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Professional Identity Development: Men and Women Persisting in the Technical Field after Graduation

Master thesis

Educational Science and Technology

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Summary

In the Netherlands, currently around 14% of all graduates in higher education pursue technical studies, from which only one in five is female. Furthermore, around 40% of those students graduating in the field of STEM do not subsequently enter the technical labor market. The problem is that, until now, it is not clear why such a small number of men and especially women in the Netherlands choose the STEM field and stay in the field after graduation. This study aims to research the differences and similarities between male and female technical alumni in their professional identity development. Life history interviews have been used to gather information from early childhood on about the life experiences of eight male and six female technical alumni who persisted in the technical field after their graduation from a university and a university of applied science. In doing so, the interviews are focused on the participants' study and career choices, other aspects that may have had an influence on such choices and the identity status of the technical alumni. The data has been analyzed through a pre-existing coding scheme. Men and women are compared to each other in order to answer the research question. Results show that males and females do follow a similar way towards the field of engineering and they build their professional identity in similar ways. Women reported on exploring their professional identity to a greater extent than men did. The females showed broader interests and tended to get different support from relatives, friends and acquaintances than the male technical alumni. Women who were already interested in the field of STEM seemed to choose the field when they were supported to decide based on their interests, on their own and on getting to know all different career possibilities. Men, instead, appeared to decide for the technical field when the support from friends and relatives confirmed their intentions. Whereas gender issues were reported to be irrelevant for the female technical alumni, some experiences were mentioned indicating a kind of denial and minimization of the gender issue. However, in order to fully understand why such a small number of men and especially women in the Netherlands choose the field of STEM and for staying in the field after graduation, more research is needed. To conclude, this study provides insights into the professional identity development of those male and female technical alumni persisting in the technical field after graduation. It also serves as evidence that more research is needed to prevent the industry from a lack of skilled employees.

Table of content

Problem statement

In the Netherlands, recently around 14% of all graduates from higher education pursue technical studies. Technical studies include science, technology, engineering and mathematics (STEM). Only one in five of these technical graduates in the Netherlands are female. This is relatively low compared to the average percentage (32%) of women graduating in technical fields in the European Union (CBS, 2016). Furthermore, around 40% of those students graduating in the field of STEM do not subsequently enter the technical labor market (Berkhout, Bisschop & Volkerink, 2013). The problem is that, until now, it is not clear why such a small number of men and especially women in the Netherlands choose the field of STEM and for staying in the field after graduation. The concept of professional identity may provide help in finding an an answer as it is about the perception of the self in an occupational context. For instance, a previous study suggests that the small number can be attributed to a conflict between self-prototypes and prototypes about a career in the technical field (Hannover, & Kessels, 2004). This is congruent with the findings of the trend analysis in the Netherlands (VHTO, 2012) in which it was discovered that especially women do not see an overlap between their self-image and a career in engineering. Thus, in finding an answer on why such a small number of men and women in the Netherlands choose the field of STEM after graduation, it is relevant to focus on their professional identity and how their professional identity develops in order to understand possible conflicts between self-prototypes and prototypes about a career in the technical field.

One aspect that can be applied to the development of a professional identity is the identity status as described in Marcia's identity status theory (1980). It is a differentiation between four different statuses in the development process that provide information about the level of commitment and exploration towards a specific field. For instance, in a study it has been found that women with high self-efficacy and high self-identity in engineering were the women that persist in the technical field after graduation (Buse, Bilimoria & Perelli, 2013). These findings suggest that those female engineers reached a high level of commitment towards a professional identity as an engineer whereas women who leave the technical field seem to blame the male-dominated culture for their abandonment (Hewlett, Luce, Servon, Sherbin, Shiller, Sosnovich & Sumberg, 2008). These findings indicate a low level of commitment to the male-dominated culture. In summary, an identity status can provide relevant information about the professional identity development and is, therefore, included in this study.

In another research, it is suggested that a gender bias may inhibit women to choose the STEM field (Moss-Racusin, Molenda & Cramer, 2015). For instance, researchers found out that a male science student was considered more competent than an identical educated female science student (Moss-Racusin, Dovidio, Brescoll, Graham & Handelsman, 2012 in Moss-Racusin, Molenda & Cramer, 2015). This is congruent with the findings of a study about national differences in gender–science stereotypes that indicate that about 70% of people worldwide associate STEM with men rather than with women (Nosek, Smyth, Sriram, Lindner, Devos, Ayala, Bar-Anan, (...), Greenwald, 2009). To sum up, gender bias may have an influence on the decision towards the field of STEM and, therefore, proves to be relevant in this study.

In trying to understand how men and women make their career choices and build up their professional identity as an engineer, it is important to investigate both genders. However, a lot of research in the field of STEM mainly focuses on women only (e.g. Buse, Bilimoria & Perelli, 2013; Perna, Lundy-Wagner, Drezner, Gasman, Yoon, Bose & Gary, 2009),

disregarding the fact that men form the clear majority in the field of STEM. Therefore, research is needed that includes both, male and female technical alumni that persist in the technical field after graduation in order to find out more about possible influences of gender bias and the development of their professional identity.

Such a development, which includes building up a self-concept with interests into a specific field and engagement in specific activities, already takes place in the early ages of life (Patton & McMahon, 2014). It has been examined that study and career choices have their roots in early childhood (Tuijl, van & Molen, van der, 2016) which clarifies the importance of life history research beginning with the early ages of life. However, a lot of the studies investigating the development of professional identities mainly focus on high school and college time only (e.g. Perna et al., 2009). By implication, research is needed that provide information from the early childhood on in order to get valuable insights into why men and women choose the field of STEM.

Furthermore, most of the studies in the field of engineering education use methods such as descriptive statistics or simple or even undocumented qualitative research methods (Neto & Williams, 2017). In order to obtain individual perspectives of the technical alumni, studies of a qualitative nature are needed that take individual life-experiences into account (Koro-Ljungberg & Douglas, 2008).

This secondary analysis research is part of a greater study which aims to provide an insight into the life experiences of male and female technical alumni that persisted in the technical field after graduation (van Hattum-Janssen & Endedijk, 2017). This may help to clarify why such a small number of men and women in the Netherlands choose the field of STEM and stay in the field after graduation. Finally, this may aid to improve retention rates in the field of engineering and be a means to prevent the industry from a skilled employees-lack. The relevance of this study is threefold. Firstly, it includes both, male and female technical alumni. The differentiation may help to understand possible gender bias and individual differences in the development of a professional identity in the field of STEM. Secondly, in this study, narrative life experience interviews are used that provide information from the early childhood on. Rather than only looking at school and study periods, this allows an understanding of the professional identity development during the whole life of technical alumni that persist in the technical field after graduation. Finally, as narrative interviews are merely used in the field of STEM, this study provides an insight into realistic life experiences told by the technical alumni. In this way, this study adds to the current research and fills a gap in literature.

Theoretical framework

In this section, first, professional identity is described. Aspects of Erikson's findings on identity (1968) and Marcia's identity status theory (1980) are introduced to explain the steps a professional identity is built through. Influencing factors such as false or incomplete prototypes and gender bias in STEM are introduced as possible barriers for entering and persisting in this field. Finally, life history research is presented and linked with the current study.

Professional Identity

In literature, the definitions of professional identity vary highly (e.g. Schein, 1978, Sutherland & Markauskaite, 2012, Goodson & Cole, 1994, Cooper & Olson, 1996, Pratt, Rockmann, & Kaufmann, 2006, Paterson, Higgs, Wilcox, & Villeneuve, 2002). Combining the findings, an individual's professional identity is about the perception of the self in an occupational context. It is created by the characteristics an individual identifies within his current or anticipated professional life (Schein, 1978). In literature, it is referred to professional identity as the process of integrating the personal and professional sides (Goodson & Cole, 1994) and as being a multifaceted concept (Cooper & Olson, 1996). Other authors define professional identity as simple as "the sense of being a professional" (Paterson et al., 2002) or as the identification with a profession where personal motives, interests, experiences and competences are compared with and related to one another (Pratt, Rockmann, & Kaufmann, 2006). Professional identity is related to career choices because it offers information for the individual about who he or she is in relation to his or her occupational context. The professional identity can be viewed from two different perspectives. The bottom up perspective starts from the premise that an individual builds his professional identity intentionally. This might be that an individual engages in a specific activity or sees other people engaging in a specific activity that is interesting to him. As an example, seeing a fireman blowing out a fire and being allowed to hold the water hose and trying out the activity himself may result in building an intentional interest in this activity. On the long run, this might be a crucial factor in becoming a fireman later on. Instead, within the top down point of view it is more focused on the influences of the environment and people around the individual in building such interests. For example, as a father has its own technical company and rears his son in a way that he knows from early childhood on to be the one who absorbs the company one day, the son is growing up in a forced environment towards the technical field. The bottom up and top down point of views can interact. For instance, the intention in early childhood to become a fireman later on can be influenced through an anxious mother who prohibits any activities towards this direction. The bottom up intention of the individual is then inhibited through the top down influences from the mother. As Vangrieken, Meredith, Packer and Kyndt (2017) summarize, there is a need for a balance between top-down and bottom-up influences to develop a professional identity.

