his own and had a workshop in the basement. This inspired the respondent (as well as other family members) to think creatively and to try to solve problems. Through this, the respondent learnt to help fixing things at home as well as how to work with vehicles, especially mopeds. The respondent also mentioned never looking into any other field before making a choice.
5.2.2 Summary of interview II

Answer to question 1: The respondent became interested in science and technology during nursery school years and made the choice to pursue the subjects as a teenager, around the age 16 - 17.

Answer to question 2: The respondent actively played with construction toys such as LEGO, but also enjoyed performing actual construction. Working with bikes, e.g. repairing them, upgrading them, replacing parts, etc. became an early hobby.

Answer to question 3: During practical classes such as wood work, the respondent felt encouraged.

Answer to question 4: There were after-school clubs that the respondent participated in. Their activities involved various constructions such as building rockets and making boats. These constructions were also tested, e.g. the rockets were launched and the boats were set to sail.

Answer to question 5b: The respondent’s parents were not engineers but taught subjects involving STEM. This was one of many motivating factors for the respondent. Additionally, the respondent always felt supported no matter what choice would have been made. Therefore, the respondent feels happy being an engineer. The respondent’s brother is also an engineer.

5.2.3 Summary of interview III

Answer to question 1: The respondent grew up liking STEM subjects and was always interested in the field. However, the decision to pursue them through a career was made around their teen years during the Swedish secondary school selection.

Answer to question 2: Construction toys such as LEGO were available during the respondent's childhood. Additionally, the respondent spent a lot of time crafting as a child, one example being sewing. The respondent also mentioned water games where water and tubes were used to create different paths and water flows. The latter was something the respondent engaged in outdoors during summers.

Answer to question 3: The respondent does not recall any specific encouragement from school. However, there were student counsellors that could advise students concerned with career choices.

Answer to question 4: The respondent went on different field trips in courses involving STEM-subjects. The schools also arranged special events during holidays where people could come and experiment.

Answer to question 5a: The respondent has parents within the field. They could always help with subjects at home. This inspired the respondent to continue in the field. The respondent did not necessarily want to choose engineering but knew that it had to be something involving STEM. Engineering appeared to be the most broad path. Hence, the respondent chose this.

5.2.4 Summary of interview IV

Answer to question 1: The respondent became interest as a child, around age 7 - 8. The choice to pursue science and technology came naturally and did not happen at any particular age.

Answer to question 2: There were clubs for children arranged by the government. The respondent was a member of a club for children with interests in electronics. There were not many toys during their childhood due to the political climate of the country the respondent grew up in. However, the clubs allowed children to build their own toys. The respondent built a robot dog among many other toys.
**Answer to question 3:** There was no encouragement from the school. The respondent’s home country had traditional teaching methods in the schools. Due to the respondent’s interest in STEM subjects, pursuing them as a career became an obvious choice.

**Answer to question 4:** There were no activities arranged by the respondent’s school.

**Answer to question 5b:** The respondent did not have any other family members within the field. However, the respondent’s father was skilled in crafting and construction and built a fair amount. This inspired the respondent. The respondent’s family was supportive of the career choice. Being the first engineer in the family did not make the respondent feel anything special, other than happy.

**5.2.5 Summary of interview V**

**Answer to question 1:** The respondent was always interested in technology and enjoyed constructing as a child. However, the decision to pursue a career within the field was made around the age of 18. The choice was influenced by another engineer.

**Answer to question 2:** There were no particular toys that inspired the respondent. However, the respondent enjoyed disassembling and reassembling horse equipment during time spent in a barn.

**Answer to question 3:** The respondent does not remember any particular encouragement.

**Answer to question 4:** The respondent cannot recall any particular activities other than the standard sessions during physics and chemistry classes.

**Answer to question 5b:** The respondent’s sister’s boyfriend (an engineer) encouraged the respondent to pursue engineering. The respondent is proud of this choice and was fully supported and encouraged by family.

**5.2.6 Summary of interview VI**

**Answer to question 1:** The respondent became interested in STEM subjects as a teenager during secondary school. However, the decision to pursue the subjects as a career was made around the age of 24, as a young adult. The decision was influenced by a career coach.

**Answer to question 2:** There were no specific toys that inspired the respondent to like science and technology. The respondent’s family shared toys and played with whatever was available. However, the respondent enjoyed educational PC games and drawing. The respondent had creative hobbies as a child and still does.

**Answer to question 3:** The respondent cannot recall any specific encouragement from school.

**Answer to question 4:** The respondent cannot recall any specific school activities relating to STEM subjects.

**Answer to question 5a:** The respondent’s family members are all engineers but this was never a factor that inspired the respondent to follow in their footsteps. The respondent realised that their family situation included stability and safety and saw this as something positive. However, engineering as a job was never an ambition. The parents helped understanding STEM subjects when the respondent needed help and this was a benefit. However, the respondent tried many options before meeting a career coach who suggested engineering.

**5.2.7 Summary of interview VII**

**Answer to question 1:** The respondent became interested in technology as a child. However, the choice to pursue the subject as a career was made around the age of 23 when the respondent browsed a career catalogue.
Answer to question 2: The toys the respondent can remember were Meccano and LEGO. However, due to these being expensive, the respondent built their own toys. Some of these include a playhouse, board games, and paper dolls.

Answer to question 3: The respondent cannot recall any form of encouragement from school.

Answer to question 4: In one of the respondent’s courses, the students built a house. In addition to this activity, the respondent also remembers field trips to recreation centres involving STEM subjects.

Answer to question 5a: The respondent’s father is a mechanical engineer. He helped the respondent with maths which encouraged the respondent to appreciate the subject. However, the respondent did not feel any need to pursue engineering because of this. The respondent studied other subjects before making a decision. The ambition was always to work creatively and to develop something. The respondent learnt that this could be achieved through engineering and that is why the decision was made.

5.2.8 Summary of interview VIII

Answer to question 1: The respondent became interested in science and technology as a child and made a choice to pursue these subjects as a teenager during the Swedish secondary school selection.

Answer to question 2: The toys that the respondent could remember were Meccano, LEGO, and Brio. In addition to existing toys, the respondent also enjoyed constructing and deconstructing. The respondent built carts, model aeroplanes, and rockets. Lastly, the respondent also remembered house building PC games being inspiring.

Answer to question 3: The respondent did not receive encouragement before making a field choice. The encouragement was received after the choice in form of support.

Answer to question 4: The respondent remembers going on school field trips. One particular memory involves a visit in Kallinge, in south Sweden. The students studied aeroplanes and built their own models of them.

Answer to question 5b: While the respondent’s family members were not engineers, the father was connected to the field as he was a construction carpenter. This inspired the respondent due to the job involving fine carpentry, construction, and development. The respondent received support from family when choosing to become an engineer.

5.2.9 Summary of interview IX

Answer to question 1: The respondent became interested as a child. The choice to pursue a career in engineering came naturally.

