Master's thesis

NTNU
Norwegian University of Science and Technology

Hanne Sofie Haugland

"Did You Know That You Are a Role Model?" - Exploring Role Models for Female Computing Students

Master's thesis in Informatics
Supervisor: Letizia Jaccheri
Co-supervisor: Anna Szlavi
June 2024

NTNU
Norwegian University of
Science and Technology

Hanne Sofie Haugland

"Did You Know That You Are a Role Model?" - Exploring Role Models for Female Computing Students

Master's thesis in Informatics
Supervisor: Letizia Jaccheri
Co-supervisor: Anna Szlavi
June 2024

Norwegian University of Science and Technology

NTNU
Norwegian University of
Science and Technology

ABSTRACT

Context: Development of new technology is limited by a significant gender gap in the computing industry. Biased technology is being produced as a result of too few women in the industry. Many computing professionals start their journey with a higher education degree in computing, and the gender gap is present already at this level. It is important to discover new ways to support non-male students in completing their degree to increase the gender balance of the computing field.
Objective: This master's thesis explores how role models can support non-male students in completing their computing studies. The overarching goal is to contribute to a more gender-inclusive computing education to increase the diversity in the field. These objectives motivated the following research questions:

- **RQ1:** How can role models improve retention of non-male identifying computing students in higher education?
- **RQ2:** How to design and develop a learning video about role models for non-male identifying computing students?

Method: The thesis follows a Design and Creation research strategy to develop a learning video teaching non-male student about role models. The learning video is based on data gathered through semi-structured interviews and then improved in iterations through focus groups in both Norway and Brazil.
Results: Analysis of data gathered through the interviews revealed that participants collect role models that increase their identity with the computing field and that relating to the role model's traits and values is important for a successful role modeling process. Analysis of the evaluations of the learning videos supported existing design principles for instructional videos as well as indicate the importance of inspiration through an emotional connection.
Conclusion: The research concludes that role models can support female students in completing their computing education by increasing their sense of belonging and showing them that it is possible to overcome gendered barriers. Future research should explore how higher education institutions could adjust their education program to facilitate a role modeling process for their female and non-binary students, focusing on both peers and teachers.

Keywords: Computing Education Research, Role models, Gender, Diversity, Computing, Retention

SAMMENDRAG

Kontekst: Utvikling av ny teknologi er begrenset av en mangel på kjønnsmangfold i IT industrien. Ikke-universell teknologi blir produsert som et resultat av for få kvinner i industrien. Mange kommer inn i arbeidslivet gjennom en grad i IT fra høyere utdanning, og mangelen på kjønnsmangfold er tydelig allerede på dette nivået. Det er viktig å finne nye måter å støtte ikke-mannlige studenter i å fullføre deres IT utdanning for å øke kjønnsmangfoldet i IT industrien.
Formål: Denne masteravhandlingen utforsker hvordan forbilder kan støtte ikke-mannlige studenter i å fullføre deres IT-studier. Hovedmålet er å bidra til mer kjønnsinkluderende IT-undervisning for å øke mangfoldet i bransjen. Disse formålene har motivert følgende forskningsspørsmål:

- **FS1:** Hvordan kan forbilder forbedre bevaringen av ikke-mannlige IT-studenter i høyere utdanning?
- **FS2:** Hvordan kan man designe og utvikle en læringsvideo om forbilder for ikke-mannlige IT-studenter?

Metode: Avhandlingen følger en Design and Creation forskningsstrategi for å utvikle en læringsvideo som formidler kunnskap om forbilder til ikke-mannlige studenter. Læringsvideoen er basert på data samlet gjennom semi-strukturere intervjuer og er så forbedret gjennom iterasjoner med fokus grupper i Norge og Brasil.
Resultater: Analyse av dataen som er samlet gjennom intervjuene viste at deltakerne samler forbilder som øker deres identitetsfølelse til IT-feltet og at å relatere til et forbildes egenskaper og verdier er viktig for å vellykket skaffe seg et forbilde. Analyse av evalueringen av læringsvideoen støtter eksisterende design prinsipper for instruksjonsvideoer samtidig som det indikerer viktigheten av å inspirere gjennom en emosjonell tilknytning.
Konklusjon: Forskningen konkluderer med at forbilder kan støtte kvinnelige studenter i å fullføre sin IT-utdanning ved å øke tilhørighetsfølelsen deres, og å vise dem at det er mulig å overkomme barrierer knyttet til kjønn. Fremtidig forskning burde utforske hvordan institusjoner for høyere utdanning kan tilpasse deres programmer til å fasilitere en prosess hvor kvinnelige- og ikke-binære studenter kan skape forbilder, med søkelys på både medstudenter og undervisere.

Nøkkelord: Forbilder, Kjønn, Mangfold, Teknologi, Informatikk, Bevaring

PREFACE

This thesis is submitted as part of the course IT3920 – Master Thesis for MSIT at the Norwegian University of Science and Technology (NTNU). The work has been done with supervision from main supervisor Professor Letizia Jachheri and co-supervisor Post-Doctoral Researcher Anna Szlavi at the Department of Computer Science.

Some sections of this thesis are taken from or based on the authors preparatory project titled "Role models as an intervention for gender diversity in computing education", submitted as part of the course IT3915 [1]. Chapter 2 is in part built on chapter 2 in the preparatory project, but is mostly rewritten and contains additional insights not included in the preparatory project. Chapter 3 is a summary of chapters 3, 4, 5 and 7 from the project, and is somewhat rewritten. The chapter is included to provide the reader with necessary information about how the project has inspired and guided this thesis. Other than this, references to the preparatory project is clearly cited throughout when used.

Appendix C presents the AI declaration in Norwegian.

ACKNOWLEDGEMENT

I want to thank Professor Letizia Jaccheri and Post-Doctoral Researcher Anna Szlavi for their supervision throughout this academic year. I also want to thank the team of Software for a Better Society for sharing valuable knowledge and being part of insightful discussions.

Professor Sabrina Marczak and Professor Sheila Reinehr have both provided essential help in recruitment of participants for the data collection in Brazil. Thank you.

I also want to thank all participants of interviews and focus groups. Your participation is greatly appreciated. Thank you for sharing. Lastly, I want to thank my friends and family for encouraging me and supporting me through this work, which has turned out to be some of my most rewarding hours spent at NTNU.

I have collected a lot of positive role models through my work.

CONTENTS

Abstract i

Sammendrag ii

Preface iii

Acknowledgement iv

Contents v

List of Figures vii

List of Tables viii

Abbreviations ix

1 Introduction 1
- 1.1 Motivation . . . 2
- 1.2 Research Objectives . . . 3
- 1.3 Project Description . . . 3
- 1.4 Thesis Outline . . . 3

2 Background 5
- 2.1 Gender . . . 5
- 2.2 The Sustainable Development Goals . . . 6
- 2.3 Gender Diversity in Computing . . . 7
  - 2.3.1 Computing Education . . . 8
- 2.4 Role Models . . . 10
- 2.5 Existing Initiatives . . . 12

3 Systematic Literature Review 15
- 3.1 Research Method . . . 15
- 3.2 Synthesized Results . . . 18
  - 3.2.1 RQ1: What recent research exists that explores the effect of role models on computing students? . . . 19
  - 3.2.2 RQ2: Who functions as role models in computing education? . . . 22
- 3.3 Conclusion . . . 22

4 Methods **25**
4.1 Research Questions . . . 25
4.2 Theoretical Foundation . . . 26
4.2.1 The Motivational Theory of Role Models . . . 26
4.2.2 Learning Video . . . 29
4.3 Design and Creation . . . 30
4.4 Data Generation Methods . . . 32
4.4.1 Interviews . . . 32
4.4.2 Focus Groups . . . 35
4.5 Qualitative Data Analysis . . . 37
4.6 Ethics . . . 39

5 Results **41**
5.1 Participant Demographics . . . 41
5.2 RQ1: How can role models improve retention of non-male identifying computing students in higher education? . . . 42
5.2.1 Increasing Sense of Belonging . . . 43
5.2.2 Collection of Role Models . . . 47
5.2.3 Educators as Role Models . . . 51
5.3 RQ2: How to design and develop a learning video about role models for non-male identifying computing students? . . . 53
5.3.1 Iteration 1 . . . 54
5.3.2 Data Analysis - Norway . . . 56
5.3.3 Iteration 2 . . . 59
5.3.4 Data Analysis - Brazil . . . 62
5.3.5 Iteration 3 . . . 65

6 Discussion **67**
6.1 RQ1: How can role models improve retention of non-male identifying computing students in higher education? . . . 67
6.2 RQ2: How to design and develop a learning video about role models for non-male identifying computing students? . . . 70
6.3 Limitations . . . 72

7 Conclusions **73**
7.1 Future Work . . . 74

References **75**

Appendices: **83**

A - Original Project Description **84**

B - Data Collection **85**

C - AI Declaration **100**

LIST OF FIGURES

2.1 Amount of Women at NTNU's Computing Departments 2018 and 2023 [26] 9
2.2 Amount of Women in Computing Programs at NTNU 2018, 2020 and 2023 [26] 10

3.1 Full SLR Process [1, p. 12] 15
3.2 Publication Year of all Query Results [1, p. 21] 20
3.3 Publication Country of Primary Studies [1, p. 19] 20
3.4 Study Focus [1, p. 25] 21

4.1 Timeline of Data Collection 33
4.2 Iterations Through Focus Groups, Inspired by [69] 36

5.1 RQ1 Themes with Correlating Codes 43
5.2 Engaging the Viewer with an Exercise 55
5.3 'Scrolling Motion' of Video 2 56
5.4 Video 2 Introduction 56
5.5 Changes to Reduce Visual Clutter 59
5.6 Ending With a Simplified Definition of Role Models 61
5.7 Changes to Make the Final Scene More Powerful 61
5.8 Increasing Diversity of Role Models Presented 61
5.9 RQ2 Themes with Correlating Codes 64

LIST OF TABLES

2.1 Relevant Targets From SDG 5 [24] 7
2.2 Work Packet 3 - Development of Leadership and Inspiration Academy [19] 14

3.1 Inclusion and Exclusion Criteria 16
3.2 Search Query 16
3.3 Quality Assessment Criteria 17
3.4 Overview of the Primary Papers [1, p.17-18] 18
3.5 Overview of the Primary Papers (Continued) [1, p.17-18] 19

4.1 Gibson's Dimensions of Role Models, With Criteria [14, p.144] . . . 28
4.2 Four Propositions by Morgenroth et al. [12] 29
4.3 Design Principles of Instructional Videos [67, p. 161-162] 30

5.1 Description of Participants 42

ABBREVIATIONS

List of all abbreviations in alphabetic order:

- **AI** Artificial Intelligence
- **CER** Computing Education Research
- **CTML** Cognitive Theory of Multimedia Learning
- **DEI** Diversity, Equity, and Inclusion
- **ICT** Information and Communications Technology
- **IDI** Department of Computer Science
- **IIK** Department of Information Security and Communication Technology
- **IT** Information Technology
- **K-12** Kindergarten and First Through 12th Grade
- **P** Participant
- **PUCPR** Pontifícia Universidade Católica do Paraná
- **PUCRS** Pontifícia Universidade Católica do Rio Grande do Sul
- **NTNU** Norwegian University of Science and Technology
- **RQ** Research Question
- **S** Study
- **SDG** Sustainable Development Goal
- **SENOBR** Software Engineering Norway Brazil
- **SLR** Systematic Literature Review
- **STEM** Science, Technology, Engineering, and Mathematics
- **TA** Thematic Analysis
- **UN** United Nations

CHAPTER

ONE

INTRODUCTION

Technology has made its way into almost every aspect of modern-day life, and a lot has happened in a short amount of time. Smart phones, voice-control, and most recently, generative artificial intelligence (AI) have become part of many people's everyday life. While this technological revolution has connected and enabled a lot of people in a positive way, there is a dark side to this moon. The industry developing these tools is lacking diversity in several aspects. This has been proven to cause problems related to gender bias in everything from physical product design to training data of machine learning algorithms.

This gender bias is prominent in a wide variety of everyday products: voice recognition systems work better with male-voices than female voices [2], most top-shelf smart phones are too large for the average size of a woman's hand [3] and generative AI algorithms have been found on multiple occasions to amplify existing negative gendered stereotypes [4]. This becomes even worse when these technological advances enter the medical field, and women are less likely to get diagnosed correctly using machine learning algorithms that are trained on male-biased data [5]. While a lot of these problems stem from biased training data [4], [5], one could argue that a more diverse industry would be able to detect these data gaps earlier. In addition to this, improved gender diversity has also been found to increase innovation [6] and efficiency of software development teams [7].

Negative gender stereotypes, discrimination, lack of peer parity and thus a lower sense of belonging are among some of the challenges faced by women in computing [8]–[10]. These challenges hinder women from entering computing, and also push them to abandon their job and education. Luckily, a lot of people recognize the benefits of diversity, and an increasing amount of research is being done on how to address these challenges and improve the gender diversity. One of the solutions that has been highlighted as promising is role models. By disproving stereotypes and serving as a representation of the possible for young women [11], they might improve both recruitment and retention of women in computing.

1.1 Motivation

Role models have been identified as an important source of motivation and aspirations for minority groups such as women and non-binary students in computing education [11], [12]. However, research is sparse about their implications on retention of these students [1]. This seems to be a more general problem with research on gender diversity in computing, as Happe describes a lack of research on good solutions rather than solely identifying challenges [13]. Furthermore, role models have the potential of being a very low-cost intervention for improved gender diversity in computing education compared to e.g., mentoring programs [14], which motivates further research on what the potential of role models influence might be.

While studies have found positive effects of female students experiences with role models such as improved interest and confidence, there is also the possibility of negative effects of role models. Studies have found that when role model enhance existing negative stereotypes, they can have a lasting negative impact on girls' interest in computing [11], [15]. Because of this, it is crucial to do further research to ensure that future efforts using role models as an active intervention does good instead of harm.

Furthermore, there needs to be a better understanding of which people function as role models to non-male computing students for efforts to be efficient. Studies have found that people might show more interest in the human side of their role models and that people outside of the field also function as role models [1], [16]. Perspectives of non-binary students is almost non-existing in research on role models in computing education [1]. Because of this, the choice was made to use gender-inclusive language in this thesis, trying to include perspectives from both female and non-binary identifying computing students.

Finally, existing research and interventions typically approach the task of providing female computing students with role models by presenting them with famous and accomplished women in the field. This has typically been done through video interviews, events, or mentoring programs [17], [18]. However, several recent studies have suggested that female computing students often are inspired by their peers or other relatable figures in a similar career or education stage [1], [17], rather than accomplished people that they don't know personally. This motivates the exploration of a different approach to role model interventions, one that helps female students find role models among themselves, teaching them the process of role modeling.

1.2 Research Objectives

Recent research on female and non-binary higher education computing[1] students' relationship to role models is sparse. This was discovered in a systematic literature review (SLR) carried out as a preparatory project fall 2023 [1]. Furthermore, most of the existing video interventions about role models are quite similar to one another. They introduce real-life people with no personal relation to the audience as suggested role models. [17]. Motivated by this, the objective of this thesis is to develop a learning video based on exploration of how role models can support non-male students in completing their computing education.

This research objective based on identified gaps in the literature motivated the following research questions (RQs):

- **RQ1:** How can role models improve retention of non-male identifying computing students in higher education?
- **RQ2:** How to design and develop a learning video about role models for non-male identifying computing students?

1.3 Project Description

This master's thesis follows an empirical Design and Creation approach to developing a digital artifact aimed at improving gender diversity in computing. The research aims to create and evaluate a digital artifact that functions as a vehicle for spreading knowledge and awareness about how role models can be utilized as a tool to improve gender diversity through the Women STEM UP project [19]. The content of the artifact is to be based on new data collection, and the work is guided by findings from the SLR [1], which was completed as preparation for this thesis. The original project description can be found in appendix A.

1.4 Thesis Outline

This thesis consists of the following chapters: Chapter 1 introduces the motivation, project description and research objectives. In chapter 2 the background is presented with an overview and status of essential concepts used in the thesis. Chapter 3 is a summary of the SLR conducted as a preparatory project, while chapter 4 presents and discusses the research methods used in this thesis. In chapter 5, the results from the research are presented. Chapter 6 discusses the findings, how they build on existing knowledge, and how they relate to the research questions. Lastly, chapter 7 concludes the paper and presents some suggestions for future research.

[1] *Computing* will be used as an umbrella term throughout the paper, encompassing all computing-related fields of study, such as informatics, software development, communication technology etc.

CHAPTER

TWO

BACKGROUND

This section presents an overview and status of essential concepts used in this thesis. Section 2.1 presents the history and context of gender, as well as defining the scope of gender in this thesis. The sustainable development goals addressed by this work, as well as how the work contributes toward them are presented in section 2.2. In section 2.3 gender diversity in computing is presented, with a subsection specifying challenges specific to computing education. Section 2.4 briefly presents the theoretical foundation of role models as well as their application in computing education. Finally, section 2.5 presents existing initiatives relevant to this thesis.

2.1 Gender

The terms gender and sex are often conflated with each other. *Gender* is a term that refers to socially constructed characteristics, and because gender is a social construct, these roles, expectations, and characteristics can look different between distinct cultures [20]. *Sex* on the other hand, describes biological attributes like chromosomes and hormones. Judith Butler, American philosopher and gender studies scholar[1], wrote in her book on gender: "Gender is not something that one is, it is something one does, an act a 'doing' rather than a 'being'" [21]. This quote summarizes the definition of gender used in this paper.

Genderqueer or *non-binary* are the two most common umbrella terms used to describe those whose gender identity falls outside of the binary man and woman [22]. The term non-binary was introduced in the early 2000s, but the concept of more than two genders is only new in some cultures. An example of this is the Native American two-spirit people, who are regarded as neither male nor female and have been around since way before the early 2000s [23]. Even though the existing theoretical foundation is sparse, this research will try to include non-binary perspectives. *Non-male identifying* people will be used as an umbrella term throughout the paper to describe people who identify as women and those who identify outside of the gender binary, both a minority in the computing field.

[1] https://vcresearch.berkeley.edu/faculty/judith-butler

This paper addresses gender inequality in computing education and aims to find ways to improve gender diversity. The main challenges for gender diversity in computing are the social norms and expectations tied to one's gender: in other words, the key to increasing gender diversity is related to perceptions of gender, not sex. While some people might experience struggles related to the female reproductive organ in their computing workspace, such as a lack of trash cans for sanitary products in toilet stalls, the main challenges are gender-based such as discrimination [9]. Therefore gender, and not sex will be the focus for this research.

2.2 The Sustainable Development Goals

In 2015 the member nations of the United Nations (UN) made 17 goals for peace and prosperity, now and in the future. They called them sustainable development goals (SDG) and they planned to achieve them by 2030 [24]. SDG 5 is the goal to "Achieve gender equality and empower all women and girls". To make it easier to monitor progress, the SDGs are each split into targets. Each target has specific indicators to tell whether the target is achieved. The research done for this master's thesis will contribute towards targets 5.1, 5.5, and 5.b.

Target 5.1 describes ending discrimination against women and girls [24]. Women in male-dominated education report experiencing discrimination more often than women in female-dominated education like social sciences [10]. Reducing the gender gap in computing education would thus likely work toward achieving target 5.1, by reducing discrimination. Furthermore, target 5.5 describes women's equal opportunities for leadership and effective participation. Giving place to women in the computing field would hopefully also give more women opportunities for leadership in tech companies that currently has a big influence on the world. Lastly, target 5.b describes using technology to promote the empowerment of women. As this thesis will develop a digital artifact to be part of a website aimed at supporting women in their computing studies, this target is also relevant to the contributions of this work. The relevant targets are presented in full in table 2.1.

While progress towards SDG 5 is made directly because of improved gender diversity in computing and the work of this thesis, other goals might be improved indirectly. More diverse software development teams have been shown to increase innovation [6]. Based on this, it can be argued that improving gender diversity in computing might also indirectly contribute towards other SDGs through the increase in innovation for technological solutions.

Table 2.1: Relevant Targets From SDG 5 [24]

5.1	End all forms of discrimination against all women and girls everywhere
5.5	Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic, and public life
5.b	Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women

2.3 Gender Diversity in Computing

The computing industry has struggled with a lack of diversity, equity, and inclusion (DEI) for a long time [9], [25]. Amongst other DEI issues, it is commonly a male-dominated field. The lack of diversity is a problem, and more diversity in the computing industry has been found to have a positive impact, such as more innovation [6], and improved communication in software development teams [7].

There are a few different obstacles that still hinder gender diversity in the computing work force. Women face obstacles such as poor work-life balance, sexism, and glass-ceilings. These obstacles have been identified as some of the most prominent challenges women face as employees in computing jobs [9]. Lack of peer parity, not being surrounded by at least one individual one can identify with, is also a challenge for women working in computing. This causes problems with both social capital and a lack of role models to inspire and give confidence to the working women [9]. These hardships are identified by working women themselves as reasons for them to want to leave their work. Addressing these challenges would be crucial in increasing retention of women in computing jobs.

While there are many ways one can enter the computing work force; a common way is through higher education in a computing program such as computer science or informatics. The gender disparity we see in the various computing industries are present already at higher education [26]. While a lot of the challenges non-male computing employees face are like those of non-male computing students, there are still some differences that distinguish them.

2.3.1 Computing Education

Keyword-analysis and literature reviews in the field of computing education research (CER) reveal that interest in research on gender and diversity in CER has increased in recent years [27]. Keyword analysis also reveals that gender and diversity often appear together with keywords such as K-12 and computational thinking [27], indicating that research on gender diversity often is tied to K-12 education and thus most likely recruitment of students. There is, however, also a problem with retention of female students. *Recruitment* and *retention* are the two focus points for trying to improve diversity in computing education. In this context, recruitment focuses on getting more non-male students to enroll in computing programs at higher education facilities, while retention refers to efforts made to keep non-male students from dropping out or changing their field of study from a computing program.

A big challenge seems to be a negative self-perpetuating cycle created in the relationship between recruitment and retention. Female students in male-dominated academic areas are more likely to consider changing their field of study [10]. As a male-dominated academic area, this is also a challenge for a lot of computing programs [28]. Because it is hard to retain the female students, it is hard to change the stereotypes and perceptions about the types of people that enjoy computing [29], which makes recruitment harder [13], [30]. This cycle goes on and on. Research has shown that drop-out rates for female students decrease when the number of female students increase [28], indicating that recruitment and retention efforts are important together and benefit from each other. However, while the two are benefiting from each other, they should also be studied as individual approaches to closing the gender gap.

The most important reason for studying recruitment and retention efforts separately is that there are different challenges limiting them [31]. Recruitment efforts need to address challenges related to stereotypes about the demographic of computing [29], and the consequent lack of interest in computing from girls [32]. For retention, the obstacles women face are often identified as stereotype threats, discrimination, and poor sense of belonging [8], [10]. In their research on role models in computing education, Drury et al. highlight the importance of being resource-efficient by distinguishing efforts aimed at recruitment and retention in research. By doing this, you avoid stretching the few women in computing thin by giving them tasks of role modeling etc. in addition to their other work. This master's thesis focuses on retention efforts for improved gender diversity in computing.