Professional Identity Development

As the steps through which a professional identity is formed are similar to the steps in identity development in general, some aspects of Erikson's (1968) and Marcia's (1980) findings on identity are introduced.

Erikson (1968), as being one of the first proposing a psychosocial developmental life-span model, used the term 'identity' as a concept that develops during adolescence. It is based on the life experiences from early childhood on. The author defined 'identity' as a permanent reproduction of self-images that are merged together into a self-concept by the individual. He argues that during adolescence individuals experience an identity crisis in which they try to discover who they are and try to understand their place in society. They assess their strengths and weaknesses and an individual way to deal with them. This process occurs in significant interaction with others. In case of a successful process, the individual discovers his or her identity and grows up into an autonomous independent adult. However, those who fail to discover and develop their identity feel self-doubt, role diffusion and even role confusion. In the following section the identity status theory by Marcia (1980) is introduced, which is still frequently used in research on identity development (e.g. Seiffge-Krenke, Beyers, 2015; Crocetti, 2017).

Marcia (1980) expanded Erikson's theory through presenting a way to think about identity in the matter of four identity statuses. He argues that the identity crisis which has been described by Erikson (1968) consists of the degree to which an individual has explored and committed to an identity. The formation process of an identity, he argues, occurs in two steps: First, the break away from childhood beliefs and second, the exploration of an alternative status and the commitment to develop to a status. The author differentiated the identity development into the following four statuses.

Identity Diffusion. In the status of Identity Diffusion individuals do not know yet what they want and do not search for it either. They have not yet made any commitment or exploration.

Identity Foreclosure. In the status of Identity Foreclosure individuals blindly accept their identity as it has been given from childhood or others such as family members. In this status individuals do not search for their identity but have a commitment.

Identity Moratorium. Individuals in the Identity Moratorium status search for their identity through comparing different values, strengths and weaknesses but still have no commitment.

Identity Achievement. In the Identity Achievement status individuals searched for their identity and have developed a strong commitment towards this identity.

Table 1 shows the distribution of the four statuses with regard to the level of exploration and commitment towards an identity.

Table 1. The four identity statuses by Marcia (1980)

		Level of Exploration (Search)	
		Low	**High**
Level of Commitment	**Low**	Diffusion	Moratorium
	High	Foreclosure	Achievement

The four stages described by Marcia (1980) can be applied to the development of a professional identity. For instance, in a previous study (Buse, Bilimoria & Perelli, 2013) about women persisting in US engineering careers it has been figured out that the women with high self-efficacy and high self-identity in engineering are those that persist in the technical field. These findings suggest that those female engineers reached a high level of commitment towards a professional identity as an engineer which can be compared to the Achievement status described by Marcia (1980). In contrast, women who leave the technical field seem to attribute the male-dominated culture for their abandonment (Hewlett, Luce, Servon, Sherbin, Shiller, Sosnovich & Sumberg, 2008). These findings indicate a low level of commitment to the male-dominated culture and can be compared to the Diffusion or Moratorium status. This suggests that the culture of the technical field may constitute a barrier for students and especially women to see their professional identity as an engineer.

Professional Identity Development of Engineers

Professional identity development is an ongoing process of change that can be described in terms of the general identity development described by Erikson (1968). Individuals organize their ongoing personal, private, public and professional experiences into a whole self-concept which finally forms their identity. Therefore, the professional identity is one part that grows out of the self-concept an individual has developed. The development of a professional identity consists of first, the activities an individual undertakes and second, aspects from outside that influence the process. In terms of activities, it has been argued that the degree of exploration and commitment is important in the process of identity formation (Erikson, 1968; Marcia, 1980). Students seem to learn the most about characteristics and responsibilities of an engineer through observation of and conversation with peers (Loui, 2005). Several articles investigating the professional identity development of engineers suggest that knowing an engineer, being more exposed to the field of engineering and having experience with corresponding tasks are critical in the development of an engineer identity (Chachra, Kilgore, Loshbaugh, McCain & Chen, 2008; Pierrakos, Beam, Constantz, Johri, & Anderson, 2009). Aspects that may influence the developmental process from the outside are false or incomplete prototypes and gender bias in STEM. Research has shown that both may inhibit students, especially women, to enter the technical field and, therefore, may serve as a barrier.

A prototype is a standard or typical example of something that may bias its interpretation and corresponding choices. Having a false or incomplete prototype about STEM, thus, is critical in making choices towards it. For instance, research has shown that students seem to be

inadequately informed about what science may offer and what scientists do (Bodzin & Gehringer, 2001; Finson, Pedersen, & Thomas, 2006; Turkmen, 2008). This lack of knowledge may cause false or incomplete prototypes about science-related careers such. Similar processes may play a role in STEM-related careers. This again may negatively influence study and career choices (Zeldin & Pajares, 2000). In addition, the prototypical image of a STEM student seems to be the male nerd. Naturally, students who identify with this profile are more likely to consider careers in that field. However, much variation has been found in the professional identity of STEM students besides having those two characteristics (Endedijk, van Veelen & Möwes, 2017). Such biased prototypes in STEM may negatively influence choices towards it, especially for those who do not identify with the standard prototype. Assuming that especially women are less inclined to identify as a male nerd, such a false or incomplete prototype may intensify a gender gap in certain STEM fields. On top of the fact that males in general show higher interests in science-related studies than women (Caleon & Subramaniam, 2008; Jones, & Howe 2000) it is important to consider these prototypical images in research about why men still form the clear majority in the field of STEM.

Researchers have identified numerous factors that contribute towards the underrepresentation of women. One of them is gender bias. A gender bias can be described as a distortion of reality which leads to a wrong depiction of gender related circumstances. For instance, people may favor men over women (Rothchild, 2007) in engineering-related tasks because men are (incorrectly) expected to perform better. In contrast to the tendency that it is strived for gender equity, especially in the Netherlands, there still exists a strong gender bias in STEM (Miller, Eagly, & Linn, 2015). According to the literature, the stereotype that links men to science is among 66 nations highest in the Netherlands. Research has shown that this gender bias may inhibit women to choose the STEM field (Moss-Racusin, Molenda & Cramer, 2015). Women seem to be less engaged in STEM because gender bias causes a lack of belonging and positivity towards it (Moss-Racusin, Sanzari, Caluori & Rabasco, 2018). Another reason for underrepresentation of women in science may be a lack of expected fit or belonging in STEM (Tellhed, Bäckström, Björklund, 2017). In the study, with 1327 Swedish secondary school students, the authors figured out that the students reported higher feelings of belongingness towards groups that consisted of more of their own sex. This means that women preferred those subjects in which more women than men engaged in and men preferred the subjects in which men engaged more in than women. Besides social belongingness, self-efficacy seems to be an important factor, too. In the study of Tellhed, Bäckström, Björklund (2017), the girls on average showed much lower self-efficacy ratings in STEM than boys. This means that boys believed more than girls to be able to succeed in this field. This can be explained by the fact that individuals tend to feel competent in those domains in which they have had exposure to and experience with. As described by Chachra et al. (2008) women tend to be less exposed to the technical field and to be less experienced with corresponding tasks. To conclude, there are numerous factors that contribute towards the underrepresentation of women in STEM with gender bias being one of them. Gender bias in STEM has great influences on feelings of social belongingness and self-efficacy in women. This finally impacts the gender gap in that field.

Life history research

A life history study is a form of narrative research that seeks to gain an insight into the experiences of a participant's life (Creswell & Creswell, 2013). It is a qualitative research

method where a participant is asked to tell a story about specific events in his or her life which then can be inductively and deductively analyzed by the researcher.

The current life history study is based on narrative interviews (Jovchelovitch & Bauer, 2000). These are useful for obtaining individual perspectives on experiences as they allow for information including all relevant aspects to the interviewee. In the field of engineering, currently, most of the studies use methods such as simple descriptive statistics and simple or undocumented qualitative research methods (Neto & Williams, 2017). However, in the literature it has been argued that the use of qualitative methods is important in the field of engineering as it provides information that could not be answered through quantitative research methods (Koro-Ljungberg & Douglas, 2008). As this study aims to gather information about life experiences of technical alumni with a specific focus on their professional identity development, narrative life history interviews are deemed suitable. As the development of a professional identity already takes place in early childhood (Patton & McMahon, 2014; Tuijl, van & Molen, van der, 2016), it is particularly important to integrate this stage of life into the interviews. Furthermore, a differentiation between life stages may help to identify self-determined and other-directed factors that may play a role in the decision towards or against the field of STEM in that specific age. On the long run, this may help to identify patterns of influencing factors during specific life stages. This study provides a framework to understand the experiences of male and female technical alumni that persisted in the technical field after graduation as a whole story including all relevant aspects to the interviewee, beginning in early childhood.