Answer to question 2: The respondent used to sew clothes for dolls during their childhood and build towns in sand boxes. While these two activities are emphasised, the respondent generally enjoyed creative play.

Answer to question 3: The respondent remembers feeling encouraged during crafting classes. The respondent also studied at an art school for 4 years which was encouraging.

Answer to question 4: The respondent says that the answer to question 3 is applicable for this question too.

Answer to question 5a: The respondent’s parents and grandparents were engineers. Therefore, choosing to pursue engineering was natural. However, the respondent also considered a career as a teacher but still within the engineering perspective.
6 Analysis

This chapter consists of an analysis of the results from the empirical research based on the theoretical research. The analysis is designed to connect the research with the research topic. This means that the analysis will be the solid foundation for the conclusion and possible recommendations.

6.1 Data relevance and validity

In order to evaluate which survey questions are truly connected to the research questions, IR can be used to calculate the precision of the survey. The algorithm for this calculation uses retrieved documents and relevant documents as input data. The total amount of questions of the main survey is 11, which in this case refers to ‘retrieved documents’.

The questions that are relevant to the research questions are 8, as seen in Table 6.1. The remaining questions, while not relevant, are useful for future research as they are connected to the research topic.

<table>
<thead>
<tr>
<th>Question</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>What kind of area did you grow up in?</td>
<td>The result of this question can be used to illustrate whether or not residential area can influence interests.</td>
</tr>
<tr>
<td>Around what age were you certain that you wanted to study technology and/or science?</td>
<td>This question has a direct connection to age and decision making, which is the main focus of this study.</td>
</tr>
<tr>
<td>What kind of learner are you?</td>
<td>This question targets education possibilities which, according to the literature review, is a potential key in motivation.</td>
</tr>
<tr>
<td>What inspired you to choose technology and/or science?</td>
<td>This question is almost identical to the main research question. The question also creates an opportunity to investigate whether toys are potential motivators or inspirations, which is the focus of the second research question. Any objects mentioned in this question could also be used to answer the sub-research question.</td>
</tr>
<tr>
<td>Did you experience any problems after choosing your field?</td>
<td>This question investigates whether or not there are potential circumstances where motivation exists but is discouraged.</td>
</tr>
<tr>
<td>How did people react when you made your choice in fields?</td>
<td>This question focuses on motivation created by encouragement and connects to the main research question from a social perspective.</td>
</tr>
<tr>
<td>Did you feel encouraged by your school to pursue this field?</td>
<td>This question is similar to the question concerning the social perspective. However, this takes into consideration education as well.</td>
</tr>
</tbody>
</table>
Were there many activities involving technology and/or science available where you grew up before you made your choice? This question investigates whether or not there is a potential in activities for inspiring children and teenagers.

Table 6.1: Relevant survey questions

<table>
<thead>
<tr>
<th>Table 6.1: Relevant survey questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>By entering these values into Formula 1, the precision can be calculated to be 72%, as seen in the following calculation:</td>
</tr>
<tr>
<td>Precision = \frac{</td>
</tr>
<tr>
<td>Precision = \frac{</td>
</tr>
<tr>
<td>This shows that 72% of the survey questions are relevant for answering the research questions. The remaining 28%, while being connected to the research topic, do not answer the research question and are therefore only useful for recommendations, i.e. future studies.</td>
</tr>
<tr>
<td>By applying this algorithmic analysis, the relevant questions become more evident and can therefore be highlighted in an efficient manner. The result presentation in chapter 5 is entirely based on this algorithm. The results of the questions that were considered to be irrelevant were not visualised while the relevant results were visualised using the spreadsheet software Microsoft Excel.</td>
</tr>
<tr>
<td>In the case of the interview, all questions were relevant for answering the research question. This is due to the fact that they were created in order to support the survey in the areas where it was not clear enough, with focus on the research topic. Therefore, the precision for the interview is 100%, as calculated below.</td>
</tr>
<tr>
<td>Precision = \frac{</td>
</tr>
<tr>
<td>The total precision of all the data gathering methods can be calculated by adding the interview and the survey questions together as one collection of retrieved documents. This gives a precision value of 81%, as calculated below.</td>
</tr>
<tr>
<td>Precision = \frac{</td>
</tr>
<tr>
<td>With a total precision value of 81%, the relevance of the data makes this study valid to a large extent. It is necessary to take into consideration that this research deals with a subjective topic. Therefore, an accurate scale of the validity is impossible to present. However, 81% can be considered a high value.</td>
</tr>
</tbody>
</table>

6.2 Data significance

To evaluate the significance of each quantitative answer in the survey, the Chi-squared test was applied. To simplify the mathematical calculations, Microsoft Excel was used to calculate each part of the algorithm step by step. The numbers used in each calculation are the values taken from the expectations in chapter 4 and the results in chapter 5. The comparison of the Chi-squared value will be based on the degree of freedom, which in this study is the amount of possible answering options minus one. In order to calculate the significance, Matt Bognar’s online calculator for Chi-squared was used (University of Iowa, 2016). However, there was one question that involved a Likert scale which was not analysed using a Chi-squared test.
6.2.1 Gender distribution

Question 1, concerning gender distribution of respondents, has a Chi-squared value of 28.9646, as seen in Table 6.2. The degree of freedom in this case is 2 due to there being 3 possible options to choose in this question. This results in an improbability of 100%. Due to this number, this result can be considered to be very unlikely in comparison to the hypothesis. In other words, IKEA may be a rare company where the gender distribution among engineers is more even compared to the rest of the world. Therefore, in IKEA’s case, the hypothesis is wrong.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Expectations</th>
<th>Respondents, O</th>
<th>Hypothesis, E</th>
<th>(O-E)^2</th>
<th>Chi-squared value ((O-E)^2)/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>76%</td>
<td>107</td>
<td>137.56</td>
<td>933.91</td>
<td>6.7891</td>
</tr>
<tr>
<td>Female</td>
<td>23%</td>
<td>72</td>
<td>41.63</td>
<td>922.33</td>
<td>22.1555</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>1%</td>
<td>2</td>
<td>1.81</td>
<td>0.03</td>
<td>0.0199</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>181</td>
<td>181</td>
<td>28.9646</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.2: Chi-squared value of gender distribution

6.2.2 Childhood residential area

Question 2, concerning childhood residential area, had answers generating a Chi-squared value of 28.1347, as seen in Table 6.3. The degree of freedom in this case is 4. There were 4 presented options but respondents could also add their own answers. Around the deadline, there were 5 different answer categories. The improbability of this answer in comparison to the hypothesis is 100%. This means that science and technology are not exclusive to urban areas but can also be of interest in rural districts. Furthermore, this also shows that these particular respondents were not dependent on their surroundings during their childhood to find interest in engineering.