Numbers at NTNU

Because most of the data generation will be done in computing programs at the Norwegian University of Science and Technology (NTNU), the gender distribution for the programs will be presented to provide context for the results later. Data was collected from students at the two departments: Department of Information Security and Communication Technology (IIK) and Department of Computer Science (IDI). According to numbers provided by Database for Statistics on Higher Education[2], both IIK and IDI had 29% female students overall across all their study programs in 2023 [26]. Five years ago, in 2018, that same number was lower for both departments, indicating a recent increase in female participation. The numbers can be seen as bar graphs in figure 2.1, with IDI to the left and IIK to the right.

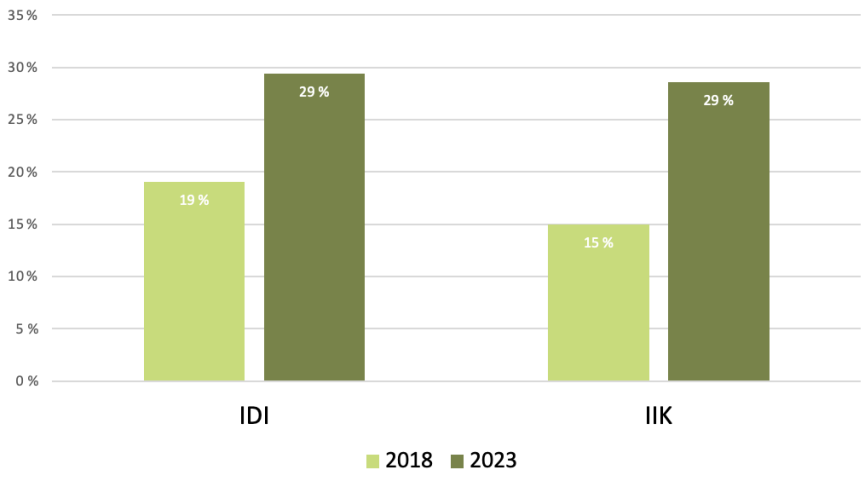


Figure 2.1: Amount of Women at NTNU's Computing Departments 2018 and 2023 [26]

Figure 2.2 presents the trends in participation of female students across relevant computing programs from both IDI and IIK. In 2023, the student mass at both B.Sc. and M.Sc. in informatics consisted of almost 25% female students. For M.Sc. in informatics there has been a significant increase in the past five years. While one could reason that this might be an indication of improved retention of female students from B.Sc. to M.Sc., there is no research to neither confirm nor deny this. For the program Cyber Security and Data Communication[3] there is currently a bigger share of women, with female students making up 33% of the student population, however, this program has experienced a decrease in female participation from 2020 until 2023. No explanation for this could be found.

[2]Because Norway only recognizes two genders [33], no numbers about the representation of non-binary students are available.

[3]This program was launched at NTNU in 2020, which is why there are no available enrollment data for the year 2018.

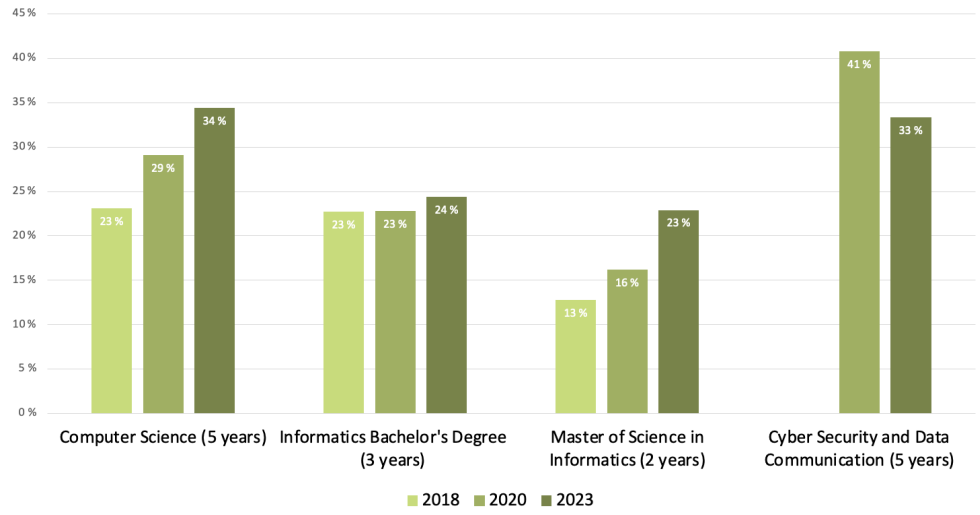


Figure 2.2: Amount of Women in Computing Programs at NTNU 2018, 2020 and 2023 [26]

Numbers in Brazil

Data generation will also be done at two universities in the South of Brazil. However, numbers about female participation in computing programs at these universities were unavailable. Instead, some recent studies and publications about gender diversity in computing will be used to provide information about the status in Brazil. Like what is found in other areas, female computing students in Brazil typically have a lower sense of belonging than their male peers. At the university where the study by Holanda et al. was conducted, female students account for only 15% of the student mass at the Department of Computer Science [34]. A different study of female participation in STEM graduate programs in Brazil revealed that computer science has one of the lowest numbers of female students at both at Master's and PhD levels [35]. These numbers indicate that Brazil has a lower female participation rate in computer programs than Norway does, which might influence the students' experiences with gendered barriers.

2.4 Role Models

Role model is a term used quite often in both everyday conversation and academic research, yet it has proven difficult to find a common academic definition of the term. The Oxford English Dictionary defines it as both "An example or guideline setting out how a task or role is to be carried out" and "A person regarded by others as an example to be imitated" [36]. Looking to the field of social psychology, Lockwood and Kunda [37] studied the effects of so called "superstars" on people's self-concept all the way back in 1997. They stated that superstars are only a source of inspiration if one compares oneself to the "superstar". Thus, it has been reasoned that similarity to the role model is of importance.

Two other significant papers presenting a theoretical framework for role models are by Gibson [14] and Morgenroth et al. [12]. While Gibson's research focuses on role models in a career context, most of the findings are transferable to the context of education as well. Gibson presents a dimensional framework for construction of role models, and suggests that rather than having one role model, it is more common to curate a collection of them [14]. Morgenroth et al. introduces the term *role aspirant* and highlights their role in understanding the effects of role models [12]. They propose that role models serve three main functions: being a source of inspiration, models of how to behave, and being examples of the possible. Role model theory will be elaborated further in chapter 4, as they are a crucial part of the theoretical framework guiding this research.

Role Models in Computing

Role models have been found to make computing more accessible to women [11]. This is because they have been found to have the potential to positively impact female students experience with computing through an improved sense of belonging, disproving stereotypes about women's computing abilities, and increase interest in computing [11], [13]. Based on definitions from the literature and the applied context of computing education, *Role models* in this study are defined as someone who has an impact on students' confidence, sense of belonging, interest, or motivation in computing.

While it has previously been pointed out that women in computing lack female role models [9], researchers disagree about whether same-gender role models are more efficient for female computing students or not [1]. Research by Drury et al. suggest that the gender of the role models might matter more in matters of retention, than with recruitment [31]. Something which was also found in the results of a study done by Cheryan et al. [15].

A variety of groups have been pointed out as potential role models. Teachers are one of these groups [1], [38]. Furthermore, older students have been identified as important role models. Through teacher-assistant positions and mentoring programs, young women get to learn from their older peers and have repeatedly identified them as role models [39], [40]. Finally, a study on family's role in African American women's interest in pursuing computing education found that also family members were good role models. Even when they had no background in computing, the family members served as sources of inspiration for personal qualities such as being a hard worker [41].

Grande et al. [42] suggest that further research should be done on who students report seeing as role models. However, a previous study on computing students' role models revealed that the students are not conscious about who their role models are [43]. Students are not actively reflecting on what people inspire and motivate them. Because of this, it can be hard to get accurate responses when trying to identify role models.

Mentoring

Along with role models, mentoring is often mentioned as being helpful for underrepresented groups in non-diverse academic and industry fields such as computing [44]. Several attempts to define mentoring have revealed a lot of ambiguity. Definitions vary a lot and are often specific to the discipline of the researcher [45], [46]. It is, despite of the ambiguity, common for the definitions to describe a process where a more experienced person, the *mentor*, provides guidance, support, and counseling for a less experienced person, the *mentee* [45]. In undergraduate programs, mentoring has been used to support underrepresented groups as well as for increasing the persistence of students in general [47].

In addition to providing knowledge and close follow-up to the mentee, mentoring has been found to contain an aspect of role modeling as well [45], [46]. However, while the two terms *role model* and *mentor* often are mentioned together, and sometimes can serve a similar function, they describe two distinct relationships. Role modeling is a one-way relationship where the role model does not have to interact directly with the other person to serve its purpose. Mentoring, on the other hand, is an interactive relationship [14]. While not all role models are mentors, all mentors can in theory function as role models. Because of the one-way relationship students have with role models, they have been identified as a less costly alternative to mentoring [14].

2.5 Existing Initiatives

Based on the volume of research suggesting different interventions to improve the gender diversity in computing programs, it is no surprise that there already exists a variety of programs implementing some of these suggestions. At NTNU there are several programs, all aiming to support, inspire and encourage women to complete their education in male-dominated academic fields. This might not be the case across the globe due to different cultural, political and economic circumstances.

Ada

In 1997 the Women and Computing project was started at NTNU to address the persistent decrease in number of female students in information and communications technology (ICT) programs. The program gave promising results and the number of female students increased. However, as the number of activities decreased over the next years, so did the number of female students. The project was re-invented in 2010, now named after computer pioneer Ada Lovelace: Ada, funded by both ICT industry and the university [28]. In its current form Ada's main goal is to support women in completing their technology degree [48], but they also work with recruitment at high schools across the country [28].

Ada's efforts have shown promising results, as the number of women registered in Ada-engineering programs has increased from 2006 to 2019. Although it can't be claimed with certainty that the increase can be credited to Ada, it is reasonable to claim that their work has had a positive effect [28]. Their retention efforts consist mainly of hosting a variety of events for female students. Some are casual social events allowing female students to create bonds and build a peer community, while other events include career professionals to serve as role models for the students [48]. The events aim to improve female technology students' sense of belonging and motivation to complete their degree, increasing retention [28]. All NTNU's computing programs are included in the Ada-program because they have few female students.

IDUN

Funded by The Research Council of Norway and NTNU, "IDUN - from PhD to professor" was a project whose goal was to increase the number of female scientists as permanent academic staff and in management positions at the IE faculty at NTNU [49], of which there aren't currently a lot [18]. Named after Idun Reiten, the IE faculty's first female professor, the project had three main targets to achieve their goal: recruit women to levels between Ph.D. and professor, reduce dropout rates of female scientists, and engage more female scientists in international research projects. IDUN built upon experiences from the Ada project [49]. The program actively utilized mentors and role models to inspire and guide female researchers at all the faculty's departments across NTNU's three locations: Ålesund, Gjøvik and Trondheim. 35 female researchers signed up for the program as mentees [49].

Women STEM UP

Women STEM UP is a European project that aims to tackle the gender gap in Science, Technology, Engineering, and Mathematics (STEM) higher education. Their approach is to eliminate factors such as prejudices and stereotypes that are hindering women in completing their STEM studies [19]. The project is co-founded by the European Union, and it is a collaboration between five different European universities, NTNU is one of them. Five different "work packets" make up the deliverables of the project. The deliverables, in the form of tools and resources, are aimed at lecturers and female undergraduate students [19].

Work Packet 3 is titled "Development of leadership and inspiration academy" and the main goal is to increase the confidence of female STEM students by addressing stereotypes about the perceived masculinity of the STEM field. The final product is expected to be a mentoring program and resources such as leadership stories, career pathways, and posters about role models in academia [19]. This thesis will contribute towards deliverable c) as presented in table 2.2, a video about role models in academia.

Table 2.2: Work Packet 3 - Development of Leadership and Inspiration Academy [19]

Development of a mentoring program that includes:
a) A set of videos, story cards, posters and presentations showcasing women role models. b) Videos, story cards, posters, and presentations of women in STEM leadership roles breaking the cycle of this male-dominated field. c) Role models in academia: videos, story cards, posters d) Directory of existing networks of mentors and mentoring programs that encourage women to pursue careers in STEM. e) A guide with strategies for establishing a mentoring program within STEM faculties as a means to connect female students with STEM professionals (female scientists, researchers, entrepreneurs, innovators) f) A training package for mentors offering guidelines about how to mentor female students.

CHAPTER

THREE

SYSTEMATIC LITERATURE REVIEW

In the preparatory project titled "Role Models as an Intervention for Gender Diversity in Computing Education" [1], an SLR was conducted. The SLR was done as preparation for this master's thesis. The objective was to gain new insights about the state of the art of role models as a research topic in the field of computing education. In total, 16 primary studies were identified. The findings of the SLR revealed several gaps in the literature, some of which will be addressed in this master's thesis. This section presents a summary of the SLR conducted and it's key findings.

3.1 Research Method

Following the guidelines presented by Kitchenham [50], further specified for Software Engineering together with Charters [51], the SLR consisted of these four steps: Identification of research, selection of primary studies, data extraction, and data synthesis. The individual steps of the full process is illustrated in figure 3.1.

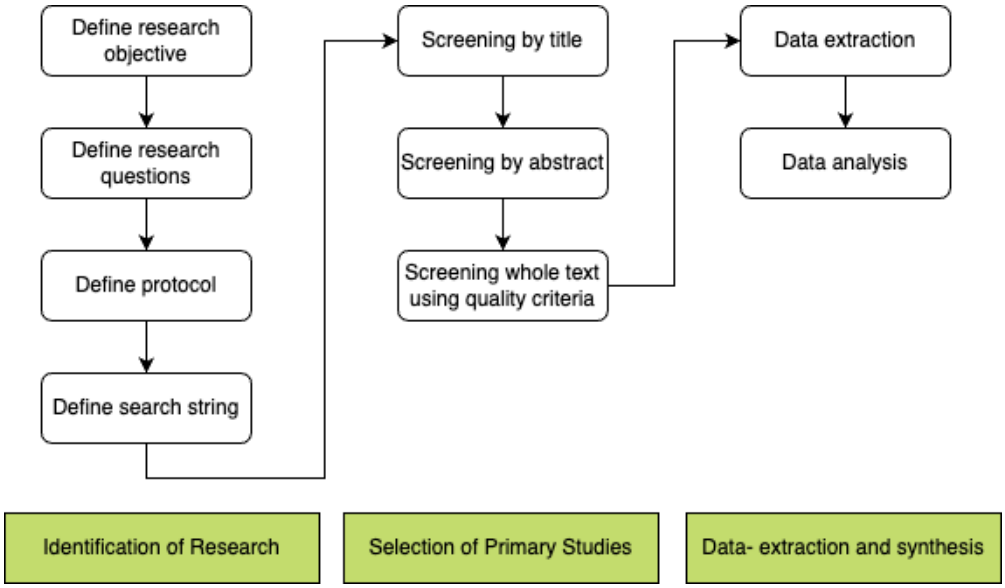


Figure 3.1: Full SLR Process [1, p. 12]

Identification of Research

Providing new insight about the state of the art of role models as an intervention for improved gender diversity in computing education and identifying gaps in the literature for further research were the objectives of the SLR. This research objective motivated the following research questions:

RQ1: What recent research exists that explores the effect of role models on computing students?
Motivation Determine the context and findings of studies on role models in computing education. The research question does not limit it to female students, in order to find data on students with gender identities outside of the binary where this is available.

RQ2:[1] Who functions as role models in computing education?
Motivation Learn what people are typically identified as role models in computing education, why they are considered good role models, as well as what significant attributes these people have. This will be useful to guide future research.

Having identified the RQs, the protocol for the SLR was developed based on the research questions and objective. A set of inclusion- and exclusion criteria, presented in table 3.1, were set. Furthermore, some quality assessment criteria were established to ensure all selected primary studies were proper research disseminated in a purposeful way. These criteria can be found in table 3.3. For the data extraction, a data extraction form was made. This was done before selecting papers in order to avoid bias in the data extraction process [50].

Table 3.1: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
1. The paper addresses one of the RQs 2. The paper has subject area computing 3. The paper mentions role models in the abstract or as a keyword 4. The study is done in the context of education	1. The paper is not in English 2. The paper is published before 2013 3. The paper is duplicate work by the same author, presenting similar results

Table 3.2: Search Query

Database	Search Query	Hits
Scopus	TITLE-ABS-KEY (("Role Model") AND ("Computer Science" OR "Computing" OR "Informatics") AND ("Gender" OR "Wom*n" OR "Girl*")) AND PUBYEAR > 2013	136

Using keywords from the RQs a search query was defined. As instructed in the guidelines by Charters and Kitchenham [51], the search query was developed in

[1] In the preparatory project RQ2 was further divided into two sub-research questions. These have been omitted in this summary to simplify the presentation of the findings.

iterations. This process was done by trying and failing with different keywords. 'Recent research' as expressed in RQ1, was defined as research published within the last 10 years. The final search query can be found in table 3.2. The chosen data source was Scopus[2], which is an electronic database containing peer-reviewed studies and published books. Supplementing with other electronic databases such as Google Scholar, ACM Digital Library, and IEEExplore could have provided more robust findings, but the time frame of the project limited the search to only one data source.

Table 3.3: Quality Assessment Criteria

Quality Criteria
1. The study is empirical
2. The study is available and complete
3. The study comments on the effect role models has on non-male students attitude towards computing
4. The study is based on research
5. The study has a clear aim
6. The context of the study is clearly described
7. There is proper use of English in the paper

Selection of Primary Studies

The selection process of the primary studies was done in iterations. The search query applied in Scopus returned a total of 136 potential studies. In the first round their title and abstract were used to include and exclude studies based on the inclusion and exclusion criteria, made to ensure the studies selected related to at least one of the RQs. After this step, 42 studies were categorized as 'include'. Thus began the next round, quality assessment. The full paper of all the 42 potential studies were assessed according to the criteria in table 3.3. The goal of evaluating all studies based on the quality criteria was to ensure that only empirical studies of high quality were included. This final step resulted in a final number of 16 primary studies.

[2]https://www.scopus.com/

Data Extraction and Data Synthesis

Data extraction was done using the data extraction form that was made initially as part of the protocol. The form contained two main sections: 'Study description', documenting general information and context of the studies, and 'study findings', documenting key findings of the studies as well as how they relate to the RQs. Ideally, a data extraction process in an SLR should be done by two or more authors [50]. Because this was not a possibility, a test-retest process was used instead to check consistency of the data extraction. A descriptive synthesis was used for data synthesis to identify themes from the studies and again, how they relate to the RQs.

3.2 Synthesized Results

To answer the RQs the search query defined in table 3.2 was used. After identification of research and selection of primary studies, a total number of 16 primary studies were found relevant to the RQs. This section presents a summary of the most important findings from the SLR. In table 3.4 and 3.5 an overview of all the primary papers can be found.

Table 3.4: Overview of the Primary Papers [1, p.17-18]

Study [1]	Title
S01 [52]	Advertising CS/IT degrees to female students in Australia
S02 [53]	Barbie, I Can('t) be a Computer Engineer: the Impact of Barbie Text and Images on Girls' Computing Performance
S03 [39]	Computing, girls and education: What we need to know to change how girls think about information technology
S04 [40]	Effective Strategies for Encouraging Girls in Informatics
S05 [54]	Female preservice teachers stereotype computer scientists as intelligent and overworked White individuals wearing glasses
S06 [55]	Females in computing: Understanding stereotypes through collaborative picturing
S07 [56]	Fostering High School Girls' Interest and Attainment in Computer Science
S08 [57]	How are Primary School Computer Science Curricular Reforms Contributing to Equity? Impact on Student Learning, Perception of the Discipline, and Gender Gaps
S09 [58]	Participant-centred planning Framework for effective gender balance activities in tech
S10 [59]	Rural Implementation of Girls' Programming Network (GPN)

Table 3.5: Overview of the Primary Papers (Continued) [1, p.17-18]

Study [1]	Title
S11 [60]	The Grad Cohort Workshop: Evaluating an Intervention to Retain Women Graduate Students in Computing
S12 [61]	The impact of teacher gender on girls' performance on programming tasks in early elementary school
S13 [41]	The Role of Familial Influences in African American Women's Persistence in Computing
S14 [62]	Towards more gender diversity in CS through an artificial intelligence summer program for high school girls
S15 [63]	Using social cognitive career theory to understand why students choose to study computer science
S16 [64]	"RemoteMentor" Evaluation of Interactions Between Teenage Girls, Remote Tutors, and Coding Activities in School Lessons

[1] The primary papers are sorted alphabetically and given an ID in the format S#, ranging from 01 - 16. The S is short for study.

3.2.1 RQ1: What recent research exists that explores the effect of role models on computing students?

This section presents an overview of the primary papers' publication year and country together with the design of the studies in order to provide context to the research done in the primary studies.

Publication Year and Country

When analyzing the publication year of the 16 primary studies, there appears to be an increase in studies in recent years. However, the numbers are inconclusive due to spikes in different years. E.g. there were four studies published in 2018, none in 2019, and then three again in 2020. Also, with a number as low as 16 it is not as useful to look for trends. To provide more insight into the matter, publication year of all 136 studies returned by the search query were extracted. Displayed in figure 3.2 is the results of this. With this sample size it is easier to identify trends, and we can see a steady increase in published studies within the past ten years. The spikes in 2018 and 2020 can be seen in this figure as well.

Included in the data extraction form was information about the publication country of the primary studies. The results are presented in figure 3.3. Each bar in the graph represents a country, and the bars are grouped together by their continent. Looking at the countries individually the US sticks out as a country with a lot more publications than the rest. When grouping by continent, however, North America, with seven, and Europe, with six, are separated by only one study.

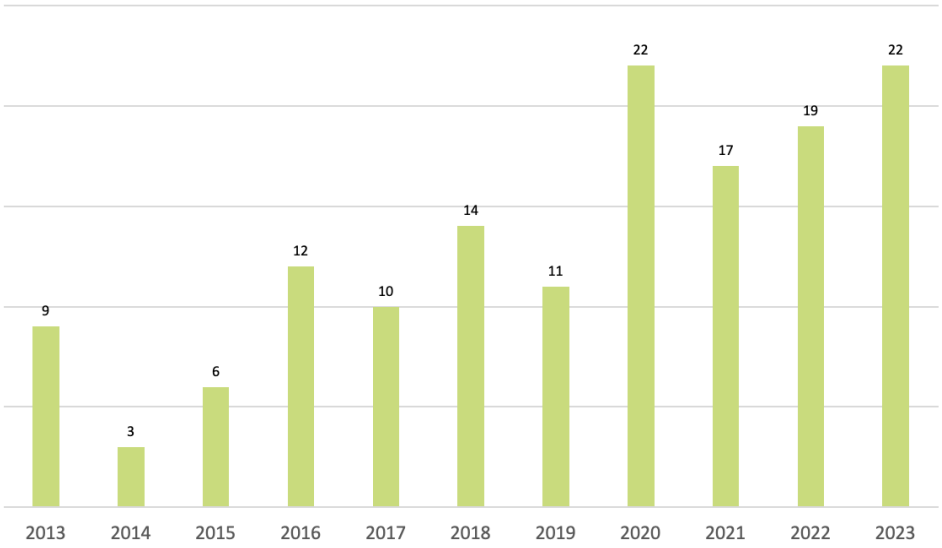


Figure 3.2: Publication Year of all Query Results [1, p. 21]

Grouping by continent also reveals that several continents are missing entirely from the collection of primary studies: Africa, South America and Asia are all part of what is by some referred to as the *Global South*. All countries and continents represented are considered a part of the *Global North*. The terms "Global North" and "Global South" are used to distinguish different economies of the world, categorized by: politics, technology, wealth, and demography of the country [65]. In other words, the primary studies lack diversity.