Current research

This study aims to gain insights into the professional identity development of male and female technical alumni remaining in the technical field after graduation. Therefore, it is looked at their life experiences from early childhood on that may have influenced any choices towards the field of STEM. Also, factors from outside that may have had an influence on their decisions are taken into account. In order to find out more about the degree to which the male and female technical alumni have explored and committed to their professional identity, the stories of the technical alumni are categorized into the different identity statuses described by Marcia (1980). As a differentiation between male and female technical alumni may help to understand possible gender bias and individual differences in the development of a professional identity in the field of STEM, the following research question is formulated:

Main Research Question:	What are the similarities and differences in the professional identity development between male and female technical alumni?
Sub Research Questions:	1.What are the similarities and differences in study and career choices? 2. What are the similarities and differences in external influences? 3. What are the similarities and differences in identity status?

Method

In this section, first, the research design with corresponding methodological information is given. The section ends with a delineation of the data analysis and coding procedures.

Research Design

Relating to the study on why technical alumni stay in the technical sector after graduation (van Hattum-Janssen & Endedijk, 2017), this study employs secondary analysis of existing qualitative data. Semi-structured life history interviews have been used to collect data on the experiences in the field of STEM with technical alumni from a university and a university of applied science. As the earlier study focused on technical male alumni only, this study will serve as an extension because it includes the data of the female technical alumni who persisted in the technical field, too.

Respondents and Sampling

Eight male technical alumni that persisted in the technical field were interviewed during the timeframe between 22.04.2016 and 14.12.2016. The corresponding data has been analyzed. Additionally, six female technical alumni that persisted in the technical field were interviewed during the timeframe between 22.01.2016 and 18.03.2018. Chain-referral sampling has been used in order to get in contact with the male and female technical alumni. No other sampling procedures have been considered due to the low accessibility of this particular group. All students graduated within the last six years and were between 25 and 28 years old at the time of the interview. The technical studies they have participated in where Electrical Engineering, Industrial Engineering and Management, Mechanical Engineering and Technical Physics. As, with the submission of the authors, ethically approved data is used for secondary analysis no further ethical permission has been requested.

Instrumentation

The data set included one hundred forty eight pages of transcribed interviews and three hundred eighty six minutes of recorded interviews. All relevant information regarding the professional identity development of the male and female technical alumni are included in the interviews. The interviews were taken individually in restaurants or university environments. A differentiation is made between four phases of life: early childhood, 12 years of age until the start of studies, university period and the transition phase to the first job. The differentiation is made in order to analyze the specific decision moments and transitions towards the field of STEM (Jovchelovitch & Bauer, 2000). It is chosen for these four different timeframes, because all of them represent specific decision moments. The following key questions were used in every interview:

Early childhood:

“What kind of experiences can you remember from your early childhood?”

“What did you like at school?”

“With what did you play / what did you do in your free time?”

“Which experiences can you remember that had to do with engineering and your interests for engineering?”

12 years of age until the start of studies:

"Which experiences can you remember at the age of 12, the transition to another type of school?"
"What did you like?"
"Wherein did your parents stimulate you?
"What did you have for hobbies?"
"At which school subjects have you been good?"
"Which teachers do you remember?"
"In which year did you go to the middle school?"
"Which have been the most important experiences during middle school?"
"What did you like doing?"
"What did you do besides school / which hobbies did you have?"
"Which teacher impressed you the most?"
"What can you tell me about your choice of the profile during middle school and how did it go?"
University period:
"In which year did you go to the university?"
"What can you tell me about the decision of your study and the whole process?"
"Can you remember what you did a lot during that time / which hobbies did you have?"
"What did you do with your friends / what have been their hobbies?"
"Which people have been the most important for you at that time?"
"What are the most important experiences during that time if you can choose 3 of them?"
Transition to the first job:
"When did you start with your first job?"
"Where was your first job?"
"Do you remember the process?"
"What can you tell me about how you got your job?"
Some of the key questions have only been relevant to the women:
"How did you experience choosing the N&T (technical) profile as a girl?"
"How did you experience choosing a technical study?"
"Did it matter being a woman?"
"How did you experience working in a technical environment as a woman?"
"What did shape your experience as a woman?"
Other general questions:
"From the studies until your current state, who have had an influence on you?"
"What have been the barriers?"
"Which experiences have played a crucial role?"
"Did you have any other jobs after that?"
"If so, how did you choose them?"
In Appendix A, a summary of the most frequently used questions and follow-up questions is given (Etherington, 2013). Demographic data of the participants as well as interviewer notes, the original coding scheme and corresponding information is retrieved from the authors of the original study (van Hattum-Janssen & Endedijk, 2017).

Procedure

All approved data was revised and assessed for quality, sufficiency and suitability for the secondary analysis. The recorded interviews were literally transcribed. All transcribed data was anonymized and the respondents were given pseudonyms.

Data Analysis

In order to get an insight into the professional identity development of the male and female technical alumni persisting in the technical field after graduation, all transcribed data has been analyzed with the aid of the qualitative research software Atlas.ti (Atlas.ti Scientific Software Development GmbH, Berlin, Germany). The data has been loosely translated into English. The coding scheme has been used in the same way as in the first analysis study, in order to be able to compare the results in the end. To allow for reliability, inter-rater agreement was determined for the indexical and non-indexical material. Seven out of the total fourteen interviews (three out of the female and four out of the male group of technical alumni) were randomly chosen and, first, the coding of the indexical material has been discussed in a group out of three raters, including the researcher. A differentiation has been made between the actions and actors of the stories. Second, the coding of the non-indexical material has been discussed within the same group of raters. No differentiation has been made between codes.

Coding procedure

In order to get an overview of the information described by the technical alumni about their professional identity development, a coding scheme was used. The coding scheme is based on Schütze (as cited in Jovchelovitch and Bauer, 2000) who proposed six steps to analyze narratives. After transcribing the data (step 1), it has been differentiated between indexical and non-indexical material (step 2). Indexical material includes all material that relates to the described events (who did what, when, where and why) and non-indexical material includes all descriptive data such as opinions, values, feelings and emotions. All indexical material is analyzed to structure the story of the individual (step 3) including a differentiation between four different time frames: Early childhood, 12 years of age until the start of studies, university period and transition to the first job. Then, non-indexical material has been analyzed and compared to the indexical material of the story (step 4). All material has been clustered (step 5) in order to be able to compare the story of the individual with others (step 6). The coding process is illustrated in figure 1.

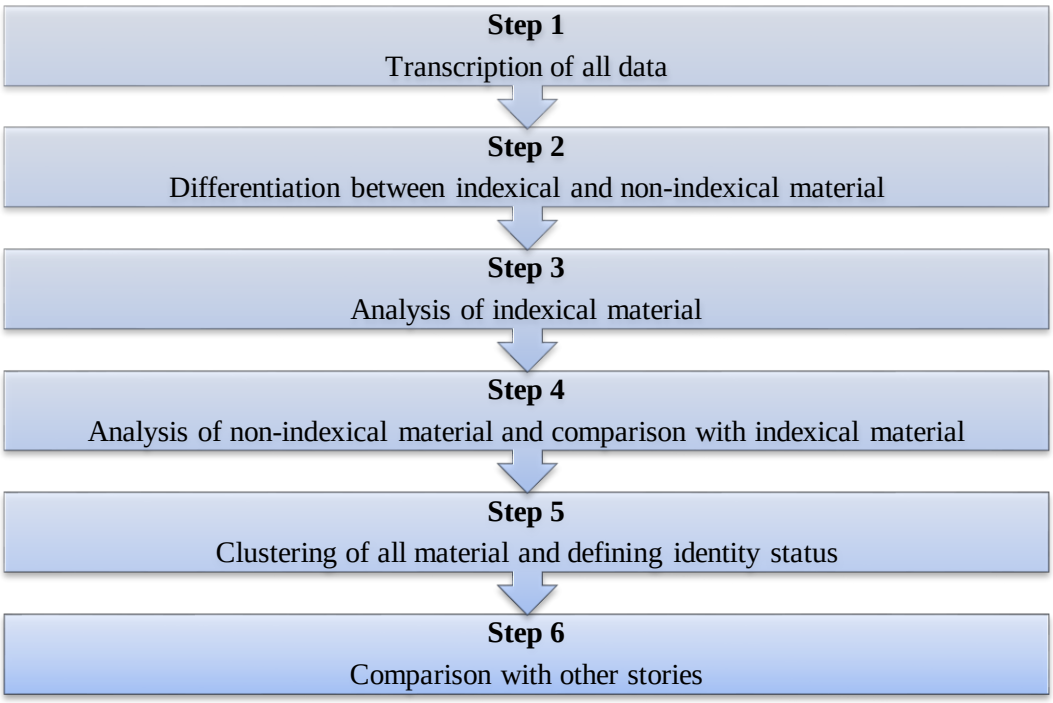

Figure 1. The coding procedure based on Schütze (as cited in Jovchelovitch and Bauer, 2000)

In order to better understand the coding procedure, it is demonstrated how the professional identity development of the male and female technical alumni are analyzed based on Schütze (as cited in Jovchelovitch and Bauer, 2000). All aspects in the stories of the interviewees that correlated with the development of a professional have been taken into account. The whole story serves as a basis for the later alignment to a specific identity status described by Marcia (1980). The life experiences of the technical alumni are sequentially ordered into the four different timeframes. It has been differentiated between indexical material (step 3) such as *"I actually went to a sum of open days, open house events and these kinds of things"* (Luke, Electrical Engineering, University) and non-indexical material (step 4) like *"I liked physics and mathematics"* (Nicole, Technical Physics, University). In this case, the indexical material has been coded as an 'action' and the non-indexical material as 'opinions and values'. In some cases sub codes were formulated. Table 2 gives an overview of the codes and corresponding sub codes. More information can be found in Appendix B.