<table>
<thead>
<tr>
<th>Area</th>
<th>Expectations</th>
<th>Respondents, O</th>
<th>Hypothesis, E</th>
<th>(O-E)^2</th>
<th>Chi-squared value ((O-E)^2)/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>23%</td>
<td>67</td>
<td>41.63</td>
<td>643.63</td>
<td>15.4608</td>
</tr>
<tr>
<td>Urban</td>
<td>50%</td>
<td>90</td>
<td>90.5</td>
<td>0.25</td>
<td>0.0027</td>
</tr>
<tr>
<td>Both</td>
<td>25%</td>
<td>22</td>
<td>45.25</td>
<td>540.56</td>
<td>11.9461</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
<td>2</td>
<td>3.62</td>
<td>2.62</td>
<td>0.7249</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>181</td>
<td>181</td>
<td>28.1347</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.3: Chi-squared value of childhood residential area

6.2.3 Age of certainty

Question 3, concerning the age at which the respondent was certain of their choice in fields, generated a Chi-squared value of 40.053, as seen in Table 6.4. This question has degree of freedom value of 5 due to there being 6 fixed options. Due to this, the improbability of this result is 100% in comparison to the theory. This means that despite youths being more susceptible to learning, career choices are not restricted to age. However, this question does not represent the age during which the respondents became interested in the subjects. Therefore, these results can be considered to be ambiguous.

<table>
<thead>
<tr>
<th>Area</th>
<th>Expectations</th>
<th>Respondents, O</th>
<th>Hypothesis, E</th>
<th>(O-E)^2</th>
<th>Chi-squared value ((O-E)^2)/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>23%</td>
<td>67</td>
<td>41.63</td>
<td>643.63</td>
<td>15.4608</td>
</tr>
<tr>
<td>Urban</td>
<td>50%</td>
<td>90</td>
<td>90.5</td>
<td>0.25</td>
<td>0.0027</td>
</tr>
<tr>
<td>Both</td>
<td>25%</td>
<td>22</td>
<td>45.25</td>
<td>540.56</td>
<td>11.9461</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
<td>2</td>
<td>3.62</td>
<td>2.62</td>
<td>0.7249</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>181</td>
<td>181</td>
<td>28.1347</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.4: Chi-squared value of age of certainty
6.2.4 Learner categories

Question 4, concerning what type of learner the respondents were, generated a small number of answers outside the given options. However, these were neglected in this question in order to focus on VARK only. The result from this question generated a Chi-squared value of 46.259, as seen in Table 6.5. With a degree of freedom value of 4 (due to this question having 5 options), this gives an improbability rate of 100%. This means that the hypothesis did not match IKEA’s current situation. This is due to the fact that the number of kinaesthetic learners was underestimated. These results clarified that there are more kinaesthetic learners among IKEA’s engineers in comparison to the hypothesis case.

While this result is does not match the hypothesis, the underestimation coincides with the theoretical findings that state that kinaesthetic learning is common among engineers (Mobley et al., 2014). Therefore, there is a contradiction between the hypothesis and this result, but not between the theoretical findings and the result. Due to this, the result of this question can be considered to be ambiguous from a scientific perspective, but relevant from a practical and local perspective.

Table 6.5: Chi-squared value of learner categories

6.2.5 Reactions from people

Question 7, concerning close people’s reactions when the respondents made their choices, generated a Chi-squared value of 1.053, as seen in Table 6.6. The degree of freedom value in this case is 5 due to there being 6 choices. This gives an improbability rate of 4% which means that the probability of this result is 96%. It is evident that engineering is often encouraged by friends and family and such is the case at IKEA as well.
Reactions | Expectations | Respondents, O | Hypothesis, E | (O-E)^2 | Chi-squared value ((O-E)^2)/E |
--- | --- | --- | --- | --- | --- |
Positively and encouragingly | 51% | 94 | 92.31 | 2.8561 | 0.03094031 |
Positively | 28% | 51 | 50.68 | 0.1024 | 0.0002020521 |
Indifferently | 12% | 23 | 21.72 | 1.6384 | 0.075432781 |
Negatively | 1% | 1 | 1.81 | 0.6561 | 0.362486188 |
Negatively and discouragingly | 1% | 1 | 1.81 | 0.6561 | 0.362486188 |
Don’t remember/know | 7% | 11 | 12.67 | 2.7889 | 0.22011839 |
Total | 100% | 181 | 181 | 1.053484377 |

Table 6.6: Chi-squared value of reactions from people

6.2.6 Encouragement from school

Question 8, concerning encouragement from school in terms of science and engineering, generated an average value of 3.5, based on a calculation of the mean value, as seen in the following calculation based on Formula 3:

\[
\frac{(50 \times 5) + (44 \times 4) + (47 \times 3) + (19 \times 2) + (18 \times 1)}{178} = \frac{623}{178} = 3.5
\]

The standard deviation for this mean value was calculated according to Formula 4. The standard value was 0.19 based on the following calculation:

\[
\sqrt{\frac{|(5 - 3.5) + (4 - 3.5) + (3 - 3.5) + (2 - 3.5) + (1 - 3.5)|^2}{178}} = 0.187 \ldots \approx 0.19
\]

By comparing the two tests’ mean and standard deviation values in a T-test calculator designed by GraphPad (2018), the probability rate for this result becomes 95%. This means that this result is highly reliable. However, this also means that encouragement from school can be considered to be ambiguous due to 3.5 being a neutral but slightly positive value. This shows that encouragement from school is a random matter. Furthermore, this means that encouragement has been prevalent in many cases as well as rare. To investigate further into this matter, qualitative data may be necessary.

6.2.7 Activities involving STEM

Question 9 involved allowing respondents to select facilities, enterprises, organisations, and so on, that arranged activities involving STEM subjects before the respondents made their career choices. The Chi-squared value of this result is 4.413, as seen in Table 6.7. The degree of freedom for this question was 5, giving this result an improbability and probability rate of 50%. This means that this result has an even chance at being true or false and can be considered to be random. One possible reason behind this could be that all the respondents grew up in different areas and were not only in urban districts. Due to this, the available activities may have been variable depending on location.
6.2.8 Importance of science and technology

Question 10 was not relevant for the research question but was created in order to evaluate whether or not engineers perceived the demand for engineers as acute. The Chi-squared value of the result is 1.889, as seen in Table 6.8. The degree of freedom in this case is 4 which gives an improbability rate of 24%. By reversing this, the possibility rate becomes 76% which means that statistically, this is a feasible assumption to make based on the theory. The engineers at IKEA value technology as important for the future, which is a value found among engineers in other companies as well.