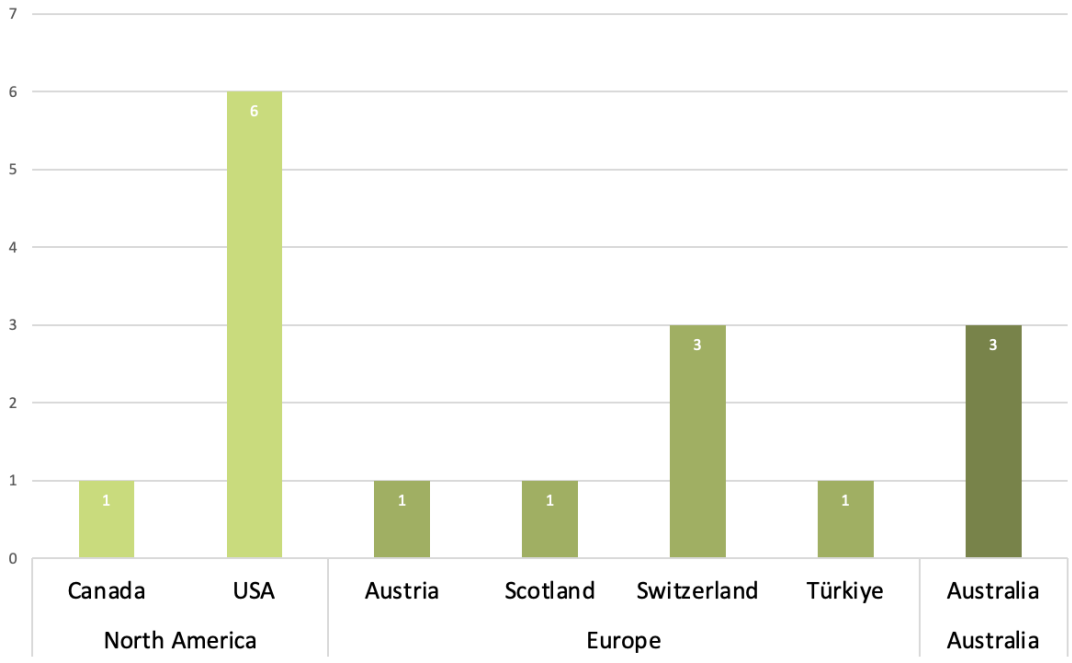


Figure 3.3: Publication Country of Primary Studies [1, p. 19]

Study Description

Out of the 16 primary papers, case study was the research strategy of 10 of the studies. Five had survey as their strategy and the final study used more than one research strategy. The high number of case studies is a reflection of the fact that most research done on this topic is evaluations of specific interventions and programs. While this is helpful insight for others wanting to develop a similar program in a similar context, the findings are limited and not as generally applicable as other research methods.

The overview of the primary studies presented in table 3.4 and 3.5 includes the title of all the studies. Reading though each of them tells us that none of the primary studies have the term *role model* included in their title. As required by the selection criteria of the SLR, all the studies present findings on the effects of role models in computing education, it is however evident that this is seldom the sole focus of the research. As an example, S03 investigates an intervention program aiming to increase girls' interest in and confidence with computing, but the program consists of more variables than the use of role models.

The pie chart in figure 3.4 presents the distribution of whether the studies focused on recruitment or retention. 81% of the primary studies focused on recruitment as a way of improving the gender diversity in computing education. Their aim is to increase girls' interest in computing by addressing the barriers that keep them from entering computing education. Role models are used as a tool for addressing these barriers. Only S11 and S16 focused on retention. They are both case studies on programs aiming to improve retention of female computing students [60], [64].

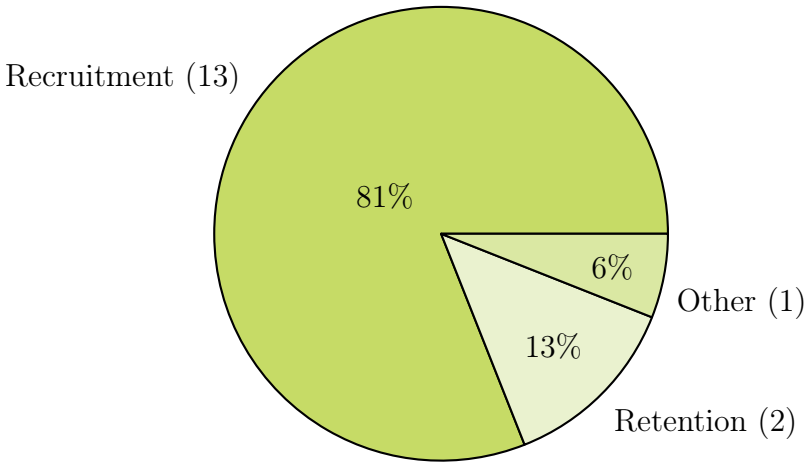


Figure 3.4: Study Focus [1, p. 25]

The dominating focus on recruiting efforts is also evident when looking at the sample population for the primary studies. Only four of the primary studies had students of higher education as part of their sample. The remainder of the studies were mostly done on kindergarten through 12th grade (K-12) students, usually trying to recruit high school girls into computing courses.

Also noteworthy is the fact that none of the primary studies reported findings on gender identities outside of the binary. While multiple studies allowed for participants to identify with non-binary genders, none had enough data to present findings related to non-binary gender identities. This is still a big gap in the research on role models' impact on gender diversity in computing education.

3.2.2 RQ2: Who functions as role models in computing education?

Educators[3] and older students were the most commonly identified group of people to function as role models. Each group were mentioned in seven different primary studies. The findings indicate that these people are considered role models because they share their interests and personal experiences in computing. In S16, the students and tutors only shared a task-based relationship, and thus the students did not develop a role model relation to their tutors [64].

Girls' lack of interest in computing has often been accredited to stereotypes about the people who study computing, people with attributes that a lot of girls don't relate to [30]. A thematic analysis of data from the data extraction form revealed that role models can improve sense of belonging and interest by disproving these stereotypes. Female participants of S03 expressed that seeing that women enjoy working in computing made an impact on them [39]. Also in S07 some participants raved about the role models passion for coding, and explicitly stated that this inspired them [56]. These findings suggest that expressing passion and knowledge is important attributes for successful role modeling.

Findings on which attributes of the role models that had an impact on their effectiveness was limited and inconclusive. Five studies highlighted same-gender as an important attribute. However, other studies found that gender was not of importance. In a survey administered in S09 42% of respondents stated that they were inspired by a role model to pursue a career in computing, yet less than half of these girls identified their role model as a woman [58]. Another attribute that was highlighted is proximity of age. This was only mentioned in tree of the studies, but was never contradicted like gender was.

3.3 Conclusion

A systematic literature review was performed to provide new insights about recent research on the effects of role models on computing students, especially non-male

[3]Teachers, professors, and other people in a teaching position at K-12 or higher education

identifying students. 16 primary studies from 2016 - 2023 were identified and revealed that there is a lack of systematic research on the effects of role models specifically. Most studies are case studies utilizing role models as only a part of a recruitment program to get more girls to enroll in computing education.

The analysis of publication country for the primary studies revealed another gap in the literature: The distribution was uneven with the USA as the biggest contributor. More alarming, however, was the fact that no parts of the Global South were represented in the findings. The effects of this is a significant lack of nuance and diversity in the findings presented.

The primary studies identified teachers and students as people who often are considered role models. Findings indicate that role models can be helpful in increasing gender diversity in computing education, as role models have been found to increase interest and sense of belonging by disproving harmful stereotypes. By sharing personal experiences in computing, the role models serve as good examples of the possibilities for young girls.

All of these findings are, however, limited to the context of K-12 education, as samples of higher education students already enrolled in computing was very sparse. Specifically recruitment in K-12 education. While these findings can provide a starting point for future research on role models in higher education computing, more research should be done to fill the current gaps.

Thesis Motivation

The SLR identified the need for research on role models in the context of higher education computing programs. Especially, how role models can increase retention of female and non-binary students enrolled in these programs. Findings from K-12 samples indicate that role models can positively influence students sense of belonging in the computing field. Because of these findings, this master's thesis will explore if a similar effect can be achieved for higher education computing students. Based on the findings from the SLR it will also aim to include a more nuanced and diverse data sample by including insights from the Global South.

CHAPTER

FOUR

METHODS

The purpose of this study is to develop a learning video based on exploration of role models as an intervention for improved gender diversity in computing education. To achieve this goal, the Design and Creation Method has been chosen as an appropriate research method. The research method is deemed fitting to help answer the research questions, which aim both to provide new knowledge and to create an intervention. This work is guided by the findings of the SLR done in the preparatory project [1].

4.1 Research Questions

The findings of the SLR presented in chapter 3 revealed, amongst other things, a lack of research on the ability of role models to improve retention of female computing students. There was also a lack of research on students in higher education, as most of the studies had a recruitment focus. The findings were also lacking valid research on the experiences of non-binary computing students [1]. This motivated the exploration of the role models of non-male identifying computing students at the university level.

The SLR also revealed that there is a lack of interventions concerned only with role models for improved gender diversity in computing. Role models are often implemented as part of recruitment programs, but their effectiveness is seldom researched in isolation [1]. Based on these identified gaps in the current literature, the objective of this study is to develop a learning video based on exploration of how role models can support non-male computing students in completing their education. This research objective motivated the following two research questions:

RQ1: How can role models improve retention of non-male identifying computing students in higher education?
Motivation Explore if and how role models can improve non-male identifying computing students' motivation and confidence, and thus increase the chances of them completing their education. What groups of people that qualify as role models and what makes them effective will also be explored to answer this RQ.

RQ2: How to design a learning video about role models for non-male identifying computing students?
Motivation Develop suggestions for how to successfully design a digital intervention in the form of a learning video, to be used for improved retention of non-male identifying computing students.

4.2 Theoretical Foundation

The topic of gender diversity in computing education is an interdisciplinary field of research, and thus theories from different disciplines have been used. The research process contains theories from psychology, career development, and educational theory. This section presents the theories that define the conceptual framework for the research process.

4.2.1 The Motivational Theory of Role Models

This subsection presents theory related to role models. The theoretical foundation defined here is the basis for development of the interview guide for the semi-structured interviews and the analysis of the results. The theory is based on research done in the fields of psychology, by Morgenroth et al. [12], and career development, by Gibson [14].

Role Models

Based on definitions in the two disciplines, there are two important aspects of a role model: what makes someone qualified to be a role model, and what function does a role model serve. Role models are created by the role aspirant because role models have some similarity to the role aspirants, and they portray a characteristic which is seen as beneficial to the role aspirant [14]. Furthermore, a role model is defined by the function they serve for the role aspirant: Here, Morgenroth et al.[12] highlight three main functions, overlapping with those mentioned by Gibson [14], that role models either show how something should be done, show what is possible, or make a goal seem desirable. In other words, role models are behavioral models, representations of the possible, and inspirations for role aspirants [12].

Both papers highlight role models' part in developing a self-identity for an individual. With their respective approaches to defining a role model framework, they elaborate on how role models can change an individual's perception and stereotypes of a group, often one they identify with themselves, an *external factor* [12]. Role models can also influence how someone views themselves, and define their self-concept, the perception someone has of themselves, an *internal factor* [14].

Dimensional Framework

Gibson presents a dimensional framework to define how people collect a variety of role models for different purposes based on their goals and aspirations [14]. This framework consists of two main dimensions: the *cognitive* dimension and the *structural* dimension, each one containing two sub-dimensions. Table 4.1 presents the full dimensional framework created by Gibson.

The cognitive dimension describes what the role model does for the role aspirant. It consists of the two sub-dimensions positive/negative and global/specific. The *positive/negative* dimension says something about whether the role model serves as an example of how one wants to behave, or how one does not want to behave. Whether a role model is *global* or *specific* is dependent on whether they encompass a variety of attributes regarded by the role aspirant, such as traits, skills, and behaviors, or only a single or small set of attributes [14].

The structural dimension describes the role aspirant's relation to the role model with its' two sub-dimensions: close/distant and up/across or down. *Close/distant* describes how well the role aspirant knows the role model, where a close role model is someone they interact with frequently and a distant one is someone outside of their regular network. The *up/down* dimension on the other hand, describes whether the role model is higher in relative hierarchical status or if they are across or down from the role aspirant [14].

Expectancy-Value Theory

Expectancy-value theory is used as a framework for how Morgenroth et al. describe the motivational theory of how and why role models are beneficial to role aspirants. Expectancy-value describes the relationship between expectancy for success at an achievement and the value of completion in motivating someone to complete said achievement. They argue that role models can influence both the students' anticipation of success and their perceived value of obtaining the goal, in other words: role models can increase motivation. The motivational theory is proposed through four propositions, presented in table 4.2.

Table 4.1: Gibson's Dimensions of Role Models, With Criteria [14, p.144]

Cognitive Dimensions	
Positive Refers to a role model having attributes which are perceived by the individual as similar, are admired and sought out for possible emulation	**Negative** Refers to a role model having attributes which are primarily observed by the individual as examples of how not to behave in a particular context
Global Refers to a variety of attributes in a role model which are attended to by the individual, including skills, traits, and behaviors	**Specific** Refers to a single or small set of attributes in a role model which are attended to by the individual
Structural Dimensions	
Close Refers to a role model who is in the same workgroup or department, and/or with whom the individual interacts with frequently	**Distant** Refers to a model who is outside the individual's workgroup or department, and with whom the individual interacts infrequently or not at all
Up Refers to a role model who is higher in hierarchical status than the individual	**Across/Down** Refers to a role model who, in relation to the individual, is a peer, a subordinate, or who is ambiguous in status (e.g., a client)

Expectancy is influenced both by the perception of external factors and internal factors. Role models as representations of the possible serve as examples of the success in overcoming obstacles such as negative stereotypes. Seeing other female students successfully complete their computing education and secure a prestigious job might reduce the perceived importance of barriers such as discrimination based on gender, external factors, and increase other female students' perceptions about their own abilities, internal factors. Both will increase the female students' expectancy of succeeding in completing their education[12].

Role models can also increase the perceived value of completing a goal, such as completing one's education. By serving as inspiration, admiration of role models can inspire new goals or increase the perceived value of existing goals. As an example, admiring a person who has completed their education and landed a well-paying job might increase the perceived value of completing one's own education based on the consequences of attaining that goal [12]. Similarity is once again an important piece of the puzzle. Morgenroth et al. reference the work done by Cheryan et al. showing that interacting with similar computer science students have had a lasting positive effect on the female students' interest in computer science [11], and thus increasing the value of completing a degree in computer science.

Table 4.2: Four Propositions by Morgenroth et al. [12]

Proposition 1	Perceived goal embodiment influences expectancy, and in turn motivation and goals, by prompting vicarious learning.
Proposition 2	Perceived goal embodiment and perceived attainability interact to influences expectancy, and in turn motivation and goals, by changing self-stereotyping
Proposition 3	Perceived goal embodiment and perceived attainability interact to influence expectancy, and in turn motivation and goals, by changing perceived external barriers
Proposition 4	Perceived desirability influences value, and in turn motivation and the adoption of new goals by prompting

4.2.2 Learning Video

As a foundation for how to develop a learning video, inspiration has been taken from educational theory. This section presents relevant theory from the discipline and how this serves as justification for choices made in development of the learning video. Design practices are developed based on a particular need. In this case, the need is to disseminate knowledge and inspire non-male computing students.

Educational Theory

According to Fyfield et al., instructional videos are most commonly designed with the principles of cognitive theory of multimedia learning (CTML) in mind. The main idea of CTML is that using a combination of words and pictures enables the student to learn more quickly [66]. CTML is not based solely on videos, but also other instructional media such as learning books. Because of this, it should not be used as a rule all template for learning videos [67].

A recently completed SLR presented a comprehensive list of empirically supported design principles for instructional videos. This SLR supports some and weakens other principles from CTML. The total list of design principles found in the review has a varied evidence base. As part of the SLR protocol, a design principle was deemed to have strong support if it had been studied at least six times and its benefits had been successfully replicated twice as many times as it failed. A total of 6 principles fits with these criteria, presented in table 4.3. These 6 principles will serve as the main theoretical foundation when developing the learning video.

Table 4.3: Design Principles of Instructional Videos [67, p. 161-162]

1	*Coherence* *	Only material directly related to the learning goal should be included
2	*Embodiment principle* *	Human movement or gestures should be included, e.g. showing hands when assembling
3	*Integrating learning activities*	Practice activities should be included, either in pauses or after the video
4	*Learner control*	Audience should have control over playback
5	*Segmenting* *	Longer videos should be broken down into meaningful chunks
6	*Video length reduction*	Shorter videos are more effective

* Included in the principles of CTML

4.3 Design and Creation

Since the research objectives was to develop a learning video about role models for non-male identifying computing students, the Design and Creation strategy's focus on development of new Information Technology (IT) artifacts seemed fitting. With Design and Creation as a research strategy, the artifact itself is considered one of the main contributions to knowledge [68]. In this master's thesis, the artifact, the learning video, serves as a vehicle for something else, the exploration of the impact of role models.

Oates et al. describe five steps of the Design and Creation research strategy. The steps are not conducted strictly in a linear fashion, but rather iterative and fluidly, always affecting one another. The five steps are as follows:

Awareness

The first step in the Design and Creation strategy is awareness. At the core of this step is the recognition of a problem [68]. The SLR [1] done as a preparation for this master's thesis is an important part of the awareness step. The review revealed the problem that there is little knowledge about role models for higher education non-male computing students. However, since the SLR revealed gaps in recent research that this master's thesis seeks to address, more awareness is needed to properly carry out the next step.

Because the problem to be solved, uncovered in the awareness phase, is dropout rates amongst female and non-binary computing students, the intended *user group* for the video is non-male computing students. The artifact is expected to be used as part of the material for the Women STEM UP project, as introduced in section 2.5.

In order to gather new knowledge and awareness about the problem for the first iteration of the artifact, qualitative data was collected through conducting interviews. The purpose of the data collection was to help answer RQ1 and to identify what newly gathered knowledge needs to be included in the learning video, as well as to inspire creative ways of presenting it. Since Design and Creation is an iterative process, the data collection done in the evaluation phase also contributed towards the awareness phase in development of iteration 2.

Suggestion

In the suggestion step, an idea of how the problem can be addressed is developed, ideally using creativity and knowledge in combination to contribute something new and innovative with higher value [68]. The author combined the knowledge gained through analysis of the interview data and pre-existing theory from the design principles presented in section 4.2.2 to brainstorm ideas for the prototype.

As an iterative process, the suggestion step was conducted several times. After evaluation of the first iteration of the prototype, a new brainstorming phase was completed to create ideas about how to improve the learning video based on feedback from the evaluation.

Development

In the development phases, the ideas from the suggestion phases were implemented. The development strategy of prototyping was used in these phases. Specifying a development methodology is important to achieve traceability in the development of Design and Creation, and to show how the product has moved from awareness all the way to the final result [68]. With prototyping, an initial version, a prototype, is designed, implemented, and analyzed before a revised prototype is produced. This process continues in iterations until a satisfactory implementation is produced. This strategy has the advantage that a full understanding of the problem is not necessary before starting implementation, which is useful in this case when the existing research on the topic presented is sparse [1].

Evaluation

In the evaluation phase, the artifact, in this case a learning video, is evaluated. Another important part of this phase is assessing ways in which the artifact might deviate from the expectations set in the awareness step [68].

The artifact will be evaluated with the goal of establishing *proof by demonstration*. It will be tested on non-male students, the intended end users, however it will not be tested in a real-life context. The evaluation will be done through focus groups. Focus groups were chosen because they are helpful in product development and time efficient compared to single person observations or surveys [69]. The focus groups consisted of showing of the video(s) and discussion based on a questioning route.

Some evaluation criteria were created to ensure the quality of the final product. Evaluation criteria should reflect the purpose of developing the artifact [68]. Considering the research objective, the purpose of developing the artifact is to create and spread new knowledge about role models for higher education non-male computing students as an intervention to improve retention. Based on this purpose, the following elements were evaluated in the focus groups:

- To what extent does the video present new knowledge?
- To what extent does the video inspire the students that watch it?
- To what extent does the visual elements of the video help convey the knowledge and inspire?

Conclusion

The final step of the Design and Creation process is the conclusion. An important part of the conclusion is presenting how the knowledge acquired through the development stages can be generalized to other situations so that others can benefit and learn [68]. The contributions and outcome of the thesis are presented in chapter 6.

4.4 Data Generation Methods

Individual semi-structured interviews and focus groups were chosen as data generation methods to collect qualitative data. The one-on-one interviews were intended to be the main source of data collection to help answer RQ1, as well as create awareness for the learning video that will be developed for RQ2. The data collected in the focus group will mainly contribute toward RQ2, while supplementing RQ1 in the discussion. The timeline of the data generation process can be seen in figure 4.1. None of the primary papers of the SLR conducted, included samples of students from countries considered part of the Global South [1]. To add to this gap in the literature, data gathering was conducted not only in Global Northern Norway, but also in Global Southern Brazil. The data generation methods and the reasoning for the choices made will be elaborated further in this section.

4.4.1 Interviews

Interviews were chosen as a data generation method because detailed information is wanted to answer the RQs. It will also allow for a more personal relationship to the participants which in turn might make them more likely to open up and share honestly, in addition to allowing the researcher to ask immediate follow-up questions [68]. Using an interview instead of a standardized test also allows for customizing each interview to get the most out of each participant as their experiences are unique and might demand different approaches [70]. While a questionnaire would likely be able to provide a bigger quantity of responses, for this exploratory research objective a qualitative data gathering was found more beneficial to get more in-depth and nuanced results.