Table 2. Overview of codes and corresponding sub codes

Material	Codes	Sub codes	
Indexical	Actions	Hobbies	
		Technic-related	
		Decision process	
		Informing about studies	
		International experiences	
	Actors	Acquaintances / Friends	Neighbor
			Mate
			Best friend
		Relatives	Sister
			Brother
			Mother
			Father
			Uncle
		Teachers	Primary school
			Secondary school
			University
			'Schooldecaan'
			Study advisor
			Role model
	Map from actions to actors		
	Sequence		
	Relations in sequence		
Non-indexical	Felt & Experienced	Decision process	
	Opinions & Values		
	Usual & Ordinary		
	Argumentative		

First, the story of each respondent is reconstructed in order to get an overview of the relevant indexical and non-indexical material of the interviews for this study. During the coding process of the indexical material, the 'map from actions to actors' (1) as well as the 'sequence' (2) and 'relations in sequence' (3) (as mentioned in Schütze (as cited in Jovchelovitch and Bauer, 2000) are analyzed through connecting the actions with the actors (1/3) and reconstructing the actions in a historical sequel (2). No further sub codes were used. In contrast to the indexical material that has mainly been used for reconstructing the stories of the individuals, the non-indexical material has mainly been applied to each indexical life experience. As this study's main focus is placed on the professional identity development, the only sub code that is used for the non-indexical material is the decision process. All non-indexical material has individually been applied to the according indexical material and can be clustered into this sub code. For instance, Tom said *"I was pretty much interested in what my father did […] I have never been pushed towards one direction"* which influenced his decision process due to his interests but at the same time he was free in his decision. Another example is that one of the female technical alumni argued *"Despite the fact that you see that there you are one out of a few women in the technical field it has been a very normal thing for me to do it"* (Mila, Industrial Engineering and Management, University) which explains a part of her decision towards the field of STEM. All material has been clustered (step 5) into male and female life experiences and compared (step 6) to the opposite group. After studying the results, all information has been aligned to a specific identity status described by Marcia (1980). For instance, technical alumni that show

high levels of exploration - due to visiting open days and looking at all different kinds of studies and jobs during their decision process - and high levels of commitment to the field of STEM - due to the will of staying in the technical sector and seeing no other option - are allocated to the status of Achievement. The decision is made based on the codes and sub codes of the overarching story of the alumni.

Results

This research aimed to find out more about the professional identity development of male and female technical alumni persisting in the technical field after graduation. Similarities and differences between male and female technical alumni in the development towards a professional identity as an engineer are examined. Study and career choices, influencing factors from the outside such as gender bias and false or incomplete prototypes about STEM, as well as the degree to which males and females explore and commit to the field of engineering, which finally defines their identity status, are regarded.

This section starts with an overview of the respondents (Table 3). Two examples are given that show the reconstruction of the stories. Differences and similarities between male and female technical alumni regarding their study and career choices, influencing factors from the outside and finally their identity status are summarized. A differentiation is made between indexical and non-indexical material. Quotations from the interviews are used for illustration.

Table 3. Overview of the male and female respondents

Gender	Respondent (Pseudonym)
Male	Tom
	Thomas
	Robin
	Luke
	Paul
	Matthew
	Rik
	Simon
Female	Nicole
	Emma
	Isabella
	Kira
	Lina
	Mila

Differences between male and female technical alumni

Study and career choices

Indexical Material

Similarities. The results of the indexical material of the male and female technical alumni show many similarities. In terms of study and career choices, both groups stated to inform about studies and go to open days as a basis for their decisions. They stated things such as *"I actually went to a sum of open days, open house events and these kinds of things"* (Luke, Electrical Engineering, University) or *"I've had everything, I brought flyers, I looked at everything and at one time then you go to open days"* (Emma, Technical Physics, University). In contrast to Emma's' first intention to inform about the study of psychology (*"First, I wanted to study psychology"*) she also went to the introduction of technical physics and thereby informed herself about future possibilities.

The male and female technical alumni mentioned that their study and career choices have been clear and easy because they fluently groomed out of preceding phases and choices. For instance, one of the male alumni said that *"the choice towards electrical engineering in higher education has been very clear for me because it has simply been a continuation"* (Tom, Electrical Engineering, University of Applied Science). A female technical alumni reported *"Due to the fact that I already did my internship [at a company] […] it has been a simple choice to go there."* (Nicole, Technical Physics, University).

Furthermore, all respondents stated that they talked with others about their upcoming study and career choices. One of the male alumni said, *"For instance, [the choice between] mechanical engineering or physics. I talked with my teacher about it"* (Luke, Electrical Engineering, University). A female technical alumnus stated, *"I even talked with a recruiter somewhere whether I wanted to enter the public service or not"* (Emma, Technical Physics, University). People such as relatives, teachers, friends and acquaintances have been mentioned by both groups: *"I talked about [my choice] with my best friend during high school"* (Mila, Industrial Engineering and Management, University) and *"I talked [with them] about it, I had a good relationship with my parents"* (Rik, Technical Physics, University of Applied Science).

In summary, it can be observed that the indexical material such as actions, corresponding actors and sequences in the study and career choices towards the field of STEM are very similar in both groups. Relatives, teachers, friends and acquaintances had an influence on their pathway towards building such connections and towards their actual study and career choices. Earlier choices influenced the study and career choices of the future.

Differences. Taking a deeper look at the study and career choices of the male and female technical alumni, a difference between both groups can be found. The female technical alumni engaged in more different vocational and non-vocational activities until they chose their current study or job. For instance, one of the female alumni stated: *"I started becoming a maritime-officer […] then I worked at my father's company […] I finally entered technical physics […] followed three [different] traineeships [and] did a half year internship abroad […] then I worked at a company at my home place […] for two, two and a half years […] and then I started here in my current job"* (Isabella, Technical Physics, University of Applied Science). One of the male alumni, in contrast, stated that he *"missed the technical orientation at school. [So I]*

searched this in my hobbies [and] had like my own repair service" (Thomas, Mechanical Engineering, University of Applied Science), which shows a clear direction towards the field of engineering without any different considerations.

In summary, the female technical alumni show broader interests in their study and career choices as they engage in more different directions than the male technical alumni.

Non-Indexical Material

Similarities. In terms of non-indexical material in study and career choices, the male and female technical alumni show some similarities. For instance, the male alumni said,*"I just liked it […] I made the choice during high school, so I made the same choice during college"* (Tom, Electrical Engineering, University of Applied Science) or *"the decision of the profile has been clear for me very soon based on what I liked"* (Robin, Mechanical Engineering, University). One of the female alumni stated that *"It was mainly based on the fact that I liked physics and mathematics that I chose for this profile"* (Nicole, Technical Physics, University). Both, male and female technical alumni not only mentioned that they liked particular school subjects but that they had been good at these, too. For instance, one of the male alumni stated that *"I never had to do homework for mathematics and I gained a 9 [out of 10] in my first attempt of the central exam"* (Robin, Mechanical Engineering, University). Likewise, a female technical alumnus mentioned that *"in mathematics and physics you always have these rules, but these have been quite logical for me"* (Nicole, Technical Physics, University). Another male alumnus specifically stated that he had been good at technical things: *"[it] has been always very easy for me, being busy with technical things. I liked it and I was good at it"* (Tom, Electrical Engineering, University of Applied Science). Another female student indicated that she liked *"being busy with the computer [at school]"* (Lina, Electrical Engineering, University).

School subjects that were mentioned as less popular by both groups were predominantly languages: *"Languages have not been my favorite"* (Isabella, Technical Physics, University of Applied Science) or *"I did not like the languages, I directly surrendered French as soon as it was possible" (*Luke, Electrical Engineering, University).

Some of the female technical alumni added emotions by saying that they chose a specific school because of their *"feelings or that I liked it here […], so mainly based on good feelings."* (Emma, Technical Physics, University) or *"Then I knew it […] I felt welcome"* (Nicole, Technical Physics, University) during an open day at a university.