6.2.9 Satisfaction of being engineer

Question 11 measures the satisfaction of being an engineer among the respondents and the Chi-squared value of this result is 1.213, as seen in Table 6.9. The degree of freedom is 2 in this case which gives an improbability rate of 45%. This means that the possibility of this result is 55%. However, there is a flaw in this calculation. Due to ‘No’ being an option and the calculation needing a value for it (division by zero is not possible), an incorrect value is represented. If ‘No’ as an option is removed from the table since it was never selected by any respondent, an accurate Chi-squared value of 0.555 can be calculated, as seen in Table 6.10. With the new value, the improbability rate becomes 24%. This means that this result is 76% possible outside of IKEA.
### Satisfaction and Expectations

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Expectations</th>
<th>Respondents, O</th>
<th>Hypothesis, E</th>
<th>(O-E)^2</th>
<th>Chi-squared value ((O-E)^2)/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>90%</td>
<td>165</td>
<td>162</td>
<td>9</td>
<td>0.055555556</td>
</tr>
<tr>
<td>No</td>
<td>0.5%</td>
<td>0</td>
<td>0.9</td>
<td>0.81</td>
<td>0.9</td>
</tr>
<tr>
<td>Other</td>
<td>9.5%</td>
<td>15</td>
<td>17.1</td>
<td>4.41</td>
<td>0.257894737</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>180</td>
<td>180</td>
<td></td>
<td>1.213450292</td>
</tr>
</tbody>
</table>

**Table 6.9:** Chi-squared value of satisfaction of being an engineer, incorrect

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Expectations</th>
<th>Respondents, O</th>
<th>Hypothesis, E</th>
<th>(O-E)^2</th>
<th>Chi-squared value ((O-E)^2)/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>90%</td>
<td>165</td>
<td>162</td>
<td>9</td>
<td>0.055555556</td>
</tr>
<tr>
<td>Other</td>
<td>10%</td>
<td>15</td>
<td>18</td>
<td>9</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>180</td>
<td>180</td>
<td></td>
<td>0.555555556</td>
</tr>
</tbody>
</table>

**Table 6.10:** Chi-squared value of satisfaction of being an engineer, correct

### 6.3 Reliability of survey

In order to conclude whether or not the survey is reliable, the data significance was compared to the relevance and validity of each question. However, due to the study being conducted mainly within IKEA, a diverse company with international employees, clustering had to be applied to make unorthodox connections, i.e. ideas not based on theory but on the particular case company.

The clusters were then broken into agglomerations for in-depth reasoning, as seen in Table 6.11. Agglomeration 1 is the first conclusion that can be made from the main cluster (the reasoning behind the answer to the question and its probability rate), and agglomeration 2 is a secondary conclusion based on its preceding conclusion. Based on the agglomerations, the external reliability was calculated as well as the internal reliability. The reason why the reliability was considered for two purposes was to illustrate the difference between IKEA as a company compared to the global average, as described in chapter 3.

<table>
<thead>
<tr>
<th>Question</th>
<th>Data type</th>
<th>Relevance to research question</th>
<th>Prob.</th>
<th>Improb. rate</th>
<th>Cluster category (reasoning)</th>
<th>Aggl. 1</th>
<th>Aggl. 2</th>
<th>External reliability</th>
<th>Internal reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Quant.</td>
<td>No</td>
<td>0%</td>
<td>100%</td>
<td>IKEA is diverse</td>
<td>Different interests depending on culture</td>
<td>Very low</td>
<td>Very Low</td>
<td></td>
</tr>
<tr>
<td>What kind of area did you grow up in?</td>
<td>Quant. Yes</td>
<td>0%</td>
<td>100%</td>
<td>STEM subjects are not area restricted</td>
<td>People travel to pursue careers</td>
<td>Parents can influence</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Type</td>
<td>Yes/No</td>
<td>Percentage</td>
<td>Notes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-------</td>
<td>--------</td>
<td>------------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Around what age were you certain that you wanted to study technology and/or science?</td>
<td>Quant.</td>
<td>Yes</td>
<td>0% 100%</td>
<td>There is no particular age for making career choices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What kind of learner are you?</td>
<td>Quant.</td>
<td>Yes</td>
<td>N/A N/A</td>
<td>Engineers are prone to kinaesthetic learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What inspired you to choose technology and/or science?</td>
<td>Qual.</td>
<td>Yes</td>
<td>N/A N/A</td>
<td>Curiosity about the world and its functions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you experience any problems after choosing your field?</td>
<td>Qual.</td>
<td>Yes</td>
<td>N/A N/A</td>
<td>Reactions from people</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How did people react when you made your choice in fields?</td>
<td>Quant.</td>
<td>Yes</td>
<td>96% 4%</td>
<td>Difficult to find jobs or knowing what kind of jobs there are</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you feel encouraged by your school to pursue this field?</td>
<td>Quant.</td>
<td>Yes</td>
<td>95% 5%</td>
<td>Male dominated field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Were there many activities involving technology and/or science available where you grew up before you made your choice?</td>
<td>Quant.</td>
<td>Yes</td>
<td>50% 50%</td>
<td>Accessibility to activities varies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notes</th>
<th>Level</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest and pursuing a career do not have to be related</td>
<td>Very low</td>
<td>Low</td>
</tr>
<tr>
<td>Blended learning is more influential than other learning methods</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Students need to feel satisfied from practical tasks</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>Activities involving toys, games, and media</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>Male dominated field</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>Engineers have valuable jobs from a societal view</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>Different interests depending on culture</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>Accessibility to activities varies</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
How important are technology and science for future development?  

Technology and science are important according to engineers  

Engineers have social status  

Engineers have valuable jobs from a societal view  

Engineers have valuable jobs from a societal view  

Are you happy with your choice of field?  

Technology and science are important according to engineers  

Engineers are satisfied with their jobs  

Engineering a stable career choice  

Engineers have valuable jobs from a societal view  

Table 6.11: Reliability analysis

Based on the cluster analysis, it is evident that the questions that are of value are the most reliable questions. However, the question concerning learner types is, despite its low reliability, relevant due to the contradictions presented in the analysis of its result. Therefore, the questions that are of highest value are the following:

- What kind of learner are you?
- What inspired you to choose technology and/or science?
- Did you experience any problems after choosing your field?
- How did people react when you made your choice in fields?
- Did you feel encouraged by your school to pursue this field?
- How important are technology and science for future development?
- Are you happy with your choice of field?

Due the moderate to low reliability on the remaining questions, they will not be worthwhile for answering the research questions. However, since some of them were relevant to the research topic, they can be considered recommendations for future studies.

6.4 Combining interview and survey data

Due to the interviews containing qualitative data only, the data from them was studied subjectively through aggregation. This means that the interview data was used to analyse the agglomerations from the clustering of the survey data. By analysing the agglomerations, further connections could be made in order to find more in-depth data. This could also highlight contradictions among the results (comparing survey with interviews). Interest is a subjective matter. Therefore, the aggregation was only used to find subjective meanings behind each agglomeration.