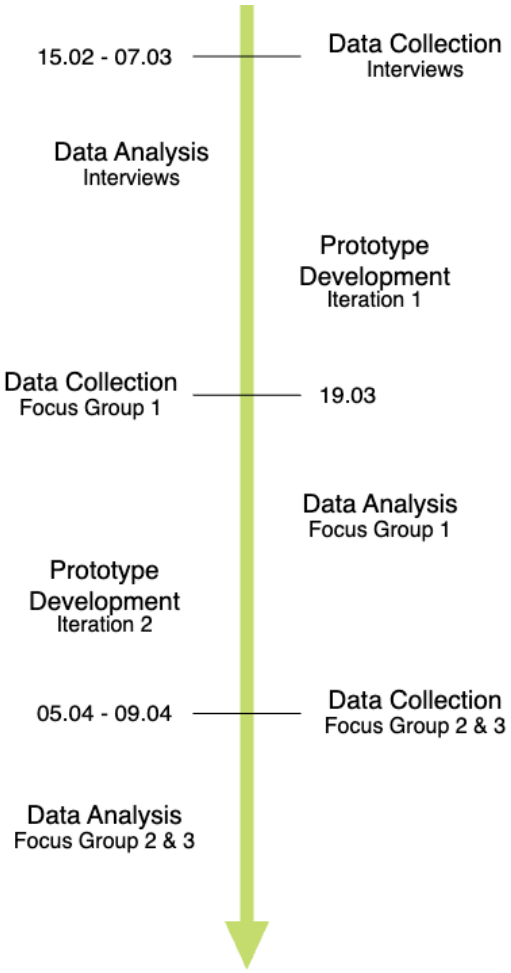


Figure 4.1: Timeline of Data Collection

A semi-structured approach was chosen for the interviews. A structured interview has the benefits of a more predictable outcome which makes it easier to ensure the interviews answer the RQs. However, you lose one of the main benefits of using interviews instead of questionnaires: flexibility. Doing semi-structured interviews allows for predictability and structure while still being able to adapt to the participant and ask follow-ups or change the order of the questions to get more relevant information, when applicable [68].

Because memory can be unreliable and prone to bias, the interviews were recorded. To give the participants as much privacy as possible and because video was not strictly necessary, audio recordings were done. Transcribing was also an option, however, since the work is carried out by a single author it was ruled out due to challenges with transcribing and being an attentive interviewer at the same time. Recording allows the author to focus solely on the process of interviewing, making the participant feel more seen and heard [68]. The audio recordings will, however, be supplemented by field notes taken during the interview. These notes will be limited to only include supplements that won't be captured by the audio recording such as notable ambiance or facial expressions made by the participant.

As part of the preparation for the interviews, a practice interview was conducted. This is highly recommended to ensure that the technical equipment works, and that the process runs smoothly with the actual participants [68]. The practice interview was also used as an opportunity to ensure that the questions gave answers that were helpful in answering the RQs. A close friend of the author was used to conduct the practice interview, as recommended by Oats [68]. While Keats suggests doing test interviews with a bigger sample and even several iterations [70], time restraints did not allow for that. The practice interview was still helpful in both ensuring audio recordings worked well, and to suggest slight changes to the questions in the interview guide.

Questioning Route

As preparation for the interview, an interview guide with a complete questioning route was developed. This is done to ensure that the interviews help answer the research question and is also a requirement for the SIKT application which will be explained in section 4.6. The interview guide describes what will happen in the interview and highlights important information for the participant: an introduction to the contents of the interview, a token of appreciation for participating in the interview, as well as information about the participants informed consent. Finally, the interview guide also consists of the questioning route that guides the interview.

The question route was structured sequential with simple feedback loops, which both allows the researcher to do a deep dive into answers given by the participants and is also more satisfying to the participant as their answered are referenced and they feel heard [70]. All questions are open ended, as exploration rather than verification was the objective of this study [68]. Additionally, open-ended questions avoid the possibility of the author's preconception about the topic influencing the answers of the participants, like they might have been with multiple-choice questions. Like suggested by Keats [70], the interview starts with more general questions and then moves on to the more specific questions. The interview ends with a closing remark including gratitude towards the participant to let them know that their efforts in participating is appreciated.

The questions in the questioning route are mainly based on the findings from the SLR [1]. Because the SLR did not reveal enough findings relevant to higher education and retention, as well as a thin theoretical foundation on the concept of role models, some additional literature has been used to motivate the questions: the work of Morgenroth et al. [12] and Gibson [14] presented in section 4.2.1. All dimensions of role models, as displayed in table 4.1, have been covered by the open-ended questions. Because computing students have been found to not have a conscious relationship to who their role models are [43], most of the questions do not explicitly use the term "role model". Instead, the questions use different aspects of the definition of a role model. An example is question v) in the interview guide: "Who do you look up to / admire in your everyday life as a student?". To overcome potential confusions about the concept of role models, the author directed interviewees' attention to their experiences with being inspired by someone.

The complete interview guide can be found in Appendix B.

Sampling

Non-probabilistic sampling techniques were chosen to recruit participants for the interviews. While non-probabilistic sampling does not provide a good basis for generalization of the findings to a larger population [68], the limited time frame of the master's thesis makes it hard to get a sample big enough for generalization of the findings anyway. A combination of snowballing and purposive sampling was chosen as the sampling technique. Self-selection sampling was also considered as an option due to its ability to save time in the sampling process, however, this often leads to primarily people with strong feelings on the topic to register and thus it was ruled out to avoid this potential bias in the data [68].

While purposive sampling will allow the author to purposefully diversify the background of participants through selection, snowballing will ensure some sort of randomization to the sample to avoid bias from the author's selection of participants [68]. Combining it with purposive sampling is crucial to maintain some way of representing as much of the sampling frame as possible, as well as ensuring that the interview objects' attributes and experiences would be relevant to answer the RQs. When asking participants for nominations through snowballing, the researcher explained that respondents needed to be female or non-binary computing students in higher education.

The goal was to obtain a sample size of 10 participants in total. A sample size of 6-12 has been recommended for a Master's project using interviews as a data generation method [71] and considering the allocated time frame 10 participants was deemed fitting for the scope of this research.

4.4.2 Focus Groups

Focus groups or group interviews were chosen for data gathering in the evaluation of the prototype and as a diversifying supplement to RQ1. Focus groups are effective at guiding product development, and a fitting choice for the evaluation of a prototype [69]. While focus group participants should not make decisions directly, the knowledge they generate can be used to make informed decisions by the researcher [69]. Focus groups were also chosen because of their ability to provide insight into the different perspectives of a group of people and because of the benefits of conversation sparking between participants facilitating reflection and discussion. Figure 4.2 shows how focus groups were used to develop the learning video.

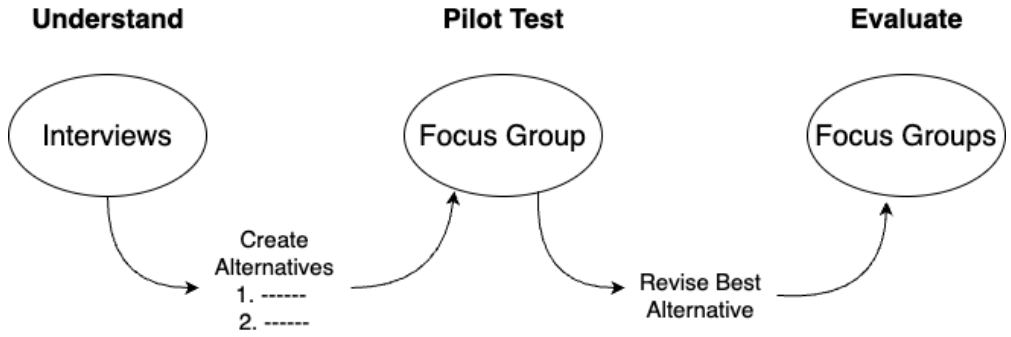


Figure 4.2: Iterations Through Focus Groups, Inspired by [69]

A total of three focus groups in two different rounds were planned. In the first round, a focus group in Norway was planned with the main objective being to pilot test different alternatives for an approach to a learning video about role models. The second round consisted of two focus groups conducted in two cities in the south of Brazil: Porto Alegre and Curitiba. These focus groups evaluated a revised version of the best alternative from the pilot test done in Norway. Responses regarding role models from all three focus groups were also used as a supplement to the one-on-one interviews to answer RQ1. While it is generally considered best practice to conduct several focus groups for each iteration of a development cycle to diversify the findings and make them more robust [69], the time limitations of the master's thesis made this impossible.

To capture the discussion in the focus group, a computer transcript approach was used. To allow the author to put more focus on the role of being moderator as suggested by Oats et al. [68], a friend of the author was called in to be a transcriber in the focus group conducted in Norway. This was however not a possibility in Brazil, so in those focus groups the researcher served both as transcriber and as facilitator.

Questioning Route

Similarly to what was done for the one-on-one interviews, an interview guide was created to guide the execution of the focus groups and to get SIKT approval for the data collection. The interview guide contained information about the content of the focus group, voluntary and informed participation, a questioning route and a thank you to the participants for taking part in the focus group.

The questions in the interview guide for the focus group were developed based on Krueger and Casey's [69] recommendations for a questioning route: Starting off with an introductory question and a few transition questions before the key questions which will take up most of the time. Finally, some ending questions to finish off the session. This structure was chosen to help facilitate conversation between participants [69]. Emphasis was put on the fact that the questions should be clear, open-ended, and one-dimensional, as well as being relevant to answer the RQs by focusing on the three evaluation criteria presented in section 4.3.

For the first focus group, the one in Norway, the participants were pilot-testing two ideas for a learning video. Participants watched and discussed each video separately before moving on to a separate part of the questioning route specific to this focus group: comparison. Participants were asked to discuss the advantages and disadvantages of each video, both in content and form. Finally, they were asked to choose which one they preferred [69]. These comparison-questions were only included in the pilot test in Norway.

The full interview guide with question route can be found in appendix B.

Sampling

For the focus group in Norway, recruitment was primarily done through a signup sheet presented as part of a presentation the author held at 'Catch IDI', a conference for students and professors at IDI, NTNU. In total 8 people signed up through the form. Because a size of 5-8 people is considered fitting for a focus group [69] all 8 were invited to participate. However, since the participation rate amongst these participants was only 13%, more students were recruited through purposive sampling to provide a big enough sample for the session.

As suggested by Krueger and Casey [69] when conducting cross-cultural focus groups, the data collection in Brazil was done in collaboration with professors participating in the Software Engineering Norway Brazil (SENOBR) project[1], a software engineer collaboration project between universities in Brazil and NTNU. They are established in the community and have links with established students that could participate. Professors at the local universities were responsible for recruitment. Both professors used purposive sampling to ensure that all participants' gender and education would be relevant to answer the RQs.

4.5 Qualitative Data Analysis

For the analysis of all qualitative data collected through interviews and focus groups, *reflexive thematic analysis* was chosen as a suitable method. Thematic analysis (TA) was chosen because of its ability to capture patterns in qualitative data [72]. Out of the three main approaches to TA, both coding reliability and codebook analysis were deemed unfitting. *'Coding reliability'* was avoided both because of the lack of previous research on the topic, making it hard to predetermine themes before coding, and because it would be difficult to calculate the reliability of the coding with only one author. The flexibility of *'codebook'* TA made it more of a valid contender to *'reflexive'* TA, however, the structured framework was deemed a poor fit considering the objective was exploration rather than verification.

[1] https://www.ntnu.edu/idi/senobr

In *reflexive* TA, interpretation is a core concept. Themes are created by the researcher in iterations, and one of the main benefits are the utilization of the author's lived experiences in the analysis. Instead of aiming to achieve an analysis that is as objective as possible, reflexive TA relies heavily on the authors personal background in interpretation of the data [72]. Through analysis the author reflects on their assumptions and expectations throughout the research process, and how these might change the outcome of the research. A positionality statement included in section 4.6 describes the author's background and characteristics that might influence the reflexive TA.

A deductive approach was used in analysis of the dataset. As highlighted by Braun et al. [71], this does not mean predetermining codes, but rather using a theoretically informed lens when analyzing the data and creating codes and themes. This is done to potentially offer new insight to the existing theory. For this analysis the deductive approach was guided by the role model theory by Gibson[14] and Morgenroth et al. [12] presented in section 4.2.1. In their paper highlighting what counts as good practice in reflexive TA, Braun and Clark emphasize that themes are created by the researcher and influenced by their interpretation of the data. They do not simply 'emerge' from the dataset. The analysis process for *reflexive* TA has been specified in six phases by Braun et al. [71]:

(1) Familiarization In the first phase of the process, the researcher reads through the data several times to get familiar with the dataset. Interesting points gets noted down for further exploration later. The interviews were audio-recorded and later transcribed and anonymized by the author. This process led to familiarization of the data.

Following familiarization, in the **(2) coding** phase all data capturing something relevant to the research questions were tagged with a code label. Codes typically describe a singular, one-dimensional concept. The digital tool NVivo[2] was used to make this process easier.

In the **(3) Initial theme** phase, similar codes united around a core concept were clustered together. The author wrote down the codes created in the coding phase on digital post it notes and moved them around to create initial themes.

(4) Reviewing and developing themes To ensure the themes captured meaningful patterns in the dataset, the initial themes were reviewed, developed, and changed as needed in phase four. The story each theme told as well as the overall analytic story was considered in this phase.

(5) Refining, defining and naming themes Themes were then defined by theme definitions that captured the scope of each theme. The themes were given names based on the story they told. Each theme also got a shorter title to be used in step 6 for section headers.

[2]https://alfasoft.com/no/programvare/statistikk-og-dataanalyse/qda-kvalitativ-dataanalyse/nvivo/

(6) Producing the report Finally, in producing the final report the overall analytic story and defined themes are presented in chapter 5. The findings are put in context in relation to existing knowledge in chapter 6.

4.6 Ethics

SIKT

Before any data collection started, an application was sent to the Norwegian Agency for Shared Services in Education and Research[3] for approval. The application contained information about how the data would be collected, how the data would be stored, and how informed consent would be gathered. The agency assessed whether the data collection would be in line with Norwegian law about data privacy. The application was approved and can be found in full in Appendix B.

Data from both the interviews and focus groups was stored using Microsoft OneDrive. Microsoft and NTNU have a data processing agreement, and all their services are protected with both a password and two-factor authentication, making it a secure place to store data. Only the author had access to personal data, and both the author and the supervisors of the master's had closed access to the transcripts of the interviews and focus groups.

Written informed consent from participants was used for all data collection throughout the project. As part of the SIKT application, two different consent forms, one for interviews and one for the focus group, were approved for use in collecting informed consent. All participants were informed prior to the data collection that their participation was voluntary and that they could easily withdraw their consent at any given moment, with information about how to do so in the consent form. The complete consent forms can be found in appendix B.

Positionality Statement

Researchers performing reflexive thematic analysis analyze qualitative data through the lenses of their social, cultural, and disciplinary background [72]. Because the audience cannot be expected to read between the lines of researcher's intersectionality and their reflexive analysis [73], a positionality statement is included to provide information about the authors background that might influence their analysis of the data. This way, both the author and the audience can reflect on how the authors experiences influence their work.

[3] https://sikt.no/

I am a cisgender female master's student, pursuing my degree in informatics. I am currently enrolled in a program at NTNU in Norway, but completed my bachelors, also in informatics, at the University of Oslo, Norway. I have completed a semester abroad at San Jose State University in California and thus have some experience with higher education in both Norway and the US. Being a female master's student likely grants me credibility with female informants in the data collection, and thus my results might be influenced by the fact that they feel safe to share more than they might be with a male researcher. Furthermore, I share a lot of the experiences described, which might influence my interpretation of them.

As a born and raised Norwegian student, my knowledge about the situation in Brazil is limited to what I can gather through literature. In connection with the data collection, I spent two weeks in Porto Alegre and Curitiba which to some extent increased my hands-on knowledge about the situation there, however Brazil is a big and diverse country and two weeks is not enough time to get detailed knowledge about the country. While I will do my best as a researcher to create a deep understanding of the differences between Norway and south of Brazil, my lack of experience in the context might influence my interpretation of the data.

CHAPTER

FIVE

RESULTS

This section presents the findings from the qualitative data analysis and the development process of the learning video. 10 Norwegian female computing students were interviewed about their role models and in total 16 Norwegian and Brazilian students were part of the focus groups evaluating the learning videos. Section 5.1 presents the participant demographic for both the interviews and the focus groups. Then, section 5.2 presents the findings related to RQ1 based on analysis of the one-on-one interviews. Finally, section 5.3 presents the development process of the learning video along with findings related to RQ2.

5.1 Participant Demographics

Interviews

Out of the 12 people asked to participate in the interviews, 10 said yes. To ensure anonymity, an overall description of the demographic will be presented. Table 5.1 presents all relevant background information. All participants have been given a random ID between 1 and 10 in the format P1 - P10[1]. The IDs are global across interviews and focus groups to avoid any confusion with having more than one P1, P2 etc.. Quotes are translated from Norwegian to English. This is done by the author to maintain their perceived tone and meaning, which was often lost when trying to use other tools for automatic translation.

Focus Groups

Norway

Out of the initial 8 people asked to participate through the recruitment from, only one responded yes. Purposive sampling was used to fill the focus group with more participants. In the end a total of 4 participants were part of the focus group. All participants were female students pursuing a bachelor or master's degree in computing at NTNU's IDI. Participants of the focus group have been given a random ID between 11 and 14 in the format P11 - P14 and quotes were translated to English by the author to maintain the perceived tone.

[1]P is short for participant

Table 5.1: Description of Participants

Study Program	Gender	Year
B.Sc. in Informatics	Woman	3
M.Sc. in Informatics	Woman	4
M.Sc. in Informatics	Woman	4
M.Sc. in Informatics	Woman	4
M.Sc. in Informatics	Woman	5
M.Sc. in Informatics	Woman	5
M.Sc. in Informatics	Woman	5
M.Sc. in Computer Science	Woman	5
M.Sc. in Cyber Security and Data Communication	Woman	5
PhD in Computer Science	Woman	2nd year of PhD

Brazil

Two focus groups were conducted in Brazil, both contributing to the data collection for iteration 2 of the prototype as well as to answer RQ1 with perspectives from a different demographic than Norwegian students.

The first focus group was conducted with five students from Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS) in Porto Alegre, Brazil. The students were all female students pursuing a degree in computing at the university, either a bachelors, masters, or a PhD. Participants of the focus group have been given a random ID P15 - P20.

The second focus group was conducted at Pontifícia Universidade Católica do Paraná (PUCPR) with 7 computing students. All participants were female students pursuing their degree in computing at different levels. Participants of this focus group have been given an ID P21 - P27 for quoting.

5.2 RQ1: How can role models improve retention of non-male identifying computing students in higher education?

Through reflexive thematic analysis, themes and patterns from the interview transcripts were created to get a better understanding of how female computing students collect role models, and how role models might support them throughout their education. Three themes related to research question 1 have been created. In figure 5.1 an overview of all themes can be found together with correlating codes.

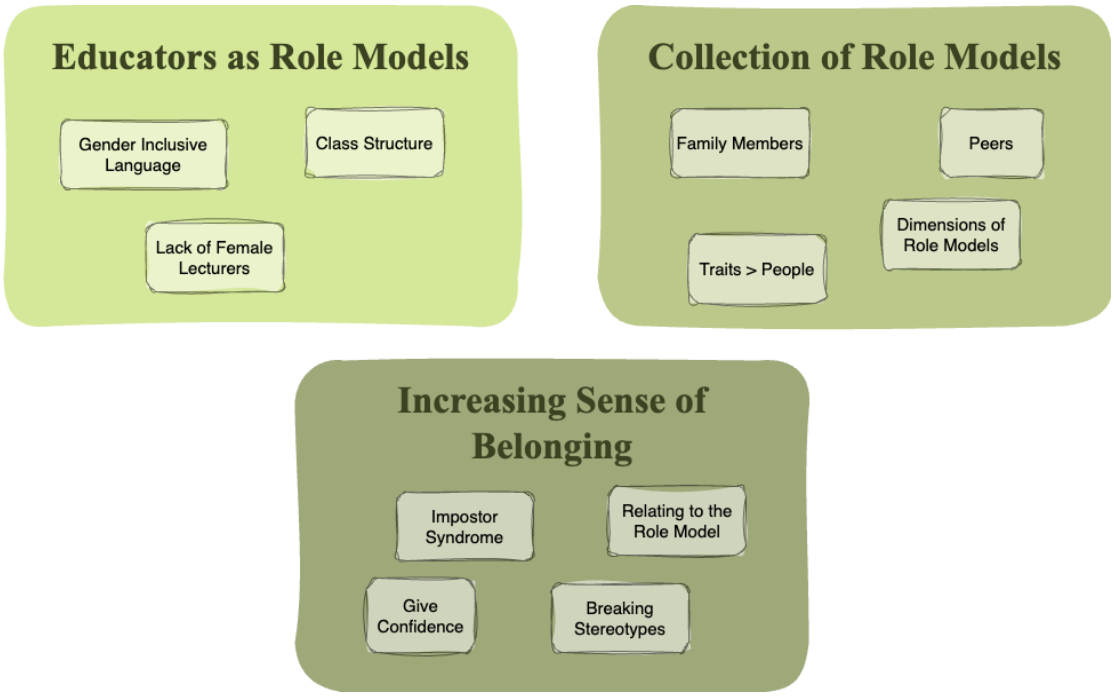


Figure 5.1: RQ1 Themes with Correlating Codes

In line with the technique of reflexive thematic analysis, each *theme* is created to tell a story from the dataset. These themes are multifaceted and tell an overarching story based on the interpretation of the data. The author has read and analyzed the data in iterations through own experiences as well as the theoretical frameworks presented in section 4.2. Each theme consists of *codes*, which are one-dimensional interpretations from the dataset. The codes come together to tell the story of the theme [72]. This section is structured after each theme. Within each theme, there is a short introduction to the main story before each code is presented along with coherent explanations and quotes from the participants.

5.2.1 Increasing Sense of Belonging

The first theme tells the story of how *collecting role models can increase female students' sense of belonging in the computing field.* Participants described being inspired by their peers overcoming barriers, breaking stereotypes, and seeing role models exemplify that success is not linear.

P6 reflected a bit about what it would be like to have positive female role models at the beginning of her studies: *"It would probably be good for me to have some role models at the begging of my studies, someone I could see myself in. Then and there, where most of the people around me were men, it would probably be good to have some women there ..."*. Indicating that having role models, someone you can see parts of yourself in that you look up to, might increase female students' sense of belonging.

Relating to the Role Model

Participants of the interviews were asked if they found it easier to relate to and be inspired by female role models. Most participants said that yes, they do gravitate towards female role models. Participants gave mainly two different reasons as to why that is. One is that other women are typically easier to relate to, especially in the context of computing where female role models typically share the same experiences with negative stereotypes and other gendered challenges. The other reason is that female computing role models are more likely to have overcome some type of barrier, which is identified by both P4 and P5 as something that makes a person admirable:

> "Yes, because men are a bit like... they can just do it without any barriers. Or, some have barriers, and then I feel like I can relate to them a bit more. But the average man that does something exiting, that means nothing to me. They could have ADHD or dyslexia, and even though I can't see that they have it it might be that they do have it, but from the outside, when I don't know them, it does not exactly inspire me."
> P4, Norway

> "I think it is easier to compare myself there than with the boys because I often feel like the boys have some sort of head start since they have previous experience. I feel like there is a bigger share of girls that are very new to this when they start"
> P9, Norway

It seems that relating to the role model in general is the most important success factor, not just having the same gender. P6 described participating in a mentoring program that failed for her. She mentions that the mentor she was matched with was a leader figure with no personal experience in the field of computing that P6 was in. The student explained that the mentor was not able to relate to any of the struggles she was facing herself, as a student in that field, and thus the mentor was not successful in serving as a positive role model.