Another influencing aspect in the alumni's study and career choices is that the field of STEM provided a positive challenge and great career expectations for them. For instance, a male alumnus told *"[the study] needs to be as difficult as possible, because that will give me the best possibilities"* (Matthew, Industrial Engineering and Management, University) and a female alumnus stated that she chose physics because *"There is more challenge in the field, it is more exciting, and there are more possibilities after that time"* (Emma, Technical Physics, University). In these cases, both, Matthew and Emma thought about the consequences of their decisions towards the field of engineering or physics and concluded that they would have great career chances with a study in the field of STEM.

In summary, it can be seen that male and female technical alumni show some similarities in their interests, likes and dislikes regarding school subjects. Among others, both, male and female technical alumni show positive affiliations concerning mathematics and physics and negative associations towards languages. The study and career choices have been greatly

influenced by what the alumni liked and where their interests were. Furthermore, individuals of both groups mention positive challenges and great career expectations as an influence on their choice towards the field of STEM.

Differences. The non-indexical material also shows some differences between the life experiences of the male and the female technical alumni that persisted in the technical field after graduation. First, the female technical alumni show broader interests and tend to get excited about more different subjects than the male technical alumni. For instance, one of the female technical alumni stated, *"I like so many things and I have a lot of different interests"* (Kira, Mechanical Engineering, University). The male technical alumni, in contrast, mentioned things like *"During childhood I always wanted to become a construction worker because I liked it to build up stones on each other [with lego]"* (Luke, Electrical Engineering, University).

Second, most of the female technical alumni indicated that their friends during school did not choose the same profile as they did. For instance, Emma (Technical Physics, University) stated that *"the girls with whom I've been friends in my class all weren't that good in mathematics and physics. That's why they went to the culture-society profile."* This was not seen as a barrier but rather very positive: *"Due to the fact that I've been separated from my friends, I've been more open to meet new people [...] in general, I liked it better*." (Emma, Technical Physics, University). In this case, Emma chose a specific profile because she was good at it and did not mind the fact that her friends chose different profiles than she did. The male technical alumni, in contrast, do not indicate any similar situations. One of the male technical alumni mentions: *"I did not look at what the others did, for the choice of my profile"* (Paul, Industrial Engineering and Management, University of Applied Science).

Third, it can be observed that conversations with others played a crucial role in the alumni's choices towards the technical field. However, the female technical alumni tend to get different support from relatives and friends than the male technical alumni. For instance, a female technical alumnus said that *"my parents played a very big role [in that decision] because they always motivated me to search for what I wanted and they never hindered me […], they really motivated me to orientate very broad and to look at every little thing before making a decision"* (Isabella, Technical Physics, University of Applied Science). Isabella also explained that her father who works as a farmer has always been a role model for her*: "I liked it the most to play with the pets, always the practical side rather than helping in the household, I wanted to help my father […] You always look up on your father"*. Another female alumnus explained that her teacher had played a role in her decision towards a specific profile: *"I told my mathematics teacher that I want to choose the profile in the direction of society together with history, economics and geography, just a little mathematics, and he looked at me and said: No, you can't mean that, you have to choose a beta profile [based on mathematics] […], if you don't do that, who is doing it instead?"* (Emma, Technical Physics, University). Emma explained that she has been very good at mathematics and that she had fun doing it, but due to the fact that she had been good at a lot of different subjects she could not decide. Finally, she thought *"maybe that's a good point, if you are good at it why shouldn't you do that. You can never go back […]; afterwards I am very thankful for his advice"* (Emma, Technical Physics, University). Another female technical alumnus said, *"My parents always told me to choose what I like the most and what feels best"* (Mila, Industrial Engineering and Management,

University). One of the male technical alumni, in contrast, concretely stated that he had been inspired by his brother who influenced his decision towards the field of STEM: *"I think that his advice to study Mechanical Engineering has been crucial. I would not have chosen it otherwise"* (Robin, Mechanical Engineering, University). His older brother has been in the technical field, too. He also said that he *"rather went to my brother for advice than to my parents [because] they did not have the experience"* (Robin, Mechanical Engineering, University). Another technical alumnus sated that he "*talked with a teacher about [the choice] during a 10 minute meeting"* (Paul, Industrial Engineering and Management, University of Applied Science).

In terms of differences between the life experiences of the male and female technical alumni regarding their study and career choices, it can be seen that females tended to have broader interests and get different support from relatives, friends and acquaintances than the male technical alumni. Women who were already interested in the field of STEM actually chose the field when they were supported to decide based on their interests, on their own and on getting to know all different career possibilities. Men, instead, actually selected for the technical field when the support of friends and relatives confirmed their intentions.

External influences

In this study, all experiences with others that could have had an influence on a decision towards or against the field of STEM are defined as external influences. It is specifically focused on affecting environments and conversations with others, experiences with gender bias and false or incomplete prototypes about the field of engineering as these are reported as barriers in other studies.

Indexical material

Similarities. In terms of external influences, alumni of both groups mentioned their environment during childhood as an influencing factor for a later decision towards the STEM-field. Both, the male and female technical alumni have had some connections to the technical field from early childhood on; either first, through relatives that worked in the technical field: *"My father has been very technical, too, he worked in a technical job"* (Tom, Electrical Engineering, University of Applied Science), *"My father also did a technical study"* (Simon, Technical Physics, University) or *"My father is a farmer and works in the field of building and construction"* (Isabella, Technical Physics, University of Applied Science), or second, through the fact that they grew up in technical surroundings: *"I grew up on a farm […] and drove a tractor"* (Matthew, Industrial Engineering and Management, University) or *"I lived at my parents' house on a farm and loved helping my father"* (Isabella, Technical Physics, University of Applied Science), or third, through any contact with others, for instance neighbors that worked in the technical field: *"I've been at my neighbor's house a lot and learned to cut wire, to assemble, […]"* (Thomas, Mechanical Engineering, University of Applied Science).

In summary, both, the male and female technical alumni spoke about their past environments as an influencing factor that brought the technical field closer to them during childhood.

Differences. In terms of conversations with others and gender bias which may have had an influence in the decision towards the field of STEM, some differences between the male and female technical alumni can be seen. For instance, one of the male alumni has been positively inspired by his brother who influenced his decision towards the field of STEM: *"I think that his advice to study Mechanical Engineering has been crucial. I would not have chosen it otherwise"* (Robin, Mechanical Engineering, University). His older brother had been in the technical field, too. In contrast, a female alumnus stated: *"[I am] always accepted and respected [in my current job, but] this was not the case in my private environment, there, they asked me: Why do you want to study in general? You are a woman; you belong behind the countertop, just get 100 children"* (Isabella, Technical Physics, University of Applied Science).

Another difference is that the female technical alumni reported to get help more often than their male colleagues in their current jobs as they state: *"at the moment when you're normally doing your job just like the male colleagues [...] then you realize that [men] are more likely to help women; because they like it, we're just a few"* (Kira, Mechanical Engineering, University). Another female technical alumnus described: *"I still am the only women in the lab […] but if I have a problem, just because I am not as strong [as the male colleagues] then […] ten men are coming and willing to help"* (Isabella, Technical Physics, University of Applied Science).

Furthermore, the female technical alumni reported to compensate their day-to-day experiences within a male-dominated culture with a female-dominated hobby: Most of the female technical alumni go horse-riding in their free time. For instance, one of the female alumni stated: *"I already have horse-riding, I reversed that. There we are mainly women, very little men"* (Mila, Industrial Engineering and Management, University).

To sum up, in contrast to the male technical alumni, who report positive influences towards the field of STEM from their families, one of the female technical alumni reports to be not supported in her decisions. Also, women mentioned to get help more often than their male colleagues and that they tend to compensate their day-to-day experiences within a male-dominated culture with a female-dominated hobby.

Non-indexical material

Similarities. The technical alumni of both groups were not exposed to any kind of negative expectations of technical studies. Solely one of the female alumni spoke about her visit to an open day at a university where she *"thought that the people here are strange […] they had strange interests or looked strange […], interests in computer games […] a little nerdy"* (Emma, Technical Physics, University). Relevant in this situation is that she finally felt positively about it as she said: *"anyhow, because I had the idea that the people here are strange, I thought that it would be easier for me to find the connection [with them]"* (Emma, Technical Physics, University). Emma was happy about the fact that the people had been 'strange'. This encouraged her decision towards the field of STEM. Finally, she explained that she had met her present cohabitant during her technical studies which indicates that she realized that the technical field not only consists of nerds.

However, the technical alumni of both groups reported that the field of STEM was quite difficult and that engineers expect the students to be very good at mathematics: *"Technology makes things more difficult"* (Paul, Industrial Engineering and Management, University of Applied Science) and *"Especially the mathematical aspect is discouraging* (Mila, Industrial Engineering and Management, University). Mila linked this to the gender gap in STEM as she concludes that *"[the difficult mathematical aspect] could have had an influence on the fact that less women chose for it".*

To sum up, the technical alumni of both groups were not exposed to crucial false or incomplete prototypes about the field of STEM. However, the alumni of both groups reported high expectations of the studies in the technical field, especially the mathematical part. One of the female technical alumni related these high expectations in mathematics to the gender gap.