6.4.1 What kind of learner are you?

The survey shows that most engineers are kinaesthetic learners. This can be connected to some of the data in the interviews concerning interests in learning how things work. Many respondents claimed that they enjoyed creating objects. In addition to this, several of the interviewees built their own toys and were introduced to crafting at an early age. By combining the interviewees interests in construction and creation with the survey respondents’ answer, it is evident that learning through practice is a motivational factor. Therefore, the theoretical claims about kinaesthetic learning having a positive impact on children by Uptitis (2001), can be considered true. However, due to this question contradicting its hypothesis, the result may need further investigation. The hypothesis was
based on results from a different country which could potentially mean that culture is connected to learning. Furthermore, kinaesthetic learning with focus on blended learning is a growing matter and is lacking in terms of research. Therefore, existing data could potentially be outdated.

6.4.2 What inspired you to choose technology and/or science?

Many answers concerning motivational factors in the survey involve creativity, construction, understanding how the world works, toys, electronics, and people. These answers can be condensed to knowledge and inspiration: knowledge from working with objects and trying to understand them, and inspiration from people or activities that spark an interest. This means that objects have the power to inspire people to learn. Furthermore, people also have this power as they can provide support. Almost all interviewees used creative methods to play or played with creative toys. This shows that people who do not have inspirational people in their lives need a push from a third party. This can be in the form of a toy, an activity, school, or an outside person, and this reasoning is also supported by Eccles et al. (2016) and Young et al. (2012).

By delving further into the subject of creation, it can be assumed that the interest in wanting to know how things work also has roots somewhere. Many of the interviewees who claimed to enjoy disassembling things to learn how they work enjoyed building objects and toys. One possible deduction that can be made from this is that construction in any form is inspiring and creates a curiosity among children.

6.4.3 Did you experience any problems after choosing your field?

Not many engineers claimed to have experienced problems after choosing engineering. All the interviewees expressed pride and happiness over being engineers which means that engineering can be considered a rewarding profession. However, in the survey, there is a small number of mentions of the lack of women in the field. The problems connected to this fact, that were mentioned, were condescending comments towards women and difficulties to enter the field. Other problems that were mentioned involved difficulties with studies due to hard subjects. However, comparing this to how satisfied the respondents claim to be, it is evident that the struggles are worth the efforts.

The reliability analysis showed that many of the questions had answers different to the hypotheses. This shows that IKEA is a company that actively works against the norm by having a relatively balanced gender distribution. Therefore, IKEA could be used as a future research subject in order to improve the situation for women in other companies that hire engineers.

6.4.4 How did people react when you made your choice in fields?

A clear majority of the survey respondents claimed that people reacted positively when they made their choices. Most of the positive reactions were encouraging as well. The interviewees were also positively encouraged by people. Therefore, it is evident that encouragement is a benefit, and that engineering is generally seen as a good profession. However, most interviewees mentioned parents being encouraging only. Hardly any interviewee was encouraged by school to pursue engineering which means that there could be some lost potential due to lack of involvement from schools. This is also an idea supported by Andersen (2013).

6.4.5 Did you feel encouraged by your school to pursue this field?

A majority of the survey respondents claimed to have felt encouraged by their schools to pursue engineering. However, the average value is neutral due to a quarter of the respondents providing neutral answers. The addition of the 37 negative answers lowered the mean value despite a majority of encouraged respondents. Additionally, most of the interviewees were not encouraged to pursue engineering. This is a contradiction and means that this question may benefit from qualitative answers only as they can provide detailed data concerning the form of the encouragement. Furthermore, Eccles et al. (2016) and Andersen (2013) emphasise children’s disconnection from STEM-subjects. These studies claim that students are not encouraged enough. Due to the lack of
clarity in this question, it is evident that the interview results are more relevant as they provide unique answers rooted in various reasons that can be used to analyse how encouragement comes about.

6.4.6 How important are technology and science for future development?

A vast majority among the survey respondents claimed that technology and science are important for the future development. This can be supported by Bursky (2002). With engineers being satisfied with their careers and understanding the importance of their work and competences, it is evident that there is a need for further research to understand why people do not choose to pursue a career within this field when the world is becoming more dependent on it. One potential factor that has been brought to light in this analysis is the lack of encouragement, however, this factor did not stop the respondents as they are already engineers. Therefore, there is a need for more data from a larger respondent group including other occupations in order to fully understand the lack of interest in engineering in comparison to the increasing dependency on technology.

6.4.7 Are you happy with your choice of field?

Almost all respondents, including data from both the survey and the interviews, are happy with their choices. One interviewee may potentially change jobs but will stay near technology. Taking into consideration everything that the interviewees enjoyed spending time on during their childhood and the people they had in their lives, it becomes clear that interest in these subjects need to originate from some form of inspirational source. It is also evident that kinaesthetic learning is a trigger for curiosity based on the survey and interviews. Therefore, it is these subjects that can be connected to each other for creating interest and satisfaction: inspirational objects, inspirational people, and blended learning.
7 Conclusion

This chapter finalises the research by answering the research questions. It is built on the analysis which means that it is the final result of this study.

One of the major discoveries in this study is that IKEA differs from the average company in its employee distribution. The average workplace for engineers as described by the literature as well as media (a general view) is that it’s male dominated and declining. While the latter is evident due to the shortage in engineers and technological growth of the market, the former is an area where this study contradicts the claims.

At IKEA, there are more male engineers than female engineers, however, the difference between the numbers is not significantly large. Therefore, IKEA can be considered to be a gender neutral workplace where both men and women are generally welcome. Furthermore, engineers at IKEA are satisfied with their current jobs and appear to not have any regrets concerning work. The theoretical findings did not mention dissatisfaction within engineering, only the demand for engineers. This means that the average engineer is satisfied with their career and that they are needed on the market, i.e. engineering is a field that needs to grow.

Due to the necessity of having engineers, this study was valid because it analysed current engineers’ way into the career. By analysing their stories and opinions, it is evident that the keys to creating engineers lie in inspirational objects, inspirational people, and blended learning. However, the reliability of this study’s result depends on where the data is applied. Enterprises that actively work towards diversity could potentially generate a similar result. In addition to this, countries with less gendered norms may also generate similar results. However, if this study is to be applied in an average company, the hypothesis values for the data collections may be more accurate and the questions that generated high improbability rates may be more relevant in those cases.

Despite IKEA being different, the qualitative data is applicable on a large scale as it is entirely individual, subjective, and reflects personal upbringing. This is also the data that is most relevant for answering the research questions. Therefore, it can be concluded that the quantitative data shows different reliability rates on each question due to IKEA being more diverse than the average company. However, the qualitative data reflects the average engineer and can be reapplied within reason as it is subjective.

In order to create statistically significant data to re-apply the study elsewhere, some modifications may be necessary. However, by focusing on the qualitative data with some minor details taken from the quantitative data, the research questions can be answered in a general manner.

7.1 Research question I

‘What can be used to create an interest in science and technology among children and teenagers?’