> "I was part of a pilot project, a mentoring program where we were matched up with women and there were a few men. Women in the industry, and I felt like it fell a bit flat. In part because I had little motivation for [specific computing-field], but also because you were matched up with some leader figure in [company name]. So she was working with people that were working with [specific computing-field]. I felt like she couldn't relate to my problems, or .. yes.. "
> P6, Norway

Some participants mentioned a lack of relatable role models. When asked about what she associated with the word role model, P10 answered: *"... okay, no I did not think about famous people, but then again it's not that often that you hear about IT-women. It's very like you almost have to create your own role model."* P5 specifically wishes for more role models that live ordinary lives and achieve simpler things that she could relate to, again highlighting the importance of relating to your role models for them to be effective:

> "Maybe IT role models that are.. a bit more relatable for me. ... There aren't as many female role models either. There are some but, I feel that the one's you hear about often are those women who have done a lot too. Maybe won an award for IT-women in Norway or something. So, a bit more normal IT role models I guess. People that might not have done something huge, but have stayed a bit more in the background, but are still working and still in the industry. A bit more normal people."
> P5, Norway

P9 said something interesting: She said she didn't have any role models related to computing, but immediately proceeded to say she had recently been inspired by a woman researching AI. From the author's perspective, there isn't one clear way to interpret this. It could be an example of how participants struggle with identifying their role models. Most research on role models is done on role models in the dimensions global, close, positive, and up [14], indicating that this is the most common perception of the term role model. The woman researching AI would be in the dimensions specific, distant, positive, and up. Because these dimensions don't fit the typical definition, P9 does not recognize her as a role model. It could also be that the woman researching AI is not relatable enough to P9, who had previously stated that her interests were front-end development.

> "If I have any role models? I don't think I have any role models directly related to technology. Even though I was very inspired by [woman researching AI] that spoke yesterday. I think it is so sick that she just has all of that knowledge in her head, like that she just knows it. I think it is super cool that like .. yes, she is doing so great."
> P9, Norway

Role Models Breaking Stereotypes

It also seems some female students collect role models specifically to increase their sense of belonging, by finding people that break stereotypes and change their internal perception about what types of people are in computing. P7 explicitly stated that one of her role models is a role model because she is breaking stereotypes about what type of people are in the computing field. She explains that this makes her feel like anyone can be part of computing, which can be interpreted as increasing her sense of belonging that she initially stated was low as she did not identify as a typical computing student: *"Pretty un-typical, and it's been less .. or.. I might have felt less and less typical as well."* Also, P9 mentions her admiration for how one of her role models are breaking stereotypes about gender, and how women are supposed to act and what interests they should have.

> "She is suuuuch a cool IT woman. She has an interdisciplinary background and she is so very untypical for an IT person. I think that is what I think is so cool about her, but she has been doing IT and does really well and is good. But she likes [interest] and [interest] and talks about lots of weird stuff. It's like.. It makes me feel like everyone can be a part of IT culture. You don't have to be the type of person that I typically imagine in IT."
> P7, Norway

Role Models Give Confidence

In the interviews, P3 and P2 also highlighted that some role models can serve as sources of confidence. P3 described how when she was a first-year student she heard an older student tell a story about how she managed to get a good job even though she had both As and Es in her report card. The participant explained that this helped her realize that getting a bad grade is not the end of the world. This statement has in the analysis been interpreted by the author as an example of how role models can give confidence by exemplifying that getting a 'bad' grade or failing an exam does not mean that you are not 'meant to do computing'. You can still become a successful IT professional.

> "I think she has been really cool, and I've looked up to her a bit because she was older than me and very approachable for questions, very pleasant. [...] It was very nice to hear that she had gotten both A and E, but it's going to be okay and you can still get a job. [...] As a first-year student, if you get a bad grade it feels like a crisis and then it is helpful that older students say that."
> P3, Norway

Impostor Syndrome

In the introductory part of the interview, the students were asked about their sense of belonging in the computing field, both as typical students and as non-male students. Most of the students mentioned not feeling like typical IT-students and a lot of them also described having a lot of struggles with impostor syndrome. When asked about how she has experienced being a female computing student P6 stated:

> "... where I started, there were so many more men, I think it might be only 14% women in the class. Then I had bad impostor syndrome directly related to gender. Like 'oh, I'm a stupid girl that doesn't know anything about computers' and so and so."
> P6, Norway

Another participant described similar feelings. When asked about whether she felt like she fit in within the computing environment, P8 answered:

> "Socially I feel like I fit in, but with the technical stuff I don't feel like I belong at all. I have really bad impostor syndrome, I've had that since day 1, but then it gets better and better. However, I think it's going to get worse again when I start working."
> P8, Norway

5.2.2 Collection of Role Models

Even though the participants typically prefer female role models in computing, they have a diverse collection of role models overall. This makes a lot of sense considering not all female computing students are the same. The role models have different backgrounds, different attributes, different purposes and different relations to the role aspirants, the participants.

Role Models of Different Dimensions

From the interviews, role models of all different dimensions of Gibson's framework [14] were identified. While some dimensions like specific, positive, and close were more common than others, the participants' role models filled the whole spectrum.

While positive role models were the main focus, negative role models were also brought up frequently, not only when probed to by the questioning route: *"It's more the traits, and kind of like, you learn very much by seeing someone doing something you don't prefer as well, in that you are thinking: 'okay, I'm going to make sure I'm not like that'"* (P3). Also in Brazil, participants mentioned negative role models: *"When I have a bad experience, they became role models of how I wouldn't want to be"* (P16).

The identified negative role models are typically people that influence their confidence and sense of belonging. When asked if she had met or seen anyone that she did not want to be like, P2 described a person that she had been working with on a group project in her first year. The person had previous experience with programming before starting their computing degree, something P2 did not have. When P2 asked for help, she got responses like 'you just simply do it like this', which she said made her feel stupid, despite their different experience levels. She said in her interview: *"... and that is not the way I would have helped anyone, like, if I get asked for help I at least want to be able to explain it to them without them feeling stupid. I think that is very important, because I thought that was very demotivating the first half year at least"*. This person, who she still clearly remembers years later, can be interpreted as a good example of a negative role model related to sense of belonging in the computing field.

When describing role models, most participants seemed to have specific ones. The closest to global role models would be the family members identified. Here, participants would list several admirable traits that they wanted to emulate and embody themselves. Other than that, just one or two traits were mentioned when talking about people who were interpreted as role models. Positive role models would have a specific achievement, a good work-life balance or be known for being helpful. Negative role models would be ignorant, condescending or not a good teammate. P2 explicitly states that while she would not want to emulate all her traits, she really admires her mother. A statement that could be interpreted as her mother being a specific role model for certain traits, like being generous and caring.

> "I think she is very cool. I want to, maybe not be exactly like her, because there are a lot of things I would not do myself, but just generally how she is towards me and my sisters. That she does a lot to make sure we are well. I think that is very nice."
> P2, Norway

Close role models were by far the most mentioned in the structural dimension. Still, there were some honorable mentions of distant ones. P1 described that while her biggest role models are people that are close to her, she has also benefited from a few distant role models: *"... but also just, maybe some other figures that I didn't talk to or have a relationship with, like distant role models I would.. I was just idolizing them, but still it was useful"*. However, for most participants they identified people close to them as role models: mostly female peers, family, and some teachers.

Determining the frequency of role models in the structural dimensions Up versus Across/down were somewhat difficult. Peers, regardless of if they are in a class above or under, would be across. However, family could be seen as either up or across. It would also depend on which family member one is describing, a grandmother or a younger sister might be categorized differently. Hierarchy within a family is also very culturally dependent. In this analysis, family has been classified as across while acknowledging that this might be heavily influenced by the authors experiences.

Given these assumptions, most participants identified role models that would be placed withing the across or down dimension. The one exception to this might be the few teachers and thesis supervisor's that were mentioned. These relations would be best described as an upwards comparison, and again they show how diverse of a collection of role models the participants have gathered. Both as a group and as individuals.

Family as Role Models

Out of the 10 participants in the one-on-one interviews, 9 of them answered that someone in their family is a role model to them. While the exact number is not of significance in a qualitative analysis, it's mentioned to emphasize just how strong the evidence base is for this particular code. Family members were also mentioned in Brazil as role models by several participants. Female computing students look to their family as examples of traits they want themselves. P10 said: *"Yes, they are strong willed. I really admire that. I want to be like: 'I came from nothing, and I've managed to build this much'"*.

Not all the role models from family relations were computing professionals, in fact, most of them were not. While these family members are not necessarily computing professionals, they are still important role models for the participants. Furthermore, the attributes and values they portray also have potential to be applied in motivating the continuation of their studies. When asked about whether she had any role models, P4 said: *"My sister is a role model to me. She is younger, but I think she is very good at working and she does not give up even though she thinks that something is difficult."* This can be interpreted as an example of how even people outside of computing can be useful positive role models for female computing students in their education.

Participants did not only look to their family for role models on strength and persistence, but also for relational role models. P15 says that her parents are her role models, especially her mother that served as a positive role model for having healthier relations by setting boundaries: *"My house has gender equality, it is not a male dominant one, my brother could not take over, my mom would stop him. I am less intimidated by men now because I am used to saying no"*. Again, while not directly related to computing as a profession, these skills she has made for herself inspired by her mother might make P15 more prepared to deal with the challenges women sometimes face as a minority gender in the computing field. P1 said it well:

> "... they are not necessarily doing what you are doing, and they are not acting like you do. Friends have very different characteristics, and behave differently, but you can learn from how they do it, and that is great."
> P1, Norway

Peers as Role Models

Another group that was very frequently mentioned either specifically as role models or as someone that inspired and motivated ambitions or goals, were peers: fellow students, either friends or acquaintances. This goes for both data collected in Norway and Brazil, however, Brazilian students highlighted their need for more female peers. Many described being the only one or one of few female students in their classes, especially in computer science, and thus they struggled to find peers to relate to: *"I felt really lost and did not find anyone to relate to"* (P17).

Peers have been mentioned specifically as a source of inspiration for overcoming academic barriers and achieving related goals like passing exams and getting relevant jobs in computing. When asked about who she looks up to in her everyday life P10 said: *"when it comes to IT, then I get really like.. everyone that has gone before me and made it and I have actually seen them study with me and then land a job and now have adult money"*. She described her older peers as role models that motivate her to complete her degree. P8 also highlights educational goals she motivated herself to achieve through her peers: *"Really just how talented and smart people are. Then I think, I also want to be as talented and smart"*.

In addition to being role models for achievements and ambition in the context of education, the participants also mentioned other admirable traits of their peers. Work life balance is one of them: *"... they are like.. they are like totally sick, and they do amazing stuff, but when I see what they can do I get like: 'wow, you are such cool people, but IT is not your whole life, but they do great things', and I think that is really cool"* (P7).

Traits Rather than People

Each participant usually described a collection of people they looked up to and were inspired by. Rather than idolizing one or two people they curate a collection of different people of different dimensions to create a well-rounded self-concept. This allows them to improve in more than one aspect of their life. Having role models for both academic achievement and interpersonal relations allows the participants to create a picture of who they want to be, both in terms of results and values.

In the interviews, most of the participants struggled with identifying any role models besides their family members. Almost all of them had previously described being inspired and influenced by several people, however, they didn't use the term role model. To the author, it seems like specific role models is most common among the participants, but like previously mentioned this does not fit the average perception of the term role model, which is usually a global role model. It appears that rather than having one global role model where the participant can mimic the whole person, the students have a collection of specific role models. The participants look at people around them, collect their traits, and use them to build an idea of what they want to achieve and who they want to be. They just don't recognize these people as role models.

We see this with P10 in her interview. When asked about who she admires and looks up to in her everyday life she mentions her peers that make her believe that she can do well, completing her degree, and getting a job. However, when asked about who her role models are later she did not mention any of these people. This has been interpreted as a focus on traits rather than people in the role modeling process. Something that is seen with several of the participants. P2 mentioned that she did not look up to one specific person, but rather became inspired by a lot of different people she saw around her:

> "No. I don't really know. No, it's hard to think about. There are so many people that are good at different stuff, but there isn't anyone I look up to. I get very like.. It's not a specific person, I mean.., but on TikTok and stuff.. when I like see girls, especially, that are like 'I made this game' or 'this is the reasons why you should study IT'. I like that very much, and they get lots of likes too because they are so few"
> P2, Norway

5.2.3 Educators as Role Models

Because previous research has highlighted teachers as important role models for women in computing [1], this was explored in the interviews. However, most Norwegian participants did not identify any higher education educators to be positive role models. While, some mentioned their lecturers as negative role models, most lecturers had not made any lasting impact on their Norwegian students. In Brazil the results were different. There, multiple participants mentioned professors and lecturers as positive role models. This theme, titled *educators have a responsibility to be positive role models*, tells the story of how educators have the potential to support female computing students in completing their education along with the potential negative pitfalls to be aware of.

Lack of Educators as Role Models in Norway

All participants were asked if they looked up to any of their higher education lecturers. Very few answered yes to this question. Similarly to how participants have praised their peers for being both smart and helpful, being a knowledgeable professor does not appear to be enough to warrant "role model status". P2, who said she looked up to one of the professors she had had as a lecturer did not mention any hard skills when describing why she admired him:

> "Yes, I think [lecturer], I had him in [name of class]. Even though I didn't understand anything, I thought he was very positive. I thought that was very nice, even though I didn't think he was that good at teaching really, but I really thought something about his energy was very good. ... I have a very good impression of him, he is just a very pleasant professor. He wanted us to succeed. I feel like the case might be with other professors that they are like.. it seems like they don't really care about how we are doing, kind of, or what grade we get in the class. But with him I felt like he actually wanted us to pass and understand it, and he was very engaged."
> P2, Norway

P3 thought one of the reasons for not having any lecturers as role models, is the fact that there is no room to build a relation there. The students do not get to know their professors at a personal level. She described classes she had at a different faculty where they had lectures in smaller groups: *"... and then you get much more of a relation to the lecturer, because they come over and talk to us and guide us on a deeper level"*. P10 also mentions the lack of an interpersonal relationship with higher education lecturers as a reason for them not being as suited to be role models:

> "Honestly, there hasn't been that many here at the university. I remember in high school; my favorite teachers are from there. Like my math teacher, physics teacher. All of them were very like: 'it's okay, you're going to get through this even though these are difficult subjects'. So those I remember very well, but not in university. Maybe teaching assistants and stuff like that, that have tried to help, but no I don't feel like any lecturers have been there and been supportive, but then again you don't have the same relationship to them as you do with teaching assistants or teachers in high school."
> P10, Norway

In Brazil, the students describe a different style of teaching. They have smaller classes and the professor responsible for the class is much more hands-on. Instead of having teaching assistants doing the grading of assignments, the professors usually must do it themselves which makes the teachers know their students better. The teaching style the Brazilian participants describe seems to be more susceptible for relation building. This difference was also mentioned by P8 who had a year abroad where she explained that: *"... I felt like they cared about every single person. And you didn't have teaching assistants, but I felt like we had contact with our teachers even though the classes were big"*.

While having a more personal relationship to your lecturer might facilitate a role modeling process, this alone does not guarantee a positive role model. Most participants chose to highlight positive role models amongst their teachers, like P22 in Curitiba: *"They care a lot, they try to help us as much as they can"*. Meanwhile, P15 described having both highs and lows of lecturers.

> "I've seen extremes, I have a teacher that on the first day of class would do roll call, she would always say "oh another girl, I'm so happy you are here" ... I did not experience this myself, but my friend had a class on March 8th this year, and the female professor said "I don't really care for International women's day, but happy women's day I guess"
> P15, Porto Alegre

Lack of Female Lecturers in Computing in Norway
Another thing that came up throughout the interviews was the lack of female lecturers in computing at NTNU. P4, P7 and P9 all estimated having had one or two female professors in total after 2-5 years of computing classes. P3 couldn't remember having had a single one. Since previous findings indicate that it is easier for female computing students to relate to other women, this lack of female professors can be interpreted as a problem hindering role modeling of teachers in higher education computing classes.

At PUCRS, there seemed to be more female professors, at least in software engineering classes: *"There are a lot of female professors in software engineering, but computer science is mostly male, I changed from computer science to software engineering and it was night and day, it was so much better"* (P18). Also in Curitiba, at PUCPR, there was a significant amount of female professors and lecturers in computing: *"Somethings we had which is nice is that out of the 5 courses, 3 of them are women, this is very inspiring, they help us and try to include us in this male focused field"* (P22). P18 also highlighted the importance of having female lecturers: *"Female professors are very essential for women and people in general to finish their study"*.

Gender Inclusive Language

Something that came up in the Brazilian focus groups were the impact of the language that teachers use. Participants explained that Portuguese, the primary language in Brazil, is a gendered language meaning that the ending of a profession, like a software engineer or computer scientist, is changed based on the gender of the person occupying that profession. There is however gender-neutral ways to articulate the same thing, something that the female participants noticed and appreciated when happened: *"[name] gave a class to professors, male and female, about gendered language, and I realized that my teacher used the term 'person who programs' which is gender neutral"* (P15).

5.3 RQ2: How to design and develop a learning video about role models for non-male identifying computing students?

After the analysis of the data collected in the interviews, two approaches for disseminating the findings through a learning video was developed in the first suggestion phase. These two concepts, one debunking the term role model, and the other a tutorial for how to create a role model, was made to be two distinct prototypes of a learning video to be evaluated through iterations of focus groups.

This section is structured after the development process of the final video. Section 5.3.1 describes the two initial prototypes and reason for choices made in the development of them. Then, section 5.3.2 presents the results from the pilot test conducted in Norway. Section 5.3.3 then presents which prototype was chosen out of the two, and what changes were made to improve the video before the second round of evaluation. Section 5.3.4 presents the findings from the two focus groups conducted in Brazil, and finally section 5.3.5 presents the final iteration of the video.

5.3.1 Iteration 1

The first iteration of the learning video was developed in the suggestion phase based on data from the semi-structured interviews conducted in Norway. After the analysis of the data, a brainstorming process was conducted to come up with a learning video that would disseminate the findings to other female students in a beneficial way. Two suggestions were chosen to be turned into a full-fledged prototype for pilot testing in the first focus group in Norway. The two suggestions made using Microsoft Power Point for animation, Apple's iMovie for audio, and YouTube for subtitles and playback control, will be explained further in the following subsections.

Video 1

For the first video, the idea was to make a learning video debunking the phrase role models and surprising the viewer with the fact that they are likely someone else's role model. The interviews indicated that a lot of participants had a role modeling process with the people around them, collecting traits and goals to improve their self-concept, but still didn't think they had any role models. This motivated the choice to make a video that simplified the definition to make viewers reflect more actively about who their role models are. Presenting the viewer with the idea that they are role models is based on the findings that most participants were inspired by their peers, making it likely that as a female computing student you have been a role model for your peers.

According to Fyfield et al.'s design principles for an instructional video, there are benefits to including integrated learning activities during or after the video [67]. Because of this, the introduction is shortly followed by the viewers being asked to participate in an exercise. They are asked to close their eyes and imagine a good role model for women in computing. This sequence can be seen in figure 5.2. After this, they are presented with the idea that someone else might have been imagining them when they closed their eyes. Another design principle taken into consideration is that shorter videos are more effective, because of this the goal was to make sure the video was between 1 and 2 minutes. Whether this is too short or not short enough is to be evaluated in the focus groups.

The first iteration of **video 1** is available to view on YouTube here: `https://youtu.be/sVLftwE_Lb8`

Figure 5.2: Engaging the Viewer with an Exercise

Video 2

For the second video, the suggestion was to make a learning video teaching female students 'how to create their own role model'. This was also based on the findings that female computing students often don't recognize their role models, which has also been seen in previous studies [43]. The purpose was to get the viewers to think and reflect on how they perceive the term role models, and hopefully be able to identify a few amongst people they already know instead of introducing them to new people, which has often been done in previous role model interventions [17].

In an attempt to integrate an interactive aspect to video 2, the choice was made to design the video to make it look like the viewer was navigating a news website as can be seen in figure 5.3. To establish this concept for the viewer, as well as to provide some context to why the upcoming tutorial is needed; the video starts with the viewer reading the start of an article about women in computing's lack of role models, before navigating to the 'tutorial' page through the top-menu. This sequence can be seen in figure 5.4.

This video also aimed to be between one and two minutes, but due to more information being needed for the message to come through video 2 ended up being slightly longer than video 1. Finally, to learn about what colors are beneficial to these types of learning videos, video 2 was made with a different, colder monochrome palette.

The first and only iteration of **video 2** is available to view on YouTube here: `https://youtu.be/RxJs4gaEQCg`

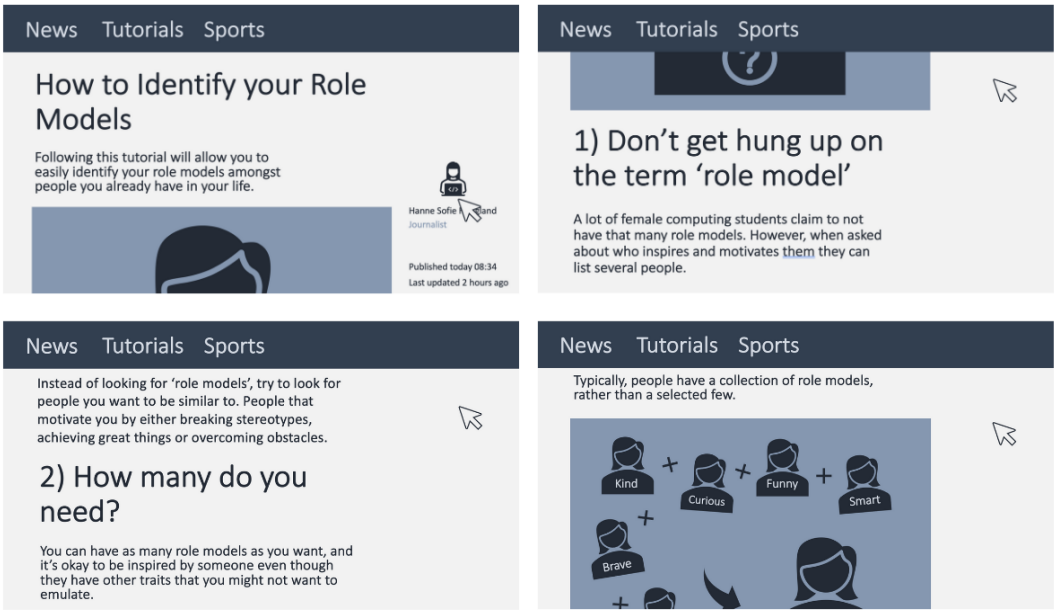


Figure 5.3: 'Scrolling Motion' of Video 2

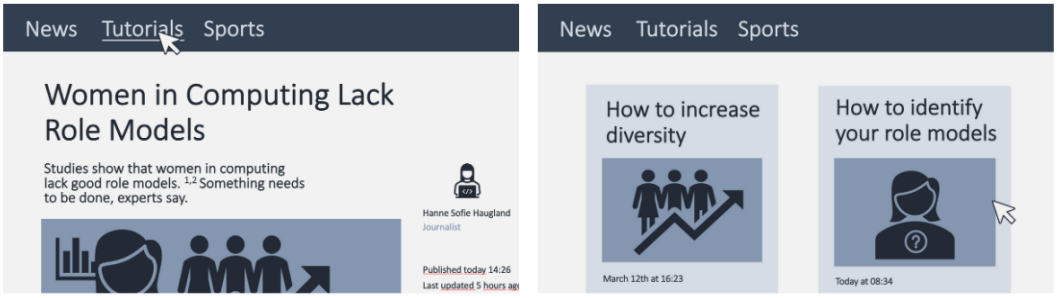


Figure 5.4: Video 2 Introduction

5.3.2 Data Analysis - Norway

Complete transcripts of the focus groups that pilot tested the two videos were used as a basis for analysis. Field notes by the author was used as a supplement to the transcript. Through reflexive thematic analysis three main themes were created from the analysis of the first focus group.

