Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Department of Computer Science

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Intersectionality in Computer Science

Enhancing Diversity, Equity, and Inclusion Through Awareness and Intersectional Peer Community

Master's thesis in Computer Science
Supervisor: Letizia Jaccheri
Co-supervisor: Anna Szlavi
June 2023

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Abstract

Context: Diversity, equity, and inclusion (DEI) is important because it creates a more inclusive environment that benefits individuals, organisations and society as a whole. To gain a comprehensive understanding of DEI in computer science (CS), it is important to do so through an intersectional lens for a deeper exploration of the complexities and nuances of the issues and possible solutions to these.

Objective: This master's thesis seeks to explore DEI in CS by looking into intersectionality in the field and developing a website designed with an intersectional approach, which aims to help increase DEI in CS by facilitating a supportive peer community and raising awareness.

Method: In the preliminary phase, a systematic literature review (SLR) was conducted to analyse literature related to intersectionality in CS. This thesis follows an empirical design and creation approach using 1) semi-structured interviews with 17 students and professionals working in the CS field who feel a connection to intersectionality; 2) prototyping to design the website DiversIT, including five iterations with usability tests. The data gathering was conducted both in Norway and Brazil.

Results: The analysed data from the interviews indicates that there are similar challenges and success factors in Norway and Brazil, which also correlate to the findings in the literature. The main difference was that the participants interviewed in Brazil experienced more challenges related to socioeconomic status, which was not a challenge addressed by any of the Norwegian participants. An essential success factor in all of the analysed data was the importance of having a supportive network, and DiversIT was developed based on this factor.

Conclusion: Based on the findings, the research concludes that the impact of intersectionality needs to be acknowledged in the field of CS. DiversIT led to a promising high-fidelity prototype in terms of increasing DEI in CS. Future research could build upon this thesis to further increase knowledge of intersectionality and develop the prototype into a functioning website.

Keywords: *Intersectionality, diversity, equity, inclusion, computer science, systematic literature review, Sustainable Development Goals, Empirical Design and Creation*

Sammendrag

Kontekst: Likestilling, mangfold og inkludering (LMI) er viktig fordi det skaper et mer inkluderende miljø som gagner enkeltpersoner, organisasjoner og samfunnet som helhet. For å kunne få et fullstendig innblikk av dette innen IT, er det viktig å bruke interseksjonelle metoder, som legger til grunn for omfattende undersøkelser av kompleksitetene og nyansene til ulike problemstillinger, samt mulige løsninger på disse.

Formål: Denne masteroppgaven utforsker LMI innen IT ved å undersøke interseksjonalitet i feltet og utvikle en nettside ved bruk av interseksjonelle metoder. Målet er å bidra til økt LMI innen IT, ved å tilrettelegge for et støttende felleskap og øke bevisstheten rundt temaet.

Metode: Innledningsvis ble det utført en systematisk litteraturoversikt for å analysere faglitteratur knyttet til interseksjonalitet innen IT. Oppgaven følger en empirisk design- og utviklingsmetode, som inkluderer 1) semi-strukturerte intervjuer med 17 studenter og fagpersoner som jobber innen IT og føler tilknytning til interseksjonalitet; og 2) prototyping for å utvikle nettsiden DiversIT gjennom fem iterasjoner med tilhørende brukertester. Datainnsamlingen ble gjennomført både i Norge og Brasil.

Resultater: Dataene analysert fra intervjuene viser at det er lignende utfordringer og suksessfaktorer i både Norge og Brasil, som samsvarer med funnene i faglitteraturen. Den viktigste forskjellen var at intervjuobjektene fra Brasil opplevde flere utfordringer knyttet til sosioøkonomisk status, som ikke var en utfordring diskutert av intervjuobjektene i Norge. En vesentlig suksessfaktor fra de analyserte dataene var betydningen av å ha et støttende nettverk, som utviklingen av DiversIT er basert på.

Konklusjon: Funnene konkluderer med at betydningen av interseksjonalitet må anerkjennes innen IT. DiversIT ble en lovende prototype når det kom til å øke LMI i IT. Fremtidig forskning kan bygge videre på denne oppgaven ved å øke kunnskap om interseksjonalitet og videreutvikle prototypen til en fungerende nettside.

Nøkkelord: *Interseksjonalitet, mangfold, likestilling, inkludering, IT, systematisk litteraturoversikt, FNs bærekraftsmål, empirisk design- og utviklingsmetode*

Preface

This thesis is submitted as a part of the course TDT4900 – Computer Science, Master's Thesis at the Norwegian University of Science and Technology (NTNU).

The work has been performed at the Department of Computer Science at NTNU Trondheim under the supervision of Professor Letizia Jaccheri as the primary supervisor and Post-Doctoral Researcher Anna Szlavi as the co-supervisor.

The master's thesis builds on previous work from the project thesis submission for TDT4501 Computer Science, Specialisation Project and the extended abstract submission for the 9th ACM Celebration of Women in Computing: WomENcourage 2022. The extended abstract *Design, Implement and Evaluate New Tech Solutions Which Contribute to Solve the Problem of Inclusion in Tech* and the poster *Design and Develop for Inclusion* may be found in Appendix B.

The project thesis, *Intersectionality in Computer Science: A Systematic Literature Review*, was published in the 4th Workshop on Gender Equity, Diversity, and Inclusion in Software Engineering at the 45th International Conference on Software Engineering (GE@ICSE) 2023 and may be found in Appendix C. This paper is also being considered for publication in a journal issue of Journal of Systems and Software (JSS).