There are three factors that have been evident throughout the data collection as well as the theoretical findings: inspirational objects, inspirational people, and blended learning. Inspirational objects can be toys, but also gadgets or other physical creations that inspire children and create curiosity. Many children and teenagers enjoy creating or assembling objects. This is evident in both males and females. Creation does not require money, it requires curiosity. Some respondents created simple toys for themselves when they could not afford to buy them such as paper dolls or using material provided by school. Therefore, inspirational objects is an umbrella term for anything that involves creation that generates curiosity to understand how things work.

Inspiring people can be role models but also figures of authority such as teachers. The respondents who had family members working within the field often did not look elsewhere before choosing engineering. This means that seeing a person’s work at an early age is a contribution.
However, this does not necessarily have to be the case either because there were respondents who had engineer family members, and these respondents tried many paths before landing on the engineer path. This is applicable to females mostly as the only respondents to have mentioned this have been female. This can also be connected to Bursky’s theory (2002) which claims that females have different interests. In addition to family members, school can also provide inspirational people.

While most of the interviewees did not receive encouragement from school, almost half of the survey respondents did. This shows that encouragement in school varies from school to school, and possibly from culture to culture. As a result of this, it is worth studying schools and their encouragement on a smaller scale through, for example, case studies. The interviewees who did not have family members within engineering still knew some people with connections to the field which simplified the choice for them. This means that people are inspired by others to a great extent and that encouragement is necessary for major decision making. While objects can create an interest, the encouragement from people pushes children and teenagers to make choices.

Lastly, blended learning is also necessary to create an interest in STEM-subjects among children and teenagers. A majority of the survey respondents considered themselves to be kinaesthetic learners. All the interviewees engaged in some form of creative hobby before becoming an engineer. There is a connection between the satisfaction of solving a problem in reality and interest. Through the results of this study, it is possible to connect tasks with incentives. If there is no incentive in performing a task, the task becomes less interesting. Feeling satisfaction is one form of incentive and can, in this case, create an interest in learning more to such an extent that a career choice can be made upon it. Therefore, the answer to the first research question is inspirational objects, inspirational people, and blended learning.

7.2 Research question II

‘To what extent can a toy, game, or any other physical object inspire children and teenagers to pursue careers within the fields of science and technology while being gender neutral?’

Many respondents in the survey mentioned unique motivational factors. However, several of them could be connected to inspirational objects, as mentioned in section 6.4.2. It is also evident that creation is an activity that inspires children and teenagers through many different methods. It can be toys that inspire children to learn how to construct, but it can also be simple creations that reward children and teenagers after managing to accomplish the constructions.

In some cases, toys have no effect at all as they are seen as playthings rather than inspirational. However, in cases where creativity is applied in a manner that requires logical thinking, toys and physical objects seem to have an effect. For instance, building vehicles requires logical thinking in order to make the vehicle operational. When this is accomplished, the constructor feels satisfaction as well as inspiration as the construction was made from scratch. This can also be applied to smaller constructions such as paper dolls or sewing, hobbies that are considered to be feminine. These constructions require precision and calculation in order to function. Therefore, it is evident that toys, games, and physical objects can inspire children and teenagers towards a career within the fields of science and technology. However, the extent of this depends on how much satisfaction one can receive from the subject in particular.

Additionally, it is noticeable that gender neutrality is not a requirement in a product in order for it to inspire children and teenagers. Many of the female interviewees had feminine hobbies but chose engineering. There were girls who played with masculine toys as well without thinking about the gender connection. What really appears to matter is the level of individual satisfaction a person can receive from playing with a certain object. Therefore, it is important to include creativity and creation in any form of product development for inspirational toys in the future. It is not relevant
whether or not a toy depicts a matter closely linked to STEM-subjects. The toy has to bring forth curiosity to learn.
8 Reflections and recommendations

This chapter contains reflections from a personal viewpoint after completing the project. It also includes recommendations for further research that could help within the research topic, i.e. issues that are not covered by this project but are of relevance. This chapter is mostly subjective.

8.1 If this study was to be repeated

The main flaws of this study is the fact that it contained general findings and descriptions of the world as it is, and a company that defies this view. Data was collected through two sources that contradicted each other in many cases. Therefore, if this study was to be repeated, it would either be narrowed down to focus on an even smaller engineering group, or conducted at a company with less diversity. The data is still valuable and can be used for product development purposes. However, more of the survey data could have been used statistically if an average company would have been studied. Furthermore, this entire study is generalising for the purpose of simplifying large-scale data. Therefore, a more in-depth analysis could have provided slightly different and perhaps more unique findings.

In addition to this, if this study would have been repeated, the data collection would have been analysed using IR before distribution in order to guarantee 100% precision instead of 81%. While no data was useless, more of it could have been used to create the conclusion if there would have been more precision from the very start. Furthermore, the interviews could have been conducted at an earlier stage if this was to be repeated as they contained valuable qualitative data that supported the survey data in a way that simplified the conclusion process.

8.2 Future research

If this study is not repeated, it is worth recommending future study areas that could strengthen this research topic. No study is complete or perfect, and therefore, there are always parts that can be added in order to cover more details. This study lacked several factors in the research framework that are still strongly connected to the subject. Therefore, it is recommended that future research involves these factors:

- **Gender distribution in engineering**: In order to learn why so few women in comparison to men apply for engineering, it is important to study the gender distribution in engineering and to analyse why women do not choose to pursue this career.

- **International views on engineering**: It is worth studying how different countries and cultures view engineering because the engineering shortage is not noticeable in all countries. Some cultural backgrounds produce more engineers, or those with the ambition to become engineers, than others per capita, and this is directly connected to the research topic of this study.

- **The difference between interests and choices**: While this study focused on what creates an interest in science and technology, it did not focus fully on what pushes people to make choices. From a psychological perspective, it could be worth investigating how people are encouraged to make decisions regarding career choices.
9 References

This chapter contains a list of all references that have been used in this study. The references have been categorised according to source type.

Scientific articles and journals


Driscoll, S. A. & Garcia, C. E. 2000 Preferred learning styles for engineering students, in Proc. 2000 ASEE Annual Conference & Exposition, St. Louis, MO, USA


**Books**


Fontana, A., & Prokos, A. 2007. *The interview from formal to postmodern*. Walnut Creek, Calif.: Left Coast Press.


**Online sources**


Appendices

This section contains the appendices of this study. These are documents that contain additional data to what has been presented in the study. This data was considered to be valuable but not necessary to answer the research question. Due to this, they were included in this section instead and could be used for future research purposes.

Appendix I: Interviews 6 pages
Appendix II: Test survey 2 pages
Appendix I: Interviews

This section contains the data from the interviews. The results in this study only include the parts from the interview that are relevant to answer the research question. However, this appendix includes everything from the interview in its full format. All statements are listed as bullet points in a summarising manner. The data is not based on transcriptions, only interview notes.