Differences. Most of the female technical alumni persisting in the technical field explained that they realized being one out of a few women in the field but that it had not been a problem for them. For instance, one of the female alumni stated*: "I realized it but […] I found it funny and great [because] then I stand out a little"* (Emma, Technical Physics, University). Another female technical alumnus outlined that *"I didn't expect it, I thought: are there other [women]? But it never really bothered me; I can always find it with men, too"* (Mila, Industrial Engineering and Management, University). The same alumnus said *"Despite the fact that you see that there you are one out of a few women in the technical field it has been a very normal thing for me to do it"* (Mila, Industrial Engineering and Management, University).

Another aspect that had been mentioned was that people may not expect the same from a technical male employee than from a technical female employee. For instance, a female technical alumnus stated *"When I am on my way to the test track with another male colleague, then they ask you: Oh, girl, that's nice, are you allowed to do a shadow shift? And then my colleague and I look at each other and my colleague says: No, she is my chauffeur for today. And then they say if she can do that, we can do that as well, we all can do that"* (Kira, Mechanical Engineering, University). Kira explains *"it doesn't bother me in that way because I know that the people who know me they trust me and they let me do that".*

Some of the female technical alumni explained that being one of a few women in the field of STEM motivated them to work even harder. On the question, whether one of the alumni thought that any decisions were based on being female, her answer was*: "Maybe just that I was willing to work even harder"* (Mila, Industrial Engineering and Management, University). The same alumnus said *"I don't like this stereotype, that people say you can't do that because you're a woman […] I'm happy that my parents or especially my mother is in the technical field, too"*. In contrast to this statement, one of the female technical alumni tells that *"Sometimes I find it hard but I am always accepted and respected. This was not the case in my private environment, there, they asked me: Why do you want to study in general? You are a woman; you belong behind the countertop, just get 100 children"* (Isabella, Technical Physics, University of Applied Science). At the same time she said: *"This led me to the point that I wanted to fight even harder"*, which at the end motivated her to insert even more energy in her studies. Due to the fact that Isabella did not get as much support from her family to work in the technical field as her brother did, she said that *"he was allowed to do more constructive things […] he is now very skilled, he has a job in the technical field, too […] and is very successful, but this is especially due to the fact that he learned so much at home. So, if I would have been allowed to learn and do it as well I would have been very good in it, too. But this wasn't the case and this is still very pity"* (Isabella, Technical Physics, University of Applied Science).

To sum up, the female technical alumni explained that they did not experience the fact of being a woman in the male-dominated technical field as a problem. However, they reported that people may not expect the same from a technical male employee than from a technical female employee and that they experienced a kind of motivation to work even harder when others, especially the family, did not expect them to be able to study something technical.

Identity status

In terms of identity status, it can be seen that the male technical alumni either fit into the Foreclosure or into the Moratorium status whereas the female technical alumni fit more into the Moratorium or the Achievement status. The female technical alumni generally showed higher levels of exploration and broader interests than the male technical alumni. However, both genders can be found in the Moratorium state which indicates high levels of exploration and relatively low levels of commitment. In Table 4, an overview of the respondents structured in each identity status is given and in Figure 3, a general overview of the results is shown.

Table 4. Overview of respondents distributed in identity statuses

	Respondent	Identity status	Gender
1	Tom	Foreclosure	Male
2	Thomas	Foreclosure	
3	Robin	Moratorium	
4	Luke	Foreclosure	
5	Paul	Moratorium	
6	Matthew	Moratorium	
7	Rik	Foreclosure	
8	Simon	Foreclosure	
9	Nicole	Achievement	Female
10	Emma	Moratorium	
11	Isabella	Achievement	
12	Kira	Moratorium	
13	Lina	Achievement	
14	Mila	Achievement	

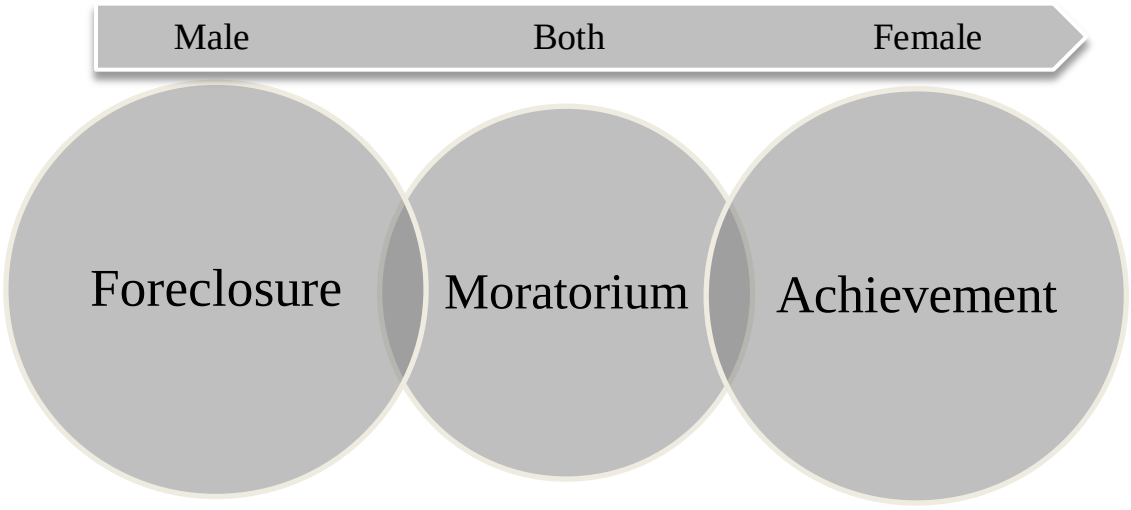

Figure 3. Identity statuses assigned to the male, both, and the female technical alumni

Indexical material

Similarities. With regard to the indexical material of the stories, similarities in the exploration and commitment between male and female technical alumni can be seen. Three male and two female technical alumni can be allocated to the Moratorium status as they show high exploration but no clear commitment to the field of STEM. Their interests can be applied to a variety of different fields. For instance, one of the male technical alumni said that *"I did not play lego or technical lego […] It has been my brother who [played with technical lego], not me"* (Robin, Mechanical Engineering, University). He did not show any interests to the technical field during early childhood. Instead, he mentioned that *"I've always been good in mathematics, analytical thinking"* (Robin, Mechanical Engineering, University). He shows high levels of exploration as he states that he *"looked at civil engineering, mechanical engineering, maritime engineering […]"*, which are all in the field of STEM. Finally, he described his decision towards the technical field as: *"I think that [my brothers'] advice to study Mechanical Engineering has been crucial. I would not have chosen it otherwise"* (Robin, Mechanical Engineering, University). A female technical alumnus, for instance, stated: *"First, I wanted to study psychology"* and *"I did not know what I wanted"* (Emma, Technical Physics, University). Then, she indicated that she went to different open days and got informed about a sum of different studies. Finally, she stated *"Then I decided to enter the field of physics because there is more challenge, more possibilities"* (Emma, Technical Physics, University). Emma explored her interests and finally decided to enter the field of physics due to the positive challenge she expects to be there. Emma considered study options that have nothing to do with the field of STEM (Psychology).

Differences. In contrast to five out of the eight male technical alumni, none of the female technical alumni showed a high commitment to and a low exploration of the field of STEM and is classified into the Foreclosure status. The five male technical alumni blindly accepted their interests without greatly exploring others. The commitment to the field of STEM is relatively high from early childhood on. For instance, one of the male technical alumni said that *"When I came in [a room] then I pushed all the buttons [...] from radios, lamps, these kinds of things"* (Tom, Electrical Engineering, University of Applied Science). He also mentioned that *"my father has been very technical, too, he worked in a technical job […] I already played with oppositions and I made components that I soldered to one another"* (Tom, Electrical Engineering, University of Applied Science). Another male alumni explained that *"I've been at my neighbor's house a lot and learned to cut wire, to assemble, […]"* and that he engaged a lot in *"riding tractors, these kinds of things, with agriculture machines"* (Thomas, Mechanical Engineering, University of Applied Science). However, four of the six female technical alumni showed high exploration and high commitment to the field of STEM and can be applied to the achievement status. For instance, a female technical alumnus spoke about an open day at a university and after visiting some different studies *("chemistry, biology, mathematics, physics")* with her sister and mother, she went to the introduction of Technical Physics: *"From the beginning on, I could participate. And I felt like: Oh, it is not that difficult […] I have been 100% sure about it that I wanted [Technical Physics]. So I went there. […] Then I knew it, I felt welcome."* (Nicole, Technical Physics, University). Nicole shows high levels of exploration within the field of STEM and high commitment to the field of STEM.