Theme 1: Inspiration is more important than information density The analysis of the focus group revealed that it is important to prioritize the learning video being inspirational. Even though this might seem counter intuitive as a learning video's main goal is to teach, the participants expressed that the knowledge gained has more of an impact on viewers if they feel inspired by the content.

All participants expressed a preference to the color scheme in video 1. It was both due to the warmer tones and because the palette was lighter and brighter overall. When asked about how the visual aids contributed to conveying the message

of video 2, P14 said: *"Bad use of color, dark and not inspiring"*. The other participants seemed to agree with this statement. When asked about what video 1 made the participants feel, P11 said: *"Proud, it's cool that you are considered"*. P14 described wonder, saying it made her think. For the same question with video 2, P12 said it *"Felt more like learning than inspiration"* and P14 described *"less emotions than the previous video"*.

> "I feel a bit proud; I consider a lot of other students as role models so maybe someone else is looking to me. ... I had not thought about that before."
> P12, Norway (about video 1)

Another identified success factor was the element of surprise in the information presented. All participants were rather struck by surprise by the statement that they were role models; they did, however, believe it. Furthermore, P13 voiced to the group that she enjoyed that the three research points presented were all something new and things she was not previously familiar with, meaning she learned something. P14 replied to this statement, saying that she agreed and that the points still felt reasonable and believable. The beginning of the video was also a surprise for the participants who thought they would be learning about something else: *"I thought the video was going in a different direction ..."* (P14).

Theme 2: There needs to be a clear message for the learning video to be effective. The focus group expressed in unison the importance of clear and precise definitions, presenting sufficient context for information given, and a powerful ending to emphasize the intended take-away for the viewers.

P13 said she *"... kind of lost the definition of role models"* at the beginning. She expressed a wish for it being emphasized more and explained that it was kind of lost when it was only included as a voice-over. Yet she worried that including a longer definition might make it boring: *"Make sure it doesn't get boring"*. This can be interpreted as the need to carefully balance a trade-off between providing enough information to make the message clear, but not too much as to make the video long and boring.

P14 did not think the research presented in video 1 was introduced well enough. After watching video 1 she was left with questions about who this research applied to: *"Is this research only about women? I feel like this applies more to female students, men would think differently"* (P14). This shows the importance of testing, as something that seemed obvious for the author when developing, considering the author has worked a lot with this topic, might not be obvious to the audience which likely are new to the topic.

Participants also mentioned the lack of a powerful ending. While the voice-over did end with an encouraging statement, this did not seem to resonate well with these participants. The ending was criticized both for not being engaging enough, meaning they struggled to grasp what was being said, and for not being encouraging enough, the message was not as inspiring. This can be interpreted as a need for a learning video to have a powerful ending to make sure that the main message really sticks with the viewer and is not easily forgotten.

Theme 3: Visual clutter takes away from the audio recording The third and final theme tells the story of how to balance visual elements, voice-over manuscripts, and on-screen text. If done wrong, this will lead to viewers being overwhelmed or missing something, and thus not getting a good learning output from the learning video.

While visual elements might help engage the viewer and make the video more interesting, like P13 suggested that most of video 1 did: *"... there was something to pay attention to, things entered the screen, it makes you not stop paying attention"*. There is also a pitfall with visual elements, both in numbers and in using the correct one. Too few visual elements might make the video more boring and less effective on the viewer: *"it wasn't interesting enough visually"* (P14, talking about video 2). However, too much or the wrong kind would do more harm than good.

What was supposed to be a creative and interactive way of keeping viewers' attention in video 2 through the scrolling gimmick ended up being distracting and annoying to the participants: *"I got a little distracted at the beginning, it took some time to realize what the 'context' was"* (P12) and *"I didn't like how the scrolling cut, it was not the same speed that I would have used"* (P13). These comments have been interpreted as a conviction of the principle that while visual elements have the potential to engage and interest the viewer, they need to be used intentionally and carefully as to not backfire.

Finally, there are two concerns regarding on-screen text in learning videos identified by interpretation of the focus group data. The first concern is that the amount of on-screen text should be reduced. As participants described, reading text while trying to pay attention to what is being said is hard. Furthermore, if there is to be included on-screen text it should for the most part match what is being said in the voice-over. P12 expressed that she struggled with trying to read what was written in the animations on-screen while also listening to what was being said. If the on-screen text is the same as the voice-over, the viewer won't miss anything by choosing to only read or listen.

> "With the first point: you said a lot, there was a lot of text, and I focused mostly on the speech bubble rather than what you were saying, so I kind of lost the thread."
> P12, Norway (about video 1)

5.3.3 Iteration 2

Based on the results from the first focus group round, the decision was made to continue with only video 1. Based on analysis of the individual feedback given, both the concept and visual style of video 1 seemed to have a bigger impact on the students. Additionally, when asked to choose in the comparison part of the focus group, all four participants clearly preferred video 1.

Video 1 showed great promise after pilot testing. When participants were asked about what they thought the purpose of the video was, they successfully identified several aspects of the knowledge that was attempted disseminated in the video: *"inspire, encourage"* (P11), *"to lower the expectations about what a role model is ..."* (P12) and *"a role model does not have to be a role model in all aspects"* (P14). There was, however, also some aspects that could be improved to increase the efficiency of the video. This section describes what changes was made to video 1 in iteration 2 to improve it:

Reducing visual clutter One of the themes from data analysis described that participant found it difficult to pay attention to what was being said in the video when there was a lot of text or visual elements on screen. In the second iteration of the video, the text in the speech bubble from research point 1 has been replaced by a question mark, indicating the confusion around the term role models without including a lot of text that would distract the viewer from paying attention to the voice recording. This change can be seen in figure 5.5, with iteration 1 on the left and the updated slide in iteration 2 on the right. Furthermore, some of the on-screen text has been worded differently to better match what is being said in the voice recording as to not be another distraction.

Figure 5.5: Changes to Reduce Visual Clutter

Providing more context For the second theme, one of the talking points among the participants was that it did not come across clearly that the research presented is done with a sample of female students. For the second iteration of the video, this is specified for each of the presented research points. Additionally, the script has been updated from "Don't believe it? Let's look at what the research says.. " to "Don't believe it? Let's look at what research says *about role models for female computing students* .. ".

Room to breathe Since participants highlighted the importance of inspiration, as well as the need to have time to process and reflect on what is presented, the video was extended with a few seconds throughout. Mainly, the duration of the introductory thought-exercise was extended to allow more time for the viewer to think about this. Additionally, the manuscript was updated to specify a certain duration for participants to close their eyes since this was not clear in the first iteration as pointed out by P11. The wording was changed from "Please, close your eyes. Now picture a good role model for women in computing." in the first iteration of the manuscript to "Please, close your eyes *for a few seconds* and picture a role model for women in computing." in the second iteration of the manuscript.

> "I closed my eyes when told to and kept them close waiting to be told to open them, but because I was wondering how long I should keep them closed I opened them slightly and found that new animations were already sliding across the screen."
> P11, Norway (about video 1)

The inspirational and thought-provoking abilities of the first iteration was highlighted by participants as one of its greatest strengths. One of the other places that has been dragged out is when the notion that the viewer might be someone else's role model is first presented. This is an important part of the video and is likely to provoke a reaction from the viewer. Based on the premise that participants felt the video would tolerate being a little longer the choice was made to include a few more moments of silence.

> "The pacing was a bit too fast when going through each point, especially towards the end. There was not enough time for me to process."
> P13, Norway (about video 1)

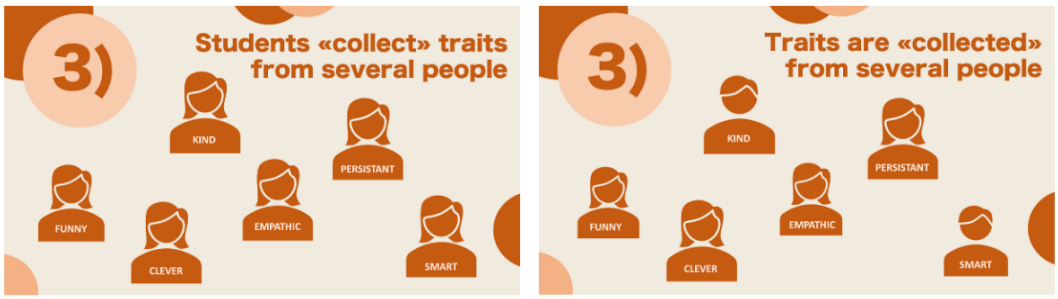
More powerful ending Also tied to the second theme of a clear message was what P11 described as a lack of a powerful ending in the first iteration of video 1. She asked how the first video ended during the discussion indicating that the ending did not make a lasting impression on her. As a follow-up question the participants were asked about what they might think made the ending less impressive. One of the suggestions was that it was a lot of talking with no animation, making it hard to follow. Similarly, P11 suggested aligning the on-screen text with the voice-over: *"If the text displays what you are saying it is easier to focus on what is being said"*, tying into theme 3 on visual elements. To improve the video, the ending is now changed to be an updated and simplified definition of a role model, in line with the findings of the interviews done, and at the very end an encouraging statement about the students position as a role model for their peers. The changes can be seen in figure 5.7 and 5.6.

Figure 5.6: Ending With a Simplified Definition of Role Models

Iteration 1 **Iteration 2**

Figure 5.7: Changes to Make the Final Scene More Powerful

Clear definition The very beginning of the video was also criticized for being too much voice-over and not enough happening on-screen. The participants were not able to pick up the introductory definition of a role model. To improve the video, an on-screen textual definition of a role model, matching the updated voice-over, was added in the introduction. The goal is that it will be easier to grasp the introductory definition.



Iteration 1 **Iteration 2**

Figure 5.8: Increasing Diversity of Role Models Presented

Not theme-related Finally, some changes not tied to any of the main themes were implemented as well. As requested by P14 some instrumental music was added in the background of the video. A fitting sample from Apple's iMovie library was chosen as to not breach any copy right laws. Participants agreed that this might make the video seem more professional, improving its believability and impact. Additionally, some changes were done to the illustrations of people in the video. As pointed out by P14 *"I believe it is intentional this way, but it would be nice with some male figures.* P11 jumped on this and added *"Yes, because women can have men as role models and men can have women as role models"*. To increase the diversity of role model characters in the video, some of the feminine presenting characters were changed to be masculine presenting.

The second iteration of **video 1** is available to view on YouTube here: `https://youtu.be/tk1avKzbZQ4`.

5.3.4 Data Analysis - Brazil

Transcripts of the focus groups conducted in Porto Alegre and Curitiba, Brazil, both evaluating iteration 2 of video 1, where used as a basis for the reflexive thematic analysis. From the data collected, no additional themes or codes were created. The three themes presented in section 5.3.2 and figure 5.9 are, however, all supported by the data collected in Brazil. This section presents the findings of the two focus groups in further detail, structured after each of the three previously defined themes.

Theme 1: Inspiration is more important than information density Also in Brazil, participants described experiencing pride, inspiration, reflection, and surprise after having watched the updated video. After the changes done in iteration 2, the video still seemed to emotionally engage the students, providing support for theme 1.

One of the changes made in iteration 2 was adding more small breaks in the manuscript with the intention of allowing viewers to process what is being said. The reflection exercise received positive feedback: *"When you told me to close my eyes, I really liked it"* (P20). This, combined with the fact that several participants said the video made them think, is interpreted as confirmation of the fact that leaving enough time for reflection for viewers is important in these videos, and that the updated video executes this successfully.

Like in Norway, most participants were initially surprised by the notion that they might be someone's role models: *"... surprised about the idea that I am a role model"* (P18) and *"It's a new realization"* (P16). However, after thinking about it and discussing it between them most agreed that this seemed reasonable: *"Role models have different characteristics, so it makes sense that I have some traits that other want"* (P18). While an element of surprise is not alone enough to make a learning video effective, the results indicate that it is effective as an attention grabber and that it facilitates self-reflection amongst the viewers, thus improving the efficiency of the learning process.

One important finding in particular is based more on interpretation from the author than the others. While discussing the topic of being a role model, in both Curitiba and Porto Alegre, the phrase *impostor syndrome* came up. Several participants explained that this is something they struggle with, especially as women in computing fields. The author interprets this as an important reminder that when developing learning videos for non-male computing students one should keep its' audience in mind. The video seems to be successful because it is presenting findings from research that the participants relate to, increasing their sense of belonging and thus slightly reducing their impostor syndrome enough for them to believe they could be role models.

> "I don't know if it is cultural as women in Brazil, we doubt ourselves and often have impostor syndrome, am I good enough to be a role model?"
> P16, Porto Alegre

One of the main objectives of the learning video was to provide the audience with role models amongst people they already know by presenting a different explanation of the term along with research that supported this explanation. After the changes made in iteration 2, the results indicate that the video is achieving its' objective. When asked about what they thought the purpose of the video was, P24 said she thought it was to identify role models. P22 thought the purpose was to inspire, P23 said *"it made me realize that it does not have to be famous unattainable people"* and P21 said *"I never thought that I could be a role model"*, indicating that it is also successful in the objective of inspiring the students.

> "... it could be to identify role models, when you said role models I thought about my mom, but then when you said computing I went blank, I had none from before, but the video made me realize that I had role models ..."
> P25, Curitiba

Theme 2: There needs to be a clear message

The theme telling the story of a supportive learning video's need for a clear message was supported through confirmation of the positive outcome of changes made based on criticism from the first round of evaluation. Participants were pleased with the content and structure of the information presented and did not have any suggestions for improvements: *"Good thought process"* (P18) and *"Branching the idea of a role model, opening up the concept which I thought was nice"* (P15).

There were no questions in either focus group questioning the context of the research, the definition of role models or what the ending was. This has been interpreted as support of the fact that having a clear message and providing enough detail will enhance the learning outcome of such a video. Instead of the participants discussing smaller details of what was presented like they did with iteration 1, the participants were now discussing the topic of role models, as intended. With the changes made, the ending went from forgettable to powerful: *I think the video was very well structured it builds up a thought and at the end it gave me shivers* (P21).

Theme 3: Visual clutter takes away from the audio recording

Results from the second evaluation of the video indicate that the improvements made to the visual elements were effective. The change to include both men and women as illustrations were highlighted as positive. When asked about thoughts on the visual aids, P24 said the following: *"I like that there are two kinds of people"*.

In regard to the balance of not too little but not too much going on on-screen, this seemed to have been improved in iteration 2. Participants described the visual aids as *"simple and clear"* (P16) and *"the animation was good"* (P18). The fact that these changes were made and the video is now getting solely positive praise is interpreted as support for the statement that there is an important balance, which has now been improved in the prototype.

The three themes created to answer RQ2 with correlating codes from the two rounds of evaluation can be seen in figure 5.9

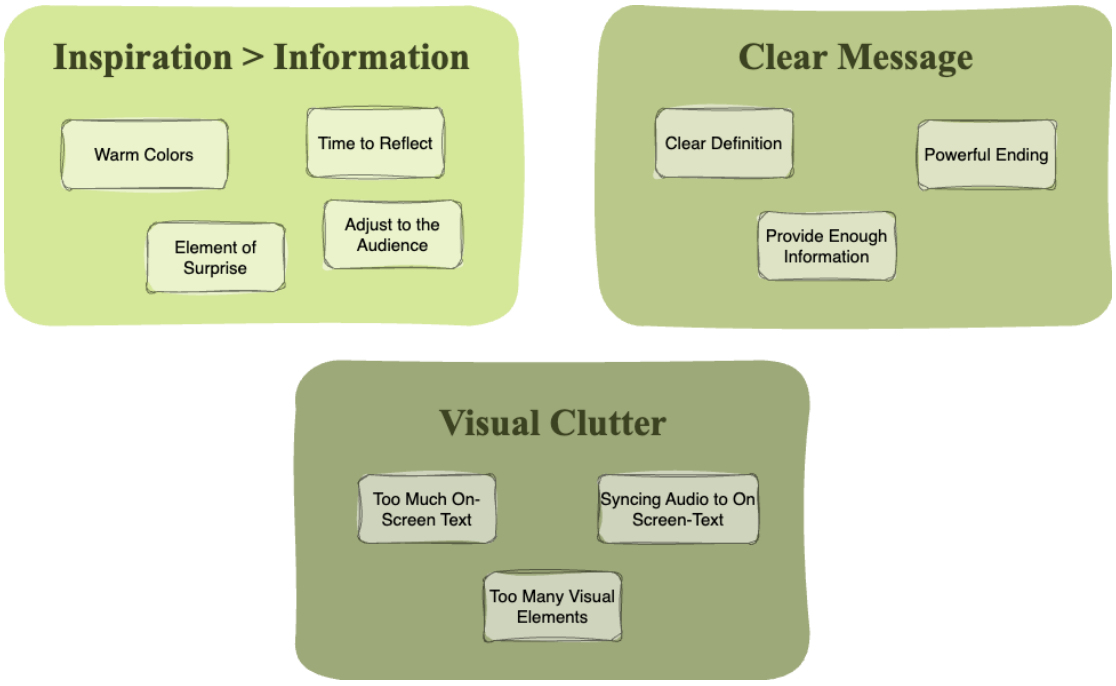


Figure 5.9: RQ2 Themes with Correlating Codes

5.3.5 Iteration 3

The original plan was to further develop the learning video in a third iteration based on feedback from the second round of focus groups. However, no constructive criticism to the video was given in either focus group, even when participants were probed to do so. It seems that saturation of feedback was reached early in the evaluation process. Furthermore, section 4.3 presented some evaluation criteria for the evaluation phase of the Design and Creation research method. The findings indicate that the final iteration successfully presents new knowledge, inspires the viewers and it uses visual elements in a way that is beneficial to help convey the knowledge and inspire.

Since the current video satisfies the criteria and participants had nothing bad to say about the video, a third iteration of the video could not be justified. The final iteration of the learning video, the one that will be used for the Women STEM UP project is iteration 2, previously linked.

CHAPTER

SIX

DISCUSSION

This chapter presents a discussion of how the findings answer the RQs and how they contribute to existing relevant research. Section 6.1 presents how role models can support female computing students in completing their education. The section includes both benefits of having role models and success factors for successful role modeling. Success factors of how to develop a learning video to support female computing students in their collection of role models are presented in section 6.2. Finally, section 6.3 discusses the threats to validity of this research and how they potentially limit the findings.

6.1 RQ1: How can role models improve retention of non-male identifying computing students in higher education?

To answer the question of *how can role models support non-male identifying computing students in completing their education*, the findings have been divided into potential benefits of having role models, and identification of success factors making these benefits possible. While the objective was to find results of both female and non-binary students, the sample does not contain any non-binary individuals and thus the findings are limited to answer a revised RQ1: How can role models support *female* computing students in completing their education?

Potential Benefits

The findings of both interviews and focus groups revealed several potential benefits to female computing students having role models. Three different ways in which the concept of role models can support female computing students have been identified: Having role models can increase female students' sense of belonging, being perceived as a role model can give confidence to the students and having role models can encourage persistence and motivate completion of studies by exemplifying the benefits of completing.

While it can't be proven that the participants have been mindfully selecting role models to improve their sense of belonging, it seems to be an outcome of their role modeling process. When asked in the interview if they felt like a typical computing student, almost all of them said no, indicating a lower sense of belonging. The participants expressed that their role models are people that make them feel like their computing class is an environment where it is safe to ask questions, where people have interests and values similar to them, where women are talented and knowledgeable about computing, and where they are not bad computing students for getting an occasional bad grade. They describe people that make them feel like they belong, something that have been found in previous work on intersectional diversity in computing [74].

Previous studies have found that role models embodying stereotypes about STEM fields can impact both women's sense of belonging and their beliefs about their abilities in the field [11], [15]. While not being able to directly support this, the findings indicate that exposure to role models breaking stereotypes might positively impact female computing students' sense of belonging and internal barriers such as belief in own abilities. Several participants described being inspired by other women in computing who are breaking stereotypes about being a computing student or professional, and about being a woman in general. This is also supported by Morgenroth et al.'s motivational theory on role modeling where they describe role models' ability to change people's perception of both internal and external stereotypes [12].

Previous work has also found that acting as a role model can build confidence in both yourself and others [8]. This has been supported through the learning video, which presented the viewers with the idea that they were a role model. The idea that the participants might be role models for someone else sparked a conversation about impostor syndrome. This initial reaction might indicate that they had not previously considered the thought that they might be a role model themselves. However, they thought more about it and found it believable in the end, saying that this knowledge gave them more confidence. In other words, female students can also get support from being role models themselves, not only having role models.

Success Factors

Through the data collection and analysis process a few different success factors for the role modeling process of female computing students were identified. The first one is to have a diverse collection of role models to build your self-concept in more than one aspect and to change perception of external barriers. Additionally, having a *close* relationship to a person, as described in Gibson's dimensional framework [14], makes a person more suitable for the role modeling process because relating to the role model is important for it to be a role model instead of simply a person with impressive merits and traits.

Almost none of the participants mentioned anyone other than various personal relations as role models, *close* role models according to Gibson's framework [14]. These findings are similar to those of Sanchez-Gordon et al. who did a similar study on Latin American computing professionals that identified *positive* and *close* role models as the most common [16]. There might be several explanations for these results. One is that since relating to a role model is an important part of positive role modeling, people in close relationships are more prone to a role modeling process. Another one is that these women are lacking exposure to distant role models. Or at least, distant role models they can relate to. However, tying these findings to the findings of Szlavi [43] it seems that for students, exposure to *close* fellow students as role models is more effective than *distant* established IT experts.