12/4, 2018 – Engineer I, male
- Engineer working as a core competence manager at IKEA of Sweden
- Grew up in a technology-oriented family
- Roots in Falköping
- Became interested around the age of 10, the age when it was possible to do things ‘on your own’
- Made his choice during secondary school selection
- Chose to study the technology programme
- Enjoyed playing with LEGO
- Appreciated LEGO for teaching children how to construct, how to handle loads, and strengths of the material
- Received technical LEGO for building aeroplanes
- He and his brothers played with LEGO
- Played with Meccano and other building toys throughout childhood
- Drew a lot
- Studied in design school for 3 years
- Did not need encouragement from school
- Never used available career choice services or support services
- Visited Chalmers (engineering school in Gothenburg, Sweden) with school
- Went on field trips with school
- Remembers there being information pamphlets available about careers
- Was attracted to creativity
- Enjoyed problem solving
- Was inspired by his father’s handiness
- His father built a house on his own
- His father had a workshop in the basement
- He used to enjoy trimming his moped when he was young
- Enjoyed fixing small things in the home
- Is fascinated by old cars
- He is happy with his choice to become an engineer

3/5, 2018 – Engineer II, male
- An engineer at IKEA of Sweden
- Became interested in technology during nursery school
- He used to play with LEGO
- Enjoyed construction toys
- Decided to pursue technology as a career around the age 16 - 17
- Used to work with his bike
- Always repaired his bike on his own
• Used to buy parts for his bike
• Learnt how to replace parts on his bike around the age 11 - 12
• Used to enjoy woodworking classes in school
• Felt encouraged during woodwork class
• Went to an after-school club
• Club activities involved constructing toy rockets
• The rockets were often launched
• The children enjoyed watching the ignition of the rockets
• Built boats in the club as well
• Designed small engines for the boats
• His brother is also an engineer
• The parents are not engineers but teach STEM-subjects
• His parents were happy with his choice and he felt supported
• He is happy with his choice to become an engineer

4/5, 2018 – Engineer III, female
• A product requirement engineer at IKEA of Sweden
• Always enjoyed building
• Used to play with LEGO as a child
• Made a choice to pursue technology during secondary school choice in Sweden
• Studied the technology programme
• Enjoyed practical subjects and natural sciences
• Enjoyed crafting various things
• Did not receive any specific encouragement
• Remembers there being student counselors that could help inspiring students
• Went on school field trips involving natural sciences
• Her school arranged science and technology leisure events during holidays
• She remembers an Easter activity week at her after-school centre involving STEM subjects
• Grew up in Lund which had a very ‘academic’ spirit
• In Lund it was quite common to study after secondary school
• Used to visit the Lund university campus with school
• Having a degree was a societal norm in Lund
• Her parents helped her with some subjects at home
• She knew she always wanted to study something within the natural sciences
• Her parents worked within the field
• During summers, she played water games which involved using tubes and pipes to make water flow
• She is happy to be an engineer

4/5, 2018 – Engineer IV, male
• An engineer who has worked in IKEA of Sweden for a short time but worked several years in his home country prior to this
• Became interested in science and technology around the age 7 - 8
• His hobby was electronics
• Joined a club for children that involved electronics
• His mother urged him to join the club
• He built a robot dog in this club
• One of the challenges with this dog was to make it bark
• He remembers there being a computer club as well
• He used to build rockets in school
• Choosing to pursue technology came naturally to him
• There were no other options for him as he did not look elsewhere
• Enjoyed physics and chemistry in school in particular
• Grew up in a communist area where not many toys were available
• He built most of his own toys
• The school environment was ‘stiff’
• The education was traditional and students were not encouraged in any particular manner
• The clubs were governed by authorities
• His father was skilled in building and constructing and this inspired him
• His parents were supportive of his choices
• He is happy to be an engineer

4/5, 2018 – Engineer V, female
• An engineer working as a core competence manager at IKEA of Sweden
• Has always been interested in technology
• Enjoyed building and fixing things on her own
• Never thought about being an engineer as long as she could do something that involved construction or creating something physical
• After secondary school, she was going to choose university and was inspired by her sister’s boyfriend to pursue engineering as he was an engineer too
• Made her choice when she was 18
• She does not remember there being any particular inspiring toys
• Had a horse and spent time in the barn quite often
• Enjoyed disassembling and assembling the horse’s equipment
• Found it easy to see how things were meant to connect and work together
• She was never inspired by the horse’s equipment in particular to make her choice but sees this time as something relating to STEM-subjects
• She assumes she received encouragement in a positive manner if this ever happened but cannot remember any particular moment being encouraged by school
• She does not recall any special activities in school other than standard activities during physics and chemistry classes
• No one in her family is into engineering
• It was a coincidence that she chose engineering as her sister’s boyfriend happened to recommend it which inspired her
• She had full support from her parents when she made her choice to pursue engineering
• She is proud over the fact that she finished her degree and has worked as an engineer for 10 years

8/5, 2018 – Engineer VI, female
• A product development engineer at IKEA of Sweden
• Works as a team leader
• Has a degree in textile engineering
• Became interested in STEM-subjects around secondary school
• Found STEM-subjects to be fun
• Was not yet decided around secondary school
• Decided to become an engineer around the age of 24
• Made her decision after meeting a career coach
• Used to study the art programme in secondary school
• Needed to add subjects to become eligible for engineer
• Started studying engineering around the age of 27
• Always enjoyed creative subjects
• She does not remember being inspired by any particular toy
• Used to share toys with her brother
• Played with toys both for girls and boys
• Enjoyed drawing and still does
• Used to play educational games on the PC
• Cannot remember any particular activities involving STEM from school
• Was not encouraged by her school to pursue science and technology
• Added extra subjects such as natural sciences to her art programme’s curriculum to have a broader knowledge
• Adding extra subjects was something that her parents encouraged her to do
• Both her parents and her brother are engineers
• She took into consideration other educations before choosing engineering
• Was never intrigued by her parents’ work
• Her family’s lifestyle was always inspiring due to it being safe and stable
• She always looked up to her parents
• They have always encouraged her
• The career coach she met, she met through her family
• She always wanted to have lots of possibilities, so she studied as much as possible to be able to study on a higher level later
• Her parents used to support her and help her with homework if needed
• She could consider changing her current job again because she likes exploring but she does not think she will ever be far away from technology
• She has always been encouraged and supported to understand technology
• She is aware of the lack of women in engineering
• Her mother’s year of engineers had 6 females and 200 males
• She is happy to be an engineer