Non- indexical material

Similarities. Just like the indexical material, the non-indexical material shows the same similarities between the male and female technical alumni that can be allocated to the Moratorium status. For instance, a male technical alumnus mentioned that he *"always wanted to become a pilot […] and if I would not get the job I would enroll for technician in the air traffic or as an aircraft mechanic […] but one week before I got the message that I will not get the job, my neighbor died in Afghanistan and then it has been clear for me that this is not going to be my job"* (Paul, Industrial Engineering and Management, University of Applied Science). Paul then worked in the bicycle shop of his father for one year and searched further: *"I think that Industrial Engineering and Management has been my second choice, after property and brokerage businesses; already before; and then I again searched for it and finally liked [Industrial Engineering and Management] the most."* (Paul, Industrial Engineering and Management, University of Applied Science). He shows high levels of exploration in different domains but with a preference towards the technical field such as becoming a technician in the air traffic or studying Industrial Engineering and Management. Another male technical alumnus whose life experiences can be applied to the Moratorium status is Matthew. He stated that *"[the study] needs to be as difficult as possible; because that will give me the best possibilities […] perhaps that was my biggest motivation"* (Matthew, Industrial Engineering and Management, University). In this case, Matthew chose the mathematics and physics profile because he thought about the positive consequences of his decision. In addition, he showed no deeper commitment to the field of STEM. One of the female technical alumni, whose life experiences can be applied to the Moratorium status is Kira. She stated that *"I like so many things and I have a lot of different interests"* (Kira, Mechanical Engineering, University). Kira explained that she had been interested in *"becoming a veterinarian"* and that *"I did not know what I wanted; as long as I will get my diploma, everything is going to be fine"* (Kira, Mechanical Engineering, University). She then doubted her intention to become a veterinarian: *"do I really want that? […] always working during the night? And my parents also advised to look at different studies, to look a little broader, to go to a technical university and to look at different things and find out what I like. So I went to [different universities in different cities] […] and I still have been interested in the medical side. […] So then I came out on biomedical technology and if you look at mechanical engineering and biomedical technology, then you can see that there is great accordance, only that in mechanical engineering it is still a little broader."* (Kira, Mechanical Engineering, University). Kira shows great levels of exploration in different fields with no clear commitment to the field of STEM.

Differences. The non-indexical material, too, shows differences between the male and female technical alumni. For instance, the male technical alumni reported to already have imaginations about their future job during early childhood: *"During childhood I always wanted to become a construction worker because I liked it to build up stones on each other [with lego]"* (Luke, Electrical Engineering, University). Another male technical alumnus stated that the expectation of being a scientist motivated him to enter the technical field: *"I thought, yes, I always want something new, I am afraid of boredom. Where better find something new than in engineering as a scientist? I can't remember where I got the ideas from that you would have this as a scientist […] but this has been the image that I had about it because you are busy with exploring*

new things, it is always new and I wanted that, I wanted to do that, always something new" (Rik, Technical Physics, University of Applied Science). These non-indexical experiences, reported by the male technical alumni can be allocated to the Foreclosure status as they present little exploration but great commitment to the field of STEM from early childhood on. Quite the opposite, the non-indexical material of the female technical alumni that are allocated to the Achievement status showed great exploration and great commitment to the field of STEM. For instance, a female technical alumnus explained about her study choice *that "for me, it has been very difficult; because I always chose for a profile as broad as possible with which you have a lot of options. Then you look at the different jobs and […] ask yourself whether you are able to do that and especially does this really is what I want?[…] Then I thought about becoming a veterinarian, things like that, […] I talked a lot with the dean about that and did some tests"* (Isabella, Technical Physics, University of Applied Science). Isabella shows high levels of exploration and at the same time high commitment to the field of STEM as she stated*: "I knew that I wanted to go to the technical field anyway. [However,] I also thought about going into music […] and my mother then said that […] it would be safer to go into a field in which there is great potential to get a job later on. That's why I chose for the technical field"* (Isabella, Technical Physics, University of Applied Science).

Summarizing the results of the indexical and non-indexical material concerning the identity status of male and female technical alumni, it can be seen that the male technical alumni either committed to the technical field from early childhood on, or that they explored their interests and finally entered the technical field because their interests could have been acted out there but also in other domains. Two different identity statuses can be adapted to the male technical alumni: **Foreclosure or Moratorium**. The female technical alumni seem to be quite open-minded in their interests which indicate a high level of exploration. In terms of identity status, this can be compared to the status of **Moratorium or Achievement**.

Discussion and Conclusion

The aim of this study was to identify differences and similarities in the professional identity development of male and female technical alumni persisting in the technical field after graduation. It is, therefore, looked at study and career choices, external influences and the exploration of and commitment to the field of STEM, which finally defined the identity status of the technical alumni. The research question in its subcategories will be discussed, as well as methodological limitations. Furthermore, practical implications that can be drawn from this study will be proposed.

Study and career choices

Results indicate that all males and females in this study do follow quite a similar path towards the field of engineering as they all show some affiliations to the technical field from early childhood on. Considering the fact, that those students decided working in the technical field later on, proofs the findings of Patton and McMahon (2014) who argue that building up a self-concept with interests into a specific field and engagement in specific activities, already takes place in the early ages of life. Furthermore, the results of this study indicate that an early exposure to the field of STEM through others (relatives, friends, acquaintances etc.) influenced later decisions in life. This can be compared to the findings of Pierrakos et al. (2009), who suggests that knowing an engineer, having more exposure to the field of engineering or experience with corresponding tasks are crucial to the development of an engineer identity. There are some similarities in the alumni's interests, as well as likes and dislikes regarding school subjects. Moreover, both, male and female technical alumni show positive affiliations concerning mathematics and physics and negative associations towards languages. This is similar to the expectation – reported by one of the female interviewees – for engineers to be very good at mathematics. Also, an overlap can be seen in the commentary by Valla and Ceci (2014) about women's underrepresentation in the STEM field, as they report that interests in a specific subject, such as mathematics, actuate a career choice in that field more than absolute math ability alone. Thus, technical women's great interest in mathematics may already influence study and career choices. The study and career choices have been greatly influenced by what the alumni liked and where their interests lay.

External influences

In this study the female technical alumni do not see a problem in being a woman and take gender issues quite unproblematic. An explanation for that might be that this study has been conducted with only those female technical alumni that stayed in the technical field after graduation which means that those leaving the field had not been taken into account. It might be interesting to find out whether resignation of those is associated with a gender bias. However, also in this study, the females report to be helped more often and to experience some sort of motivation to work even harder when others, especially the family, do not expect them to be able to succeed in something technical. The female technical alumni reported, people might not expect the same technical proficiency from a technical female employee as from a technical male employee. It seems that, still, a gender gap in the field of STEM exists and that the female technical alumni experience this gap in their everyday life. Even though the results of this study show that women persisting in the field of STEM do not see gender issues as a problem, comparing to the findings

of Britton (2017), these results might indicate some kind of denial and minimization of the gender issue. More research is needed to confirm this assumption.

Findings of Buse, Bilimoria and Perelli (2013) indicate that women persisting in the technical field, and thereby resisting possible gender bias and other barriers, show high levels of self-efficacy. In this study, results indicate that the women persisting in the technical field show high exploration and most of them, additionally, high commitment to the field of STEM. Those women seem to be confident concerning their skills in subjects such as mathematics and physics, even though their female friends chose different profiles. They furthermore report to not care about being one out of a few women in the technical field and not bother about the fact that their friends chose different profiles in school. In congruence with the findings of Buse, Bilimoria and Perelli (2013), it can be assumed that women with high self-efficacy and high self-identity in engineering are those that persist in the technical field after graduation.

False or incomplete prototypes towards the field of STEM have been mentioned by one female alumnus. She reports that she revised her prejudices during college time. However, these results indicate that social prejudice in technical fields still exists. Anyway no one of the other technical alumni reported any prototypes which can be explained with the fact that those men and women having studied in the field of STEM know what it is like and may have reconsidered possible earlier false or incomplete assumptions.

Identity status

In terms of identity status, it becomes visible that the male technical alumni either fit into Foreclosure or Moratorium status. As the identity status of Foreclosure presupposes a high commitment to the field of STEM without great exploration, it is questionable whether those students actively engaged in the formation process of their identity as described by Erikson (1968). Based on this theory, the first step of breaking away from childhood beliefs and the second step of exploring an alternative status and building a commitment to a new field have never been conducted by those male technical alumni allocated to the status of Foreclosure. The future impact this has on industry is yet to be evaluated. However, based on the theory, the Foreclosure status can be seen as problematic with regard to the development of a professional identity.

The female technical alumni fit more into the Moratorium or the Achievement status. They generally show higher levels of exploration and broader interests than most male technical alumni. The Achievement status indicates that the process of breaking away from childhood beliefs, exploring an alternative status and committing to the new field (Erikson, 1968) is fully completed. The obvious question is why only women in this study can be allocated to the Achievement status. One assumption is that women generally show broader interests than men (Wensierski, von, 2015), which finally helps women to explore alternative statuses and commit to them.