Previous studies have found teachers to be good role models for computing students [1]. However, Norwegian participants describe mostly negative experiences with their lecturers. Descriptions of lecturers that don't seem to care about students' understanding of or success in a course dominated the interviews. Furthermore, participants did not have close relationships with their lecturers as they have big classes and get follow-up from teaching assistants rather than the professors themselves. At least this is the case for the computing classes, this class structure might not apply to all courses at the sample university, NTNU. Participants did however mention some high school teachers they did consider role models. Since most previous studies have been done on a K-12 sample and in the US, there seems to be a significant difference both between K-12 and higher education and between different geographical regions.

Brazilian participants on the other hand, do highlight some of their professors as important role models. They also talk of significant representation of female lecturers in computing classes, though this might be specific to the sample universities, something that was missing with the Norwegian participants and is a previously recognized problem [18]. In Brazil, the participants also describe a more hands-on approach from their lecturers where they get to interact with and talk to their teachers. This suggests that for teachers to be positive role models for their students, the students need to know them well enough to be familiar with their personal traits, and furthermore they should have personal traits that the students admire. This is similar to what was found in the study of Sanchez-Gordon et al. where participants were more interested in the moral values and human side of their role models [16].

Previous studies are divided on whether the gender of a role model is of significance [11], [31], [75]. The findings from this master's thesis suggest that female computing students typically are more prone to collect female role models in the realm of computing. However, as emphasized by several of the participants, this is because they as women in computing have lived similar experiences as the role aspirants and thus are easier to relate to. Drury et al.'s work [31] suggest that the gender of the role models matter more in retention efforts. While this seems to be true in the sense that female students benefit from other female computing role models to increase their sense of belonging and create relevant goals, female computing students also benefit from and collect role models of other gender identities as well as role models not in the computing field.

Similar to the studies of the SLR [1], most students identified both peers and family as important role models. Family members were not necessarily computing professionals, they usually were not. However, they still served as important role models for the computing students as behavioral models of being persistent, hard workers, caring or talented. Behaviors they for the most part could apply to their computing education.

All in all, it seems that having a diverse collection of role models in several aspects of life help female computing students with their studies. They have peers as role models to increase their sense of belonging and create goals and ambitions for their education and future career. Furthermore, they look to family members for how to approach adversity, how to behave as good people, and how to be good team members. This supports previous similar findings, where computing professional would have a mosaic of characteristics from a collection of people rather than having one or two *global* role models [16].

6.2 RQ2: How to design and develop a learning video about role models for non-male identifying computing students?

Findings from the interviews, supported by previous research [43], indicate that there is a lack of knowledge about the concept of role modeling among female computing students, and that they might benefit from a learning video on the topic. Participants would describe people that fit the definition of a role model but would not refer to them as role models. Evaluation of the prototype indicate that there in fact is a demand for and benefits of developing such a digital product. These findings indicate that the final learning video might help support female computing students complete their education. This is supported by previous studies that also found videos to be an effective tool in interventions against gendered challenges in STEM [17], [76].

To answer RQ2, this section presents suggestions for how to develop learning videos about role models to support female computing students. The findings are limited to female computing students because the sample did not include any non-binary students. The suggestions are based on evaluation of the learning video created through the Design and Creation research strategy and preexisting theoretical frameworks for development of instructional videos. The development and evaluation process found support of the following design principles for instructional videos as presented by Fyfield et al. [67]: integrating learning activities, signaling, emotional design, and transience.

Participants highlighted the importance of these learning videos to be inspirational to be effective. It does not help that the content is very information dense if the viewers cannot relate to or engage in the content they are being presented with. Just like people need to be relatable for them to be role models, a learning video about role models needs to be relatable to be effective. A design principle found to help engage, inspire, and encourage self-reflection with the viewer is including an integrated learning activity. Preferably a learning activity that gets the viewer to consider their own situation. These findings are supported by previous research that found that instructional videos are more effective than e.g. classroom teaching, only when there is an interactive element to it [77].

Another important principle that was highlighted and corrected throughout the evaluation and development process is transience: when too much information is presented too quickly a video will lose its advantages over static media [67]. It is important to consider what information is strictly necessary to convey the message without it becoming overwhelming for the viewer, causing them to lose interest.

Finally, one should consider signaling and emotional design when developing learning videos for this purpose. The principle of emotional design suggests that warm high-saturation colors should be used in videos to increase viewer satisfaction [67], this was supported by our findings as the participants clearly preferred the warm and bright palette of video 1 over the dark blues in video 2. Signaling was also proven important, as some of the punchlines were missed by participants in early iterations when they were not highlighted by an animation.

6.3 Limitations

Even though different techniques for demonstrating validity of the research were used [78], like acknowledging the researcher's perspective, there are some limitations worth discussing. This section presents important threats to both external- and construct validity, discussing them in response to related research.

Due to time and resource limitations of a master's thesis and the exploratory nature of the research, there are some threats to external validity. With the sparse number of students interviewed, none of them being non-binary, the findings can't be generalized to the whole population of non-male identifying computing students of Norway and Brazil. Instead, they can be seen as interesting trends to be further studied with larger samples to confirm or deny the findings. These limitations are similar to those of related previous work [16].

Another noteworthy threat to external validity is the language barrier with data collection in Brazil. Including female computing students from universities in Brazil was an important part of the research process to produce results contributing to the knowledge gap on gender diversity in computing education in parts of the Global South. However, as the author does not speak Portuguese, and an interpreter was not a viable option for the focus groups, the results from Brazil might not be as generally applicable for the entire population. Both because only Brazilian students with proficient English-knowledge were eligible for the focus groups, and because the interviewer and the participants were communicating in their second language and thus might have oversights on both ends.

The objective of the research was to develop a learning video based on exploration of how role models can support non-male students in completing their computing education. While interesting findings have been made towards this objective, no students that have actually dropped out from a computing program were included in the sample. Their insights would have been valuable in comparing if there are any differences in collection of role models between those who stayed and those who left. This serves as a threat to the construct validity of the thesis, as it is a knowledge gap that the research design does not cover.

CHAPTER

SEVEN

CONCLUSIONS

Through this exploratory Design and Creation research there has been found indications that with a diverse collection of role models, female computing students can find support and potentially increase their sense of belonging within the computing field. The findings provide new knowledge both on the importance of role models for female computing students and on how to develop learning videos for improved gender diversity in computing education.

The findings support previous work indicating that a wide variety of role models can increase female computing students' sense of belonging in their field. Furthermore, the findings challenge previous findings about teachers as role models in higher education, most likely due to big regional differences in the structure of higher education computing classes. This research contributes to knowledge about what role models can provide in supporting female computing students in completing their education, as well as what types of people are typically qualified for such a role modeling process.

Previous video interventions about role models have typically been videos that introduce the viewer to actual people as potential role models. As a video intervention focusing more on increased knowledge on the topic for students to find their role models from existing relations, this research is providing a new approach to helping non-male identifying computing students collect more role models. The evaluation of the learning video support that it is important to make sure viewers are emotionally connected to the content that is being presented to them in these types of instructional videos. This could be achieved through emotional design with warm colors and active reflection exercises included in the video. Furthermore, for the information to be presented in a way that is easy to understand and remember for the viewers one should consider using signaling to highlight important information and keep transience in mind as to not try and include too much information in too little time.

7.1 Future Work

As an exploratory study limited to the time frame of a master's thesis, the number of participants in the interviews is not big enough to draw generalized conclusions about the larger population of Norway or Brazil. Since the findings indicate some significant geographical differences between Norway and Brazil more research should be done in different geographical areas. To gain knowledge from a more diverse geographical area there are plans for this work to be continued, conducting data collection in Türkiye, a country in the intersection between the Global North and Global South.

Even though the goal was to include both female and non-binary voices in the data collection, the final sample was only female. Future studies should continue to include gender identities outside of the binary, as there is still very sparse knowledge about this group of students and how they experience the mostly homogeneous computing field. Furthermore, it seems that female computing students, at least in Norway, collect a lot of role models that increase their sense of belonging and mirror personal traits that they admire. These traits are, however, very gender-typical in line with existing stereotypes such as women being caring, kind and helpful. It would be interesting to do a more extensive investigation into the process of collecting role models for women and men and compare how they each benefit from role models since men typically already have a strong sense of belonging in computing and thus might collect role models to increase their ambition instead.

Finally, future research should explore how higher education institutions could adjust their classes to facilitate a role modeling process for their students. This research suggests that a personal relation to the teacher is important for them to serve as good examples and relevant role models to their female computing students. Furthermore, since female students often are inspired by their peers, especially their female peers, research should explore how class design can facilitate networking for their female students, so they don't have to rely on external projects such as Ada.

REFERENCES

[1] H. S. Haugland, *Role models as an intervention for improved gender diversity in computing*, Preperatory Project, NTNU, Trondheim, Norway, Dec. 2023.

[2] R. Tatman, "Gender and dialect bias in YouTube's automatic captions," in *Proceedings of the First ACL Workshop on Ethics in Natural Language Processing*, D. Hovy, S. Spruit, M. Mitchell, E. M. Bender, M. Strube, and H. Wallach, Eds., Valencia, Spain: Association for Computational Linguistics, Apr. 2017, pp. 53–59. DOI: 10.18653/v1/W17-1606.

[3] E. Gustafsson, P. W. Johnson, and M. Hagberg, "Thumb postures and physical loads during mobile phone use – a comparison of young adults with and without musculoskeletal symptoms," *Journal of Electromyography and Kinesiology*, vol. 20, no. 1, pp. 127–135, 2010. DOI: 10.1016/j.jelekin.2008.11.010.

[4] A. Caliskan, J. J. Bryson, and A. Narayanan, "Semantics derived automatically from language corpora contain human-like biases," *Science*, vol. 356, no. 6334, pp. 183–186, 2017. DOI: 10.1126/science.aal4230.

[5] A. J. Larrazabal, N. Nieto, V. Peterson, D. H. Milone, and E. Ferrante, "Gender imbalance in medical imaging datasets produces biased classifiers for computer-aided diagnosis," *Proceedings of the National Academy of Sciences*, vol. 117, no. 23, pp. 12 592–12 594, 2020. DOI: 10.1073/pnas.1919012117.

[6] C. R. Østergaard, B. Timmermans, and K. Kristinsson, "Does a different view create something new? the effect of employee diversity on innovation," *Research policy*, vol. 40, no. 3, pp. 500–509, 2011. DOI: 10.1016/j.respol.2010.11.004.

[7] G. Catolino, F. Palomba, D. A. Tamburri, A. Serebrenik, and F. Ferrucci, "Gender diversity and women in software teams: How do they affect community smells?" In *2019 IEEE/ACM 41st International Conference on Software Engineering: Software Engineering in Society (ICSE-SEIS)*, IEEE, 2019, pp. 11–20. DOI: 10.1109/ICSE-SEIS.2019.00010.

[8] K. Widdicks, A. Ashcroft, E. Winter, and L. Blair, "Women's sense of belonging in computer science education: The need for a collective response," in *Proceedings of the 2021 Conference on United Kingdom & Ireland Computing Education Research*, ser. UKICER '21, Glasgow, United Kingdom: Association for Computing Machinery, 2021. DOI: 10.1145/3481282.3481288.

[9] B. Trinkenreich, R. Britto, M. A. Gerosa, and I. Steinmacher, "An empirical investigation on the challenges faced by women in the software industry: A case study," in *Proceedings of the 2022 ACM/IEEE 44th International Conference on Software Engineering: Software Engineering in Society*, 2022, pp. 24–35. DOI: 10.1145/3510458.3513018.

[10] J. Steele, J. B. James, and R. C. Barnett, "Learning in a man's world: Examining the perceptions of undergraduate women in male-dominated academic areas," *Psychology of women quarterly*, vol. 26, no. 1, pp. 46–50, 2002. DOI: 10.1111/1471-6402.00042.

[11] S. Cheryan, B. J. Drury, and M. Vichayapai, "Enduring influence of stereotypical computer science role models on women's academic aspirations," *Psychology of women quarterly*, vol. 37, no. 1, pp. 72–79, 2013. DOI: 10.1177/0361684312459328.

[12] T. Morgenroth, M. K. Ryan, and K. Peters, "The motivational theory of role modeling: How role models influence role aspirants' goals," *Review of general psychology*, vol. 19, no. 4, pp. 465–483, 2015. DOI: 10.1037/gpr0000059.

[13] L. Happe, B. Buhnova, A. Koziolek, and I. Wagner, "Effective measures to foster girls' interest in secondary computer science education: A literature review," *Education and Information Technologies*, vol. 26, pp. 2811–2829, 2021. DOI: 10.1007/s10639-020-10379-x.

[14] D. E. Gibson, "Role models in career development: New directions for theory and research," *Journal of vocational behavior*, vol. 65, no. 1, pp. 134–156, 2004. DOI: 10.1016/S0001-8791(03)00051-4.

[15] S. Cheryan, J. O. Siy, M. Vichayapai, B. J. Drury, and S. Kim, "Do female and male role models who embody stem stereotypes hinder women's anticipated success in stem?" *Social psychological and personality science*, vol. 2, no. 6, pp. 656–664, 2011. DOI: 10.1177/1948550611405218.

[16] M. Sánchez-Gordón, R. Colomo-Palacios, and A. S. Gordon, "Characterizing role models in software practitioners' career: An interview study," *Proceedings of the 317th International Conference on Cooperative and Human Aspects of Software Engineering*, 2024. DOI: 10.48550/arXiv.2402.09925.

[17] J. Steinke, B. Applegate, J. R. Penny, and S. Merlino, "Effects of diverse stem role model videos in promoting adolescents' identification," *International Journal of Science and Mathematics Education*, pp. 1–22, 2021. DOI: 10.1007/s10763-021-10168-z.

[18] L. Jaccheri, C. M. Cutrupi, M. G. Diaconu, A. Szlavi, A. J. W. Takaoka, and V. Lenarduzzi, "Where are the female professors in stem?" *Authorea Preprints*, 2023. DOI: 10.36227/techrxiv.21760532.v2.

[19] *Women stem up*, visited: 25/01/2024, 2023. [Online]. Available: https://women-stem-up.eu/summary/.

[20] W. H. Organization, *Gender and health*, visited: 31/01/2024, 2024. [Online]. Available: https://www.who.int/health-topics/gender#tab=tab_1.

[21] J. Butler, *Gender trouble*. routledge, 2002, ISBN: 9780203902752.

[22] S. Monro, "Non-binary and genderqueer: An overview of the field," *International Journal of Transgenderism*, vol. 20, no. 2-3, pp. 126–131, 2019. DOI: 10.1080/15532739.2018.1538841.

[23] I. H. Service, *Two-spirit*, visited 31/01/2024. [Online]. Available: https://www.ihs.gov/lgbt/health/twospirit/.

[24] U. Nations, *Goal 5 achieve gender equality and empower all women and girls*, visited: 25/10/2023, 2023. [Online]. Available: https://sdgs.un.org/goals/goal5.

[25] B. Myers, *Women and minorities in tech, by the numbers*, visited: 06/03/24, Mar. 2018. [Online]. Available: https://www.wired.com/story/computer-science-graduates-diversity/.

[26] T. D. for Higher Education and Skills, *Dbh*, data retrieved from Database for Statistics on Higher Education, https://dbh.hkdir.no, Jan. 2024.

[27] M. Apiola, M. Saqr, S. López-Pernas, and M. Tedre, "Computing education research compiled: Keyword trends, building blocks, creators, and dissemination," *IEEE Access*, vol. 10, pp. 27 041–27 068, 2022. DOI: 10.1109/ACCESS.2022.3157609.

[28] V. A. Lagesen, I. Pettersen, and L. Berg, "Inclusion of women to ict engineering–lessons learned," *European Journal of Engineering Education*, vol. 47, no. 3, pp. 467–482, 2022. DOI: 10.1080/03043797.2021.1983774.

[29] P. Brauner, M. Ziefle, U. Schroeder, T. Leonhardt, N. Bergner, and B. Ziegler, "Gender influences on school students' mental models of computer science: A quantitative rich picture analysis with sixth graders," in *Proceedings of the 4th Conference on Gender & IT*, 2018, pp. 113–122. DOI: 10.1145/3196839.3196857.

[30] A. Master, S. Cheryan, and A. N. Meltzoff, "Computing whether she belongs: Stereotypes undermine girls' interest and sense of belonging in computer science," *Journal of Educational Psychology*, pp. 424–437, 2016. DOI: 10.1037/edu0000061.

[31] B. J. Drury, J. O. Siy, and S. Cheryan, "When do female role models benefit women? the importance of differentiating recruitment from retention in stem," *Psychological Inquiry*, vol. 22, no. 4, pp. 265–269, 2011. DOI: 10.1080/1047840X.2011.620935.

[32] S. Cheryan, A. Master, and A. N. Meltzoff, "Cultural stereotypes as gatekeepers: Increasing girls' interest in computer science and engineering by diversifying stereotypes," *Frontiers in psychology*, p. 49, 2015. DOI: 10.3389/fpsyg.2015.00049.

[33] L. og diskrimineringsombudet, *7. registrering av kjønn*, visited: 19/02/2024. [Online]. Available: https://ldo.no/diskriminert_oldstart/nyheiter-og-fag/Analyser/fagoppsummering-skk/kap.-7/.

[34] M. Holanda, A. Araujo, D. Da Silva, *et al.*, "Sense of belonging of female undergraduate students in introductory computer science courses at university of brasília in brazil," in *2021 IEEE Frontiers in Education Conference (FIE)*, 2021, pp. 1–6. DOI: 10.1109/FIE49875.2021.9637281.

[35] M. Holanda, T. Klysnney, A. Araujo, *et al.*, "Gender diversity in stem graduate programs at the university of brasília in brazil," in *2022 IEEE Frontiers in Education Conference (FIE)*, 2022, pp. 1–9. DOI: 10.1109/FIE56618.2022.9962722.

[36] "Oxford english dictionary," in role model (n.), Oxford University Press, Jul. 2023. DOI: 10.1093/OED/9687057022.

[37] P. Lockwood and Z. Kunda, "Superstars and me: Predicting the impact of role models on the self.," *Journal of personality and social psychology*, vol. 73, no. 1, p. 91, 1997.

[38] V. Grande, A. Berglund, and M. Daniels, "Experiences of teachers in computing as role models: A phenomenographic study," in *Proceedings of the 17th Koli Calling International Conference on Computing Education Research*, 2017, pp. 133–137. DOI: 10.1145/3141880.3141901.

[39] C. Lang, J. Fisher, A. Craig, and H. Forgasz, "Computing, girls and education: What we need to know to change how girls think about information technology.," *Australasian Journal of Information Systems*, vol. 24, 2020. DOI: 10.3127/ajis.v24i0.1783.

[40] Z. Şahin Timar and Ö. Mısırlı, "Effective strategies for encouraging girls in informatics," in *International Conference on Human-Computer Interaction*, Springer, 2023, pp. 377–392. DOI: 10.1007/978-3-031-35897-5_27.

[41] Y. Rankin, M. Agharazidermani, and J. Thomas, "The role of familial influences in african american women's persistence in computing," in *2020 Research on Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT)*, IEEE, vol. 1, 2020, pp. 1–8. DOI: 10.1109/RESPECT49803.2020.9272503.

[42] V. Grande, A.-K. Peters, M. Daniels, and M. Tedre, "'participating under the influence': How role models affect the computing discipline, profession, and student population," in *2018 IEEE frontiers in education conference (FIE)*, IEEE, 2018, pp. 1–9. DOI: 10.1109/FIE.2018.8658944..

[43] A. Szlavi, "Barriers, role models, and diversity – women in it," *Central-European Journal of New Technologies in Research, Education and Practice*, vol. 3, no. 3, pp. 20–26, 2021. DOI: 10.36427/CEJNTREP.3.3.2582.

[44] A. Szlavi, M. F. Hansen, S. H. Husnes, and T. U. Conte, "Intersectionality in computer science: A systematic literature review," in *2023 IEEE/ACM 4th Workshop on Gender Equity, Diversity, and Inclusion in Software Engineering (GEICSE)*, IEEE, 2023, pp. 9–16. DOI: 10.1109/GEICSE59319.2023.00006..

[45] G. Crisp and I. Cruz, "Mentoring college students: A critical review of the literature between 1990 and 2007," *Research in higher education*, vol. 50, pp. 525–545, 2009. DOI: 10.1007/s11162-009-9130-2.

[46] C. A. Mullen and C. C. Klimaitis, "Defining mentoring: A literature review of issues, types, and applications," *Annals of the New York Academy of Sciences*, vol. 1483, no. 1, pp. 19–35, 2021. DOI: 10.1111/nyas.14176.

[47] L. G. Lunsford, G. Crisp, E. L. Dolan, and B. Wuetherick, "Mentoring in higher education," *The SAGE handbook of mentoring*, vol. 20, pp. 316–334, 2017.

[48] NTNU, *Ada*, visited: 01/02/2024. [Online]. Available: https://www.ntnu.no/ada.

[49] NTNU, *Idun - from phd to professor*, visited: 01/02/2024. [Online]. Available: https://www.ntnu.edu/idun.

[50] B. Kitchenham, "Procedures for performing systematic reviews," *Keele, UK, Keele University*, vol. 33, no. 2004, pp. 1–26, 2004.

[51] B. Kitchenham and S. Charters, "Guidelines for performing systematic literature reviews in software engineering," vol. 2, Jan. 2007.

[52] D. Lamers and R. Mason, "Advertising cs/it degrees to female students in australia," in *Proceedings of the 20th Australasian Computing Education Conference*, ser. ACE '18, Brisbane, Queensland, Australia: Association for Computing Machinery, 2018, pp. 1–8. DOI: 10.1145/3160489.3160497.

[53] M. Fulcher, K. Schroeder, and J. Rabung, "Barbie, i can ('t) be a computer engineer: The impact of barbie text and images on girls' computing performance," *Journal for STEM Education Research*, pp. 1–27, 2023. DOI: 10.1007/s41979-023-00110-z.

[54] L. Vasconcelos, F. Ari, I. Arslan-Ari, and L. Lamb, "Female preservice teachers stereotype computer scientists as intelligent and overworked white individuals wearing glasses," *Computers & Education*, vol. 187, p. 104 563, 2022. DOI: 10.1016/j.compedu.2022.104563.

[55] T. Berg, A. Sharpe, and E. Aitkin, "Females in computing: Understanding stereotypes through collaborative picturing," *Computers & Education*, vol. 126, pp. 105–114, 2018. DOI: 10.1016/j.compedu.2018.07.007.

[56] M. Gutica, "Fostering high school girls' interest and attainment in computer science," in *Proceedings of the 26th ACM Conference on Innovation and Technology in Computer Science Education V. 1*, ser. ITiCSE '21, Virtual Event, Germany: Association for Computing Machinery, 2021, pp. 471–477. DOI: 10.1145/3430665.3456353.

[57] L. El-Hamamsy, B. Bruno, C. Audrin, *et al.*, "How are primary school computer science curricular reforms contributing to equity? impact on student learning, perception of the discipline, and gender gaps," *arXiv preprint arXiv:2306.00820*, 2023. DOI: 10.1186/s40594-023-00438-3.