8/5, 2018 – Engineer VII, female
• Started as a product requirement engineer at IKEA of Sweden 3 years ago and worked as this until 30/4, 2018
• She is working as a project leader within product development and has been since 1/5, 2018
• She came to IKEA as a consultant and worked for 8 months before completely migrating to IKEA of Sweden
• She expressed how upset she was upon seeing the survey because it made her realise that engineering is not advertised or explained enough
• She said that many do not know what engineering entails and that the survey emphasised this
• She enjoyed playing with toys such as LEGO and Meccano as a child. Since these toys were pricey, she did not have them at home but used to play with them at friends’ places, nursery school or whenever she had the opportunity to
• Studied societal studies and culture during secondary school
• She added maths to her programme in order to become an architect
• Was not admitted into the architecture programme and decided to look in an education catalogue to see what other options there were
• She knew she wanted to work with product development and was very interested in creation
• Her mother was a freelance journalist
• She enjoyed building when she was in nursery school
• She built her own playhouse as a child
• She used to draw scaled floor plans in order to rearrange furniture as a child
• When she browsed the education catalogue, she was 23
• She enjoyed creating her own toys
• She made her own paper dolls and board games
• She does not remember being encouraged in school
• During primary school, she had a course in which the students built a house
• She remembers going on a field trip with school to Experimentum, a recreation centre in west Sweden involving STEM subjects
• Her father is a mechanical engineer
• Her father helped her with maths which was encouraging
• Her father enjoys working with computers
• Her sister was inspired by their father and pursued a career relating to computers as an interaction designer
• She studied culture before choosing engineering
• Decided to study in university when she was certain on her choice
• She knew she wanted to produce something, especially something physical
• Had the freedom to do whatever she wanted
• Had supportive parents
• She knew she wanted to work with something creative and innovative
• She studied engineering in Malmö
• She is happy to be an engineer

8/5, 2018 – Engineer VIII, male
• A mechanical design engineer at IKEA of Sweden
• Was always interested in science and technology
• Made his choice during Swedish secondary school selection
• He remembers a subject called ‘Technology’ in primary school
• As a child, he used to play with LEGO, Meccano, and Brio
• He enjoyed crafting and constructing
• He grew up in an expanding area which always had some part under construction
• He used to visit construction sites which was inspiring to him
• Liked seeing things on the inside to learn how they worked
• Used to disassemble and reassemble things
• He used to build carts and raced using them
• During his childhood, there were not any proper television programs for children as there was only one channel (later it became two)
• Children had to play with toys or build their own gadgets because there was no TV or Internet
• He did not receive any encouragement from school before making his choice
• The school encouraged him supportively after he made his choice
• He studied a secondary school programme involving wood technology in Kungsstad, Växjö, Sweden
• His school took the students on field trips
• He remembers visiting Kallinge in south Sweden where they studied aircrafts
• He used to build model aeroplanes
• He used to build model rockets and launch them
• His father is a construction carpenter
• His father was a great inspiration for him
• Through his father’s work, he was introduced to fine carpentry
• His family always supported him
• He never enjoyed traditional schooling methods and thought that lectures were annoying
• Preferred practical classes where students were allowed to engage in activities
• Has a passion for creation
• Believes that satisfaction from creating is a motivational factor
• He thinks children had to be more creating (physical products) during his childhood due to differences in time and availability
• Remembers there were house building PC games when computers became more normal
• He is happy to be an engineer

16/5, 2018 – Engineer IX, female
• Became interested in technology as a child
• Used to sew clothes for her dolls
• Started sewing clothes for herself around the age of 12
• Pursuing engineering came naturally to her
• Studied sewing design and technologies at Kaunas University of Technologies in Lithuania
• Has worked with product development her whole life so far
• Started working with garment development but has continued to work with other products as well
• As a child, she wanted her dolls to be dressed nicely
• Enjoyed the process of creation
• One of her favourite activities was to build towns in sand boxes
• Used to build sand towns and focus on infrastructure
• Wanted to make her towns as good-looking as possible (included green areas)
• Had handicraft classes in school that strengthened her interests in sewing
• Studied 4 years in art school which generated a creativity boost
• Her grandparents were engineers (within architecture)
• Her parents were also engineers (within chemistry)
• Becoming an engineer was not strange
• She considered becoming a teacher within something related to engineering, e.g. handicraft teacher
Appendix II: Test survey

The test survey was never used with the intention to answer any research question. However, its results were in some cases relevant for the main survey hypotheses. Therefore, it has been included in this appendix. The qualitative questions, however, have been neglected. This survey was conducted in Swedish and was translated for this section.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>19 (41.3%)</td>
</tr>
<tr>
<td>Female</td>
<td>27 (58.7%)</td>
</tr>
</tbody>
</table>

Table A2.1: Gender distribution of respondents

<table>
<thead>
<tr>
<th>Swedish secondary school programme</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural sciences programme</td>
<td>31 (72.1%)</td>
</tr>
<tr>
<td>Technology programme</td>
<td>5 (11.6%)</td>
</tr>
<tr>
<td>Societal sciences programme</td>
<td>2 (4.7%)</td>
</tr>
<tr>
<td>Agriculture programme</td>
<td>1 (2.3%)</td>
</tr>
<tr>
<td>Electricity and energy programme</td>
<td>1 (2.3%)</td>
</tr>
<tr>
<td>Economy programme</td>
<td>1 (2.3%)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (4.7%)</td>
</tr>
</tbody>
</table>

Table A2.2: Swedish secondary school programme choices among the respondents

<table>
<thead>
<tr>
<th>Age</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 12</td>
<td>12 (26.0%)</td>
</tr>
<tr>
<td>12 - 18</td>
<td>23 (50.0%)</td>
</tr>
<tr>
<td>18 - 30</td>
<td>7 (15.2%)</td>
</tr>
<tr>
<td>30 - 50</td>
<td>2 (4.4%)</td>
</tr>
<tr>
<td>50 ≤</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Don’t know/remember</td>
<td>2 (4.4%)</td>
</tr>
</tbody>
</table>

Table A2.3: Age around which respondents knew they wanted to pursue science and technology

<table>
<thead>
<tr>
<th>Reactions of friends and family</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positively and encouragingly</td>
<td>24 (52%)</td>
</tr>
<tr>
<td>Positively</td>
<td>13 (28%)</td>
</tr>
<tr>
<td>Indifferently</td>
<td>6 (13%)</td>
</tr>
<tr>
<td>Negatively</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>
Negatively and discouragingly: 0 (0%)
Do not know/remember: 3 (7%)

**Table A2.4:** Reactions of friends and families of the respondents (after making a career choice)

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negatively and discouragingly</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Do not know/remember</td>
<td>3 (7%)</td>
</tr>
</tbody>
</table>

**Figure A2.1:** Organisations that arranged activities for the respondents during their childhoods (number of mentions; multiple-options question)

**Figure 12:** Importance of science and technology for future development of the world according to the respondents (Likert scale)

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>44 (95.7%)</td>
</tr>
<tr>
<td>No</td>
<td>1 (2.2%)</td>
</tr>
<tr>
<td>Other</td>
<td>1 (2.2%)</td>
</tr>
</tbody>
</table>

**Table A2.5:** Satisfaction with career among respondents