However, both sexes can be found at Moratorium status which indicates high levels of exploration and relatively low levels of commitment. The explanation might be that those students actively searching for the best opportunities at the study and job market are talented and interested in technical issues but could exert these talents elsewhere than in the field of STEM, too. Although it seems that the technical alumni see their jobs in the technical field as very positive: *“there is a lot of variety”; “it is very relaxed that you […]have your own working*

schedule and that 40 hours really are 40 hours" (Robin, Mechanical Engineering, University) and are willing to stay in the technical sector within the next five to ten years. The high level of exploration and low level of commitment to the field of STEM indicate a risk for leaving the technical sector one day. There is need for more research that focusses on exactly these students in order to explore the reasoning of leaving and staying in the technical field.

Methodological limitations

One limitation of this study is the fact that it is of qualitative nature, which makes it impossible to generalize the results. However, the qualitative approach is needed in order to obtain the individual perspectives of the alumni (Koro-Ljungberg & Douglas, 2008). Furthermore, due to the fact, that women are merely represented in the field of STEM, more men than women participated in this study. The underrepresentation of women may have caused incalculable influences on the results. Also, during the interviews, women were asked about the impact of being a woman in the field of STEM. Men were not asked about that, which makes it difficult to compare the results of gender bias between the groups. Further research is needed that includes both genders equally to get comparable results of the influences that gender bias may have on the professional identity development towards STEM.

Another limitation of this study is the inter-rater reliability of testing the coding procedure. The application of the coding scheme based on Schütze (as cited in Jovchelovitch and Bauer, 2000) has been very difficult. First, the codes "Map from actions to actors", "Sequence" and "Relations in Sequence" within the indexical material had a lot of overlap with different other codes and could not be ascertained reliably. Second, the overlap between all codes within the non-indexical material made it impossible to receive reliable agreements. The added value of the differentiation has not been clear for the group of raters. This limitation disputes the results to such a great extent, that it should be considered whether another coding scheme would have been more suitable for this study. In this regard, it is important to follow clear definitions and differentiations of codes. Another methodological limitation is the fact, that no clear boundaries have been set during the alignment to the four different identity statuses described by Marcia (1980). The alignment has been made based upon the general differences between the stories, but without clear definitions of high or low commitment and high or low exploration towards the field of STEM. In order to address these limitations, it is important to make boundaries measurable and define all codes from scratch. Mixed methods studies may have been more appropriate for this study, as they combine the advantages of qualitative and quantitative research. However, an important quality of this study is the life history approach that includes both, male and female technical alumni. This study adds to the understanding of differences and similarities in the professional identity development between the groups.

Practical implications

Results of this study could be used to, first, improve the inflow of STEM students and, second, to increase the number of STEM students persisting in the field of STEM after graduation.

First, as this study shows the development towards the field of STEM begins in early childhood (also compare with Tuijl, van & Molen, van der, 2016), preschools, primary schools and secondary schools, the results of this study could be used to improve the inflow of STEM students in such a way, that science, technology, engineering and mathematics become interesting for the children. The dutch Ministerie van Economische Zaken (2016) reports that

an agreement with, among others, educational institutions has been declared to focus more on those subjects covering scientific backgrounds. These subjects are called "bèta" and are preconditions for the possible later decision towards the field of STEM. Also, they want to engage in making the technical field more attractive for the children. The results of this study confirm the importance of these initiatives. However, when trying to make the technical field more attractive, it is important to keep in mind, how males and females of this study show differences in the development of their professional identity towards the field of STEM. For instance, in this study those women, who were already interested in the field of STEM, seem to actually decide for the field, as soon as they are supported to decide based on their interests, on their own and on getting to know all different career possibilities, a different approach may be suitable for keeping technology interesting to them than the approach for men. The consideration of these differences may potentially help to diminish the gender gap in technical studies.

Second, as around 40% of students graduating in the field of STEM do not subsequently enter the technical labor market (Berkhout, Bisschop & Volkerink, 2013), it is relevant to examine the reasons. The identity status of the students may be a starting point in order to examine the exploration and commitment to the field of STEM. The results of this study show that a great commitment and high levels of exploration may indicate great chances to stay in the technical sector after graduation. Therefore, consistent assessment of the professional identity status can help to identify those students opting to leave the technical field after graduation. Likewise, differences in identity status between male and female students should be taken into account. Universities and Universities of Applied Sciences may use repetitive talent development courses for the students to explore their own identity statuses and finally make a commitment to the field of STEM. These outcomes may serve as a first step to identifying a risk group and may unfold future ways for interventions. Additionally, it can be interesting to compare the results of this study, which dealt with men and women persisting in the field of STEM after graduation with those leaving the technical field. Differences in identity statuses may provide additional information for assessing the risk group.

While this study cannot explain why men and women choose the technical field after graduation or leave, it does give an insight into the professional identity development of those male and female technical alumni persisting in the technical field after graduation. Differences and similarities in the professional identity development of male and female technical alumni aim at stimulating future research in order to gain more insights into the gender gap in STEM, reasons for it and possible strategies.

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Appendix

Appendix A – Interview questions

1. Welke gebeurtenissen uit je vroege jeugd (kleuterschoolleeftijd) kun je je nog herinneren? Wat vond je toen leuk op school? Waar speelde je mee? Hoe bracht je je vrije tijd door? Welke gebeurtenissen kun je je herinneren die te maken hadden met techniek en jouw interesse voor techniek?

2. Welke gebeurtenissen rond je 12de, overgang naar andere schooltype, kun je je nog herinneren? Wat vind je leuk? Waarin stimuleerden je ouders je? Wat waren je hobby's? Waar was je goed in op school? Wat vond je leuk? Welke leraren herinner je je nog?

3. In welk jaar ben je naar de middelbare school gegaan? Wat waren belangrijke gebeurtenissen op de middelbare school? Wat vond je leuk om te doen? Wat deed je naast je school? Wat waren je hobby's? Welke leraar heeft het meeste indruk op je gemaakt? Wat kun je vertellen over je profielkeuze op de middelbare school en hoe die verlopen is? (Hoe heb je het ervaren als meisje een N&T-profiel te kiezen? Was je je ervan bewust dat je vrouw was?)*

4. In welk jaar ben je naar de universiteit gegaan? Wat kun je vertellen over de keuze voor je studie en hoe dat proces is verlopen? Weet je nog waar je in die tijd veel tijd aan besteedde? Wat waren je hobby's? Wat deed je met vrienden? Wat waren hun hobby's? Welke mensen waren in die tijd het belangrijkst voor je? Wat waren de belangrijkste gebeurtenissen tijdens je studie voor jou als je er drie zou mogen uitkiezen? (Hoe heb je het ervaren als meisje een technische studie te kiezen? Was je je ervan bewust dat je vrouw was?)*

5. Wanneer ben je aan je eerste baan begonnen? Waar was dat? Weet je nog hoe dat proces verlopen is? Wat kun je vertellen over hoe je in je eerste baan terecht bent gekomen? (Hoe heb je het ervaren als meisje in een technische werkomgeving te functioneren?)*

6. Wie hebben invloed op je gehad vanaf je studie tot waar je nu zit? Wat heb je als barrières ervaren? Welke ervaringen hebben een rol gespeeld?

7. Heb je daarna nog andere banen gehad? Hoe heb je die gekozen? (Wat heeft je ervaring gevormd als vrouw?)*

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*questions in brackets indicate those only relevant for the female technical alumni

Appendix A - Follow up questions (Etherington, 2013)

1. Hoe wist je dat? Waarom denk je dat dat gebeurd is?
   Wat vond je daarvan?
   Was dat iets wat je vaker deed?
   Was je het daarmee eens?

2. Wat zag/hoorde je? Hoe kwam dat op je over?
   Wat was er naar jouw idee aan de hand?
   Hoe ging je daarmee om?
   Welke invloed had dat op je? Wat voelde/dacht je toen?
   Wat vond je van wat hij/zij deed?
   Had je daar toen duidelijke ideeën over?

3. Wie waren de anderen karakters?
   Wat vindt je familie daarvan?
   Met wie heb je erover gepraat? Wie praatte er met jou over?
   Heb je iemand om hulp gevraagd? Wisten mensen wat er aan de hand was?
   Hoe zat het met je vrienden?

4. Waarom besloot je om daarheen te gaan?
   Wat was je bedoeling?
   Waarom wilde je dat doen?
   Wat hoopte je dat er zou gebeuren?
   Wanneer nam je die beslissing?

5. Wat gebeurde er op dat moment nog meer in je leven?
   In welk jaar was dat?
   Hoe oud was je toen?

6. Waar begint je verhaal?
   Hoe kwam je in die situatie terecht?
   Wat gebeurde er daarna?
   Wanneer keek je terug op je beslissing?

7. Kun je een beeld schetsen? Hoe moet ik me dat voorstellen?
   Je zei dat het was alsof….. Kun je dat uitleggen?
   Heb je daar een beeld bij?
   Deed dat je ergens aan denken?
   Kun je tekenen in woorden?