[58] E. Taylor-Smith, C. Barnett, S. Smith, M. Barr, and C. Shankland, "Participant-centred planning framework for effective gender balance activities in tech," in *Proceedings of the 2022 Conference on United Kingdom & Ireland Computing Education Research*, ser. UKICER '22, Dublin, Ireland: Association for Computing Machinery, 2022. DOI: 10.1145/3555009.3555016.

[59] S. Clayton, C. Hawkins, and J. Brandsema, "Rural implementation of girls' programming network (gpn)," *Australian and International Journal of Rural Education*, vol. 31, no. 2, pp. 38–45, 2021.

[60] J. G. Stout, B. Tamer, H. M. Wright, L. A. Clarke, S. Dwarkadas, and A. M. Howard, "The grad cohort workshop: Evaluating an intervention to retain women graduate students in computing," *Frontiers in psychology*, vol. 7, p. 2071, 2017. DOI: 10.3389/fpsyg.2016.02071.

[61] A. Sullivan and M. U. Bers, "The impact of teacher gender on girls' performance on programming tasks in early elementary school," *Journal of Information Technology Education. Innovations in Practice*, vol. 17, p. 153, 2018. DOI: 10.28945/4082.

[62] M. E. Vachovsky, G. Wu, S. Chaturapruek, O. Russakovsky, R. Sommer, and L. Fei-Fei, "Toward more gender diversity in cs through an artificial intelligence summer program for high school girls," in *Proceedings of the 47th ACM Technical Symposium on Computing Science Education*, ser. SIGCSE '16, Memphis, Tennessee, USA: Association for Computing Machinery, 2016, pp. 303–308. DOI: 10.1145/2839509.2844620.

[63] A. Alshahrani, I. Ross, and M. I. Wood, "Using social cognitive career theory to understand why students choose to study computer science," in *Proceedings of the 2018 ACM Conference on International Computing Education Research*, ser. ICER '18, Espoo, Finland: Association for Computing Machinery, 2018, pp. 205–214. DOI: 10.1145/3230977.3230994.

[64] B. Spieler, J. Mikats, S. Valentin, L. Oates-Indruchová, and W. Slany, ""remotementor" evaluation of interactions between teenage girls, remote tutors, and coding activities in school lessons," in *Learning and Collaboration Technologies. Designing, Developing and Deploying Learning Experiences: 7th International Conference, LCT 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings, Part I 22*, Springer, 2020, pp. 547–567. DOI: 10.1007/978-3-030-50513-4_40.

[65] L. E. Odeh, "A comparative analysis of global north and global south economies," *Journal of Sustainable Development in Africa*, vol. 12, no. 3, 2010.

[66] S. D. Sorden, "The cognitive theory of multimedia learning," *Handbook of educational theories*, vol. 1, no. 2012, pp. 1–22, 2012.

[67] M. Fyfield, M. Henderson, and M. Phillips, "Improving instructional video design: A systematic review," *Australasian Journal of Educational Technology*, vol. 38, no. 3, pp. 155–183, 2022. DOI: 10.14742/ajet.7296.

[68] B. J. Oates, M. Griffiths, and R. McLean, *Researching information systems and computing*. Sage, 2022, ISBN: 978-1-5297-3269-6.

[69] R. A. Krueger and M. A. Casey, *Focus Group - A practical gruide for applied research*. Sage, 2009, ISBN: 1412969476.

[70] D. M. Keats, *Interviewing : a practical guide for students and professionals*, eng. Buckingham: Open University Press, 2000, ISBN: 0335206670.

[71] V. Braun, V. Clarke, N. Hayfield, L. Davey, and E. Jenkinson, "Doing reflexive thematic analysis," in *Supporting Research in Counselling and Psychotherapy: Qualitative, Quantitative, and Mixed Methods Research*, Springer, 2023, pp. 19–38, ISBN: 978-3-031-13941-3.

[72] V. Braun and V. Clarke, "One size fits all? what counts as quality practice in (reflexive) thematic analysis?" *Qualitative research in psychology*, vol. 18, no. 3, pp. 328–352, 2021. DOI: 10.1080/14780887.2020.1769238.

[73] C. Hampton, D. Reeping, and D. S. Ozkan, "Positionality statements in engineering education research: A look at the hand that guides the methodological tools," *Studies in Engineering Education*, vol. 1, no. 2, 2021. DOI: 10.21061/see.13.

[74] A. Szlavi, M. F. Hansen, S. H. Husnes, T. Conte, and L. Jaccheri, "Integrating intersectionality in software engineering," *Available at SSRN 4797964*, 2024. DOI: 10.2139/ssrn.4797964.

[75] P. Lockwood, ""someone like me can be successful": Do college students need same-gender role models?" *Psychology of women quarterly*, vol. 30, no. 1, pp. 36–46, 2006. DOI: 10.1111/j.1471-6402.2006.00260.x.

[76] C. A. Moss-Racusin, E. S. Pietri, E. P. Hennes, *et al.*, "Reducing stem gender bias with vids (video interventions for diversity in stem).," *Journal of Experimental Psychology: Applied*, vol. 24, no. 2, p. 236, 2018. DOI: 10.1037/xap0000144.

[77] D. Zhang, L. Zhou, R. O. Briggs, and J. F. Nunamaker Jr, "Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness," *Information & management*, vol. 43, no. 1, pp. 15–27, 2006. DOI: 10.1016/j.im.2005.01.004.

[78] D. S. Cruzes and L. ben Othmane, "Threats to validity in empirical software security research," in *Empirical research for software security*, CRC Press, 2017, pp. 275–300, ISBN: 9781315154855.

APPENDICES

A - ORIGINAL PROJECT DESCRIPTION

To be accepted as a master student, you are encouraged to participate to attend the 10th ACM Celebration of Women in Computing womENcourage[1] that is going to take place in Trondheim, Norway, 20-22 September, 2023! You will have the option to present a poster and network with the community, gaining inspiration (including a hackathon and a career fair).

This project/master thesis will build on existing bulk of knowledge about gender and diversity in software development (TDT10) to provide increased knowledge and solutions about Inclusion and Diversity, especially gender diversity, in Computer Science over Europe. Specifically in this project/master thesis, the student(s) will propose one or more goals to investigate as discussed below.

The student(s) will

- analyze data in connection with the gender aspects of Computer Science education,
- contribute to developing a Leadership and Inspiration Academy at NTNU to facilitate gender-inclusive education,
- design, implement, and evaluate new tech solutions which contribute to solve the problem of inclusion in Computer Science education (for example, developing an app or a website for university students)

Students will work within the frames of the project Women STEM UP (Home – Women Stem Up (women-stem-up.eu). Materials to analyze are readily available, including surveys collected with NTNU students and teachers regarding the state of CS education and gender.

Some possible practical outcomes are: developing a mobile app or a website for mentoring, gender awareness, gender training in CS, etc.

The supervisors will provide the student(s) with Initial Literature and help the student(s) to access to Stakeholders and initial data for the Empirical Investigation.

[1] https://womencourage.acm.org/2023/

B - DATA COLLECTION

B1 - Sikt Application

Sikt

Notification Form

Reference number
882540

Which personal data will be processed?

- Voice on audio recordings
- Background information that, when combined, can be used to identify an individual

Describe the background information
Gender, Enrolled university including year of study, Nationality, Signature (for consent form only)

Project information

Title
Role models as an intervention for gender diversity in computing

Summary
The project is a masters project that aims to plan, develop and test new technology related to using role models as an intervention to improve gender diversity in computing.

What is the purpose for processing personal data?
The purpose of the research is to develop an online platform about role models in computing as an intervention for improved gender equality in computing education. Becuase of the aim of the research information about gender i required. Information about nationality and enrolled university is required because this research aims to fill a gap about lack of research on gender equality in the global south and students from Brazil will hopefully be interviewed. It is helpful to learn if there is any difference between Norwegian and Brazilian students. Audio recordings is required to improve the reliability of the research, as it would be challenging to script everything said in the interview live. Signature is required only for the participants to sign a consent form to be part of the interview.

External funding
Ikke utfyllt
Type of project
Master's

Contact information, student
Hanne Sofie Haugland, hsofiehaugland@gmail.com, tlf: +4791998490

Data controller

Institution responsible for the project
Norges teknisk-naturvitenskapelige universitet / Fakultet for informasjonsteknologi og elektroteknikk (IE) / Institutt for datateknologi og informatikk

Project leader
Letizia Jaccheri, letizia.jaccheri@ntnu.no, tlf: 91897028

Do multiple institutions share responsibility (joint data controllers)?
No

Sample 1

Describe the sample
Non-male computing students (Bachelor, masters and doctorate) at university level from Norway and Brazil.

Describe how you will identify or contact the sample
I will recruit from my own network in Norway and through the NTNU IDI's network in Brazil.

Age group
19 - 35

Are any of these groups included in the sample?
- Persons residing in countries outside the EU/EEA

Which data relating to sample {{i}} will be processed? 1

- Voice on audio recordings
- Background information that, when combined, can be used to identify an individual

How will data relating to sample 1 be collected?

Personal interview

Attachment

Interview Guide.pdf

Legal basis for processing general personal data
Consent (General Data Protection Regulation art. 6 nr. 1 a)

Information for sample 1

Will the sample receive information about the processing of personal data?
Yes

How does the sample receive information about the processing?
Written (on paper or electronically)

Information letter

Information letter SIKT.pdf

Sample 2

Describe the sample
Non-male computing students and university-educators of all genders.

Describe how you will identify or contact the sample
Will recruit from own network and as a presenter at a conference.

Age group
19 - 60

Are any of these groups included in the sample?

- Persons residing in countries outside the EU/EEA

Which data relating to sample {{i}} will be processed? 2

- Background information that, when combined, can be used to identify an individual

How will data relating to sample 2 be collected?

Group interview

Attachment

Group Interview Guide.pdf

Legal basis for processing general personal data
Consent (General Data Protection Regulation art. 6 nr. 1 a)

Information for sample 2

Will the sample receive information about the processing of personal data?
Yes

How does the sample receive information about the processing?
Written (on paper or electronically)

Information letter

Information letter SIKT Focus Gorup.pdf

Third persons

Will the project collect information about third persons?
No

Documentation

How will consent be documented?

- Electronically (email, e-form, digital signature)

How can consent be withdrawn?
By contact via email to either the supervisor or me, the master student.

How can data subjects get access to their personal data or have their personal data corrected or deleted?
By contact via email to either the supervisor or me, the master student.

Total number of data subjects in the project
1-99

Approvals

Will any of the following approvals or permits be obtained?
Ikke utfyllt

Security measures

Will the personal data be stored separately from other data?
Yes

Which technical and practical measures will be used to secure the personal data?

- Continuous anonymisation
- Multi-factor authentication
- Restricted access

Where will the personal data be processed

- Hardware
- ?

Who has access to the personal data?

- Project leader
- Student (student project)
- Data processor

Which data processor will be processing/have access to the collected personal data?
Microsoft OneDrive is used to store the data from the interviews. NTNU has a data processors agreement with Microsoft, and all services are protected with password and 2FA. The student responsible for the empirical study, will be the only one with access to the personal data.

Will personal data be transferred to a third country?
No

Closure

Project period
08.01.2024 - 01.07.2024

What happens to the data at the end of the project?
Personal data will be anonymised (deleting or rewriting identifiable data)

Which anonymisation measures will be taken?

- The identification key will be deleted
- Any sound or video recordings will be deleted

Will the data subjects be identifiable in publications?
No

Additional information

B2 - Consent Form Interview

Are you interested in taking part in the research project

"Role Models in Computing Education for Improved Gender Diversity"?

Purpose of the project
You are invited to participate in a research project where the main purpose is to develop a prototype that utilizes role models as an intervention for improved gender diversity in computing education. The interview aims to answer the following research question:

RQ1: How can role models improve retention of non-male identifying computing students in higher education?

The project is carried out as a Master's thesis at NTNU's IDI.

Which institution is responsible for the research project?
Norwegian University of Science and Technology is responsible for the project (data controller).

Why are you being asked to participate?
The sample population for participants are non-male computing students enrolled at university in Norway or Brazil. 14 people have been asked to participate.

What does participation involve for you?
If you chose to take part in the project, this will involve that you participate in an interview. It will take approx. 30 minutes. The interview includes questions about role models in computing, and you motivation throughout your computing studies. The interview will be recorded electronically for transcription purposes.

Participation is voluntary
Participation in the project is voluntary. If you chose to participate, you can withdraw your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you chose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data
We will only use your personal data for the purpose(s) specified here and we will process your personal data in accordance with data protection legislation (the GDPR).

- Only the master student responsible for the research will have access to the personal data
- The data will be stored in Microsoft One Drive with personal data separate from the interview answers. Access to the data is restricted with both login and 2FA to keep it secure

Participants will not be recognizable in the final publications. Quotes from interviews will not be cited along with any personal information, as to not be recognizable for anyone in the publication.

What will happen to your personal data at the end of the research project?
The planned end date of the project is 08.07.2024. At this time, the audio recordings will be deleted along with personal data. Only leaving the interview answers, but no longer able to be tied to you personally. The reason for not deleting all data is the possibility of a publication of the findings from the master's thesis.

Your rights
So long as you can be identified in the collected data, you have the right to:

- access the personal data that is being processed about you
- request that your personal data is deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and
- send a complaint to the Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?
We will process your personal data based on your consent.

Based on an agreement with Norwegian University of Science and Technology, The Data Protection Services of Sikt – Norwegian Agency for Shared Services in Education and Research has assessed that the processing of personal data in this project meets requirements in data protection legislation.

Where can I find out more?
If you have questions about the project, or want to exercise your rights, contact:

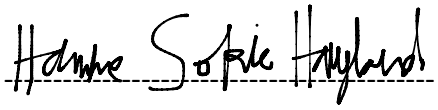
- Norwegian University of Science and Technology via Letizia Jaccheri (letizia.jaccheri@ntnu.no) and Hanne Sofie Haugland (hash@stud.ntnu.no)
- Our Data Protection Officer: Thomas Ørnulf Helgesen

If you have questions about how data protection has been assessed in this project by Sikt, contact:

- email: (personverntjenester@sikt.no) or by telephone: +47 73 98 40 40.

Yours sincerely,

Hanne Sofie Haugland
(Master's Student)



Consent form

I have received and understood information about the project "Role Models in Computing Education for improved Gender Diversity" and have been given the opportunity to ask questions. I give consent:

☐ to participate in an interview

I give consent for my personal data to be processed until the end of the project.

(Signed by participant, date)

B3 - Interview Guide

Interview Guide

Role Models for Female and Non-Binary Computing Students

Structure:

The interview will be about 30 minutes. The interview will be semi-structured, so participants might share more information than what is provided by the questions, but only if related to the overarching topic of role models in computing education. All questions will be voluntary to answer.

Purpose:

The purpose of the interview is to explore which role models female and non-binary students have gathered throughout their education, and how these role models have influenced their motivation to complete their studies.

Questions:

Intro Thank you so much for taking time out of your day to participate in this interview. I will be asking a few questions I have prepared, but you are always welcome to share other thoughts you might have on the topics we touch on. All questions are voluntary to answer, and you may also stop the interview at any given time if you feel the need to.

- What country are you studying in?
- What gender do you identify as?
- What study program are you currently enrolled in?
- What year are you currently in?

i) Do you see yourself as a typical computing student?
    a. Why? / Why not?
ii) What are your experiences with being a female/non-binary data student?
iii) What has motivated you to continue with your computing studies?
iv) Can you think of any people who have been part of why you have continued with your field of study?
v) Who do you look up to / admire in your everyday life as a student?
    a. Why do you look up to these people?
    b. Do you have something in common with this person(s)? Gender? Age? Personal characteristics?

vi) Do you remember seeing or meeting someone who made you think "I don't want to be like them" during your education? Teacher, student, lecturer, company representative etc.
    a. If so, what did they do that you wouldn't do yourself?
vii) Have you ever been inspired by a fellow student?
    a. If so, was the person in a higher or lower grade?
    b. If so, did you know the person well?
viii) Can you remember any teachers or lecturers who have motivated or inspired you during your education?
    a. If so, can you tell a little about why they motivated? Were they inspiring? Good at teaching? Good at your subject?
    b. Did you have something in common with this teacher? Sex? Age? Personal characteristics?
ix) Does anyone in your family work with STEM?
    a. If so, how do you think this has affected your interest and motivation throughout the course of study?
x) Do you have any role models?
    a. Do you find other female/non-binary role models easier to relate to and/or more inspiring than male role models?
xi) What do you associate with the word role model?
xii) Is there anything else on your mind about this topic that you haven't been able to share?

B4 - Consent Form Focus Group

Are you interested in taking part in the research project

"Role Models in Computing Education for Improved Gender Diversity"?

Purpose of the project
You are invited to participate in a research project where the main purpose is to develop a prototype that utilizes role models as an intervention for improved gender diversity in computing education. The focus group aims to answer the following research question:

RQ2: How to design and develop a digital artefact about role models for non-male identifying computing students?

The project is carried out as a Master's thesis at NTNU's IDI.

Which institution is responsible for the research project?
Norwegian University of Science and Technology is responsible for the project (data controller).

Why are you being asked to participate?
The sample population for participants are non-male computing students enrolled at university and employees in a teaching position at university. You are being asked to participate because you fit one of these sample descriptions.

What does participation involve for you?
If you chose to take part in the project, this will involve that you participate in a focus group. It will take approx. 40 minutes. The focus group will start by showing of an animated video, followed by some questions about the video. Answers will be documented using digital note taking continuously throughout the focus group.

Participation is voluntary
Participation in the project is voluntary. If you chose to participate, you can withdraw your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you chose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data
We will only use your personal data for the purpose(s) specified here and we will process your personal data in accordance with data protection legislation (the GDPR).

- Only the master student responsible for the research will have access to the personal data
- The data will be stored in Microsoft One Drive with personal data separate from the transcript. Access to the data is restricted with both login and 2FA to keep it secure

Participants will not be recognizable in the final publications. Quotes from the focus group will not be cited along with any personal information, as to not be recognizable for anyone in the publication.

What will happen to your personal data at the end of the research project?
The planned end date of the project is 08.07.2024. At this time, any personal data will be deleted. Only leaving the answers given, but no longer able to be tied to you personally. The reason for not deleting all data is the possibility of a publication of the findings from the master's thesis.

Your rights
So long as you can be identified in the collected data, you have the right to:

- access the personal data that is being processed about you
- request that your personal data is deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and
- send a complaint to the Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?
We will process your personal data based on your consent.

Based on an agreement with Norwegian University of Science and Technology, The Data Protection Services of Sikt – Norwegian Agency for Shared Services in Education and Research has assessed that the processing of personal data in this project meets requirements in data protection legislation.

Where can I find out more?
If you have questions about the project, or want to exercise your rights, contact:

- Norwegian University of Science and Technology via Letizia Jaccheri (letizia.jaccheri@ntnu.no) and Hanne Sofie Haugland (hash@stud.ntnu.no)
- Our Data Protection Officer: Thomas Ørnulf Helgesen

If you have questions about how data protection has been assessed in this project by Sikt, contact:

- email: (personverntjenester@sikt.no) or by telephone: +47 73 98 40 40.

Yours sincerely,

Hanne Sofie Haugland
(Master's Student)

Consent form

I have received and understood information about the project "Role Models in Computing Education for improved Gender Diversity" and have been given the opportunity to ask questions. I give consent:

☐ to participate in a focus group

I give consent for my personal data to be processed until the end of the project.

(Signed by participant, date)

B5 - Focus Group Guide

Interview Guide – Focus Group

Role Models for Female Computing Students

Structure:
The focus group will be about 30-45 minutes. To start off, all participants will be shown a video about role models in computing education. The participants will then be asked questions about the video, both content and form.

Purpose:
The purpose of the focus group is to get an evaluation of a digital artifact (animated video) whose intended use is to educate about role models in the context of computing education.

Questions:
Intro Thank you so much for taking time out of your day to participate in this focus group. I will be asking a few questions I have prepared, but you are always welcome to share other thoughts you might have on the topics we touch on.

Introductory

i) What did the video make you feel?

Transition

ii) What are your thoughts on the information presented?
iii) To what extent do you feel heard and seen by the content presented?

Key questions

iv) What do you think is the purpose of the video?
v) How do you think the chosen visual aids help convey the message?
vi) What do you think about the structure of the video?
vii) To what extent was this video helpful for you?

Ending questions

viii) Do you feel like any important points are missing?
ix) Is there anything that we have not talked about that you would like to share?

Comparison (Only group 1)

x) What format do you prefer and why?
xi) What content do you prefer and why?

C - AI DECLARATION

NTNU

Deklarasjon om KI-hjelpemidler

Har det i utarbeidingen av denne rapporten/avhandlingen blitt anvendt KI-baserte hjelpemidler?

- ○ Nei
- ◉ Ja

Hvis *ja*: spesifiser type av verktøy og bruksområde under.

Tekst

- ☑ **Stavekontroll.** Er deler av teksten kontrollert av:
  Grammarly, Ginger, Grammarbot, LanguageTool, ProWritingAid, Sapling, Trinka.ai eller lignende verktøy?
- ☐ **Tekstgenerering.** Er deler av teksten generert av:
  ChatGPT, GrammarlyGO, Copy.AI, WordAi, WriteSonic, Jasper, Simplified, Rytr eller lignende verktøy?
- ☐ **Skriveassistanse.** Er en eller flere av ideene eller fremgangsmåtene i oppgaven foreslått av:
  ChatGPT, Google Bard, Bing chat, YouChat eller lignende verktøy?

Hvis *ja* til anvendelse av et tekstverktøy - spesifiser bruken her:

Jeg har brukt Microsoft Word sitt rettskrivingsverktøy til stavekontroll i teksten.

Koder og algoritmer

- ☐ **Programmeringsassistanse.** Er deler av koden/algoritmene som i) fremtrer direkte i rapporten eller ii) har blitt anvendt for produksjon av resultater slik som figurer, tabeller eller tallverdier blitt generert av: *GitHub Copilot, CodeGPT, Google Codey/Studio Bot, Replit Ghostwriter, Amazon CodeWhisperer, GPT Engineer, ChatGPT, Google Bard* eller lignende verktøy?

Hvis *ja* til anvendelse av et programmeringsverktøy - spesifiser bruken her:

Bilder og figurer

- ☐ **Bildegenerering.** Er ett eller flere av bildene/figurene i rapporten blitt generert av:
  Midjourney, Jasper, WriteSonic, Stability AI, Dall-E eller lignende verktøy?

Hvis *ja* til anvendelse av et bildeverktøy - spesifiser bruken her:

Andre KI-verktøy. Har andre typer av verktøy blitt anvendt? Hvis *ja* spesifiser bruken her:

- ☑ Jeg er kjent med NTNUs regelverk for bruk av kunstig intelligens. *Jeg har redegjort for all anvendelse av kunstig intelligens enten i) direkte i rapporten eller ii) i dette skjemaet.*

Hove Sobenhus 29/05/24, Trondheim

Underskrift/Dato/Sted

NTNU

Norwegian University of
Science and Technology