Acknowledgement

We want to thank Professor Letizia Jaccheri for her supervision through the project and Post-Doctoral Researcher Anna Szlavi for the co-supervision. In addition, we want to thank everyone in the master's group and the entire team of *Software for a Better Society* for valuable discussions and knowledge sharing. Thank you for all your encouragement, support, and feedback throughout this process.

This study has partly been supported by UTF-2020/10066 SE-NO-BR (Software Engineering Practices and Experiences Exchange between Norway and Brazil), where Professor Tayana Uchôa Conte has played an essential role in preparation for the data gathering in Brazil, helping us with the recruitment of participants.

Lastly, we want to thank everyone who participated in the interviews and usability tests conducted in Norway and Brazil. This thesis would not have been possible without the experiences you shared and your feedback on DiversIT.

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Tables

Acronyms

ACM Assosiation for Computing Machinery. 19

AI artificial intelligence. 2, 12, 13

ARG model Affinity Research Group model. 45

CE computer engineering. 12

CS computer science. iii, xv, 1–6, 10–14, 17–25, 31, 34, 39, 41–48, 50, 51, 54, 56–60, 64, 66–69, 71, 73–78, 81–87, 89, 90, 92–94, 96–102, 104–112, 114, 116, 118, 122, 126, 128, 131, 136, 137, 139, 143–149, 151, 153–155

CSA computer systems architecture. 12

DBH Database for Statistics on Higher Education. 14–17

DEI diversity, equity, and inclusion. iii, 1–6, 8–11, 14, 17, 21, 23, 34, 39, 42, 44, 50, 54, 58–60, 64, 66, 77, 83, 85, 87, 89, 91, 93, 108, 114, 118, 120, 122, 126, 136, 139, 143, 145, 147–149, 151, 153–155

EUGAIN European Network For Gender Balance in Informatics. 20

GDPR EU General Data Protection Regulation. 15

HCI human-computer interaction. 12, 43, 51, 53, 57, 62

IDI Department of Computer Science. xv, xvii, 14–17

IE Faculty of Information Technology and Electrical Engineering. 18

IM information management. 12

IPPSnet Intersectional PhD Support network. 59

IS information systems. 12

IT information technology. 12

LDO Equality and Antidiscrimination Ombud. 8

NSD Norwegian Centre for Research Data. 69

NTNU Norwegian University of Science and Technology. vii, 14, 17–20, 69

OECD Organisation for Economic Co-operation and Development. 14

OS operating systems. 12

PDC parallel and distributed computing. 12

RQ research question. xvii, 3, 21–24, 28, 29, 41, 42, 46, 49, 50, 64–66, 68, 71, 143, 153, 154

SDG Sustainable Development Goal. 1, 2, 5, 10, 11, 14, 44, 143, 145, 151, 154

SE software engineering. 6, 12, 19

SENOBR Software Engineering Practices and Experiences Exchange between Norway and Brazil. 19, 64, 151

SLR systematic literature review. iii, xv, xvii, 3–5, 21–32, 34–36, 38, 39, 41, 42, 44–47, 56, 58, 62, 64, 72, 91, 93, 94, 105, 107, 108, 111, 112, 114, 118, 140, 145–147, 149, 151, 153, 155

STEM science, technology, engineering, and mathematics. 1, 11–13, 18, 20, 43, 45, 58

UFAM Federal University of Amazonas. 19

UI user interface. 52, 56, 58, 127, 130, 150

UN United Nations. xv, 2, 6, 10, 11, 144

UX user experience. xvii, 52, 53, 56, 58, 62, 120, 130, 136, 148, 150

WCAG Web Content Accessibility Guidelines. 148, 155

Chapter 1

Introduction

During an age defined by extraordinary technological improvements, computer science (CS) emerges as a vital foundation for innovation and pushing society forward. The global market for CS jobs is booming, where 71% of all new jobs in the science, technology, engineering, and mathematics (STEM) field are in CS [1]. In the rapid evolution and remarkable achievements in CS, an essential element has often been overlooked: the crucial need for diversity, equity, and inclusion (DEI). Having diverse developers is known for preventing the development of software that perpetuates harmful biases, stereotypes, and exclusion. Intersectionality is a framework that recognises the interconnected nature of various social identities and systems of oppression, highlighting how individuals may experience unique forms of discrimination and marginalisation at the intersection of multiple identities [2]. When researching DEI in CS and related fields, applying an intersectional approach is important to get a nuanced understanding of the different complexities within DEI to find the best possible solution. By implementing an intersectional approach to the DEI conversations, greater success and creativity can be accomplished in CS [3]. In order to reach the Sustainable Development Goals (SDGs) within CS by 2030, intersectionality needs to be a part of the research and future solutions [4].

1.1 Motivation

Achieving DEI in CS using an intersectional approach is aligned with the SDGs by the United Nations (UN) [4]. The CS field has traditionally been dominated by a homogenous group, primarily consisting of "white" men, which implies a lack of representation from various dimensions of diversity such as ethnicity, gender, and other factors related to intersectionality [5, 6]. Research shows that diverse teams surpass homogeneous ones in performance and exhibit a greater level of innovation and problem-solving capabilities [7, 8]. Building an inclusive team culture is significant as it benefits both employees and employers [9]. Nelson [8] also points out that organisations with a greater diversity, related to gender and ethnicity, were associated with improved business outcomes. Embracing an intersectional approach when focusing on DEI does not only benefit the organisation's own success but also the society at large as it aligns with the UN SDGs promoting a more inclusive and equitable society.

Technology itself is socially shaped and requires diverse perspectives and voices to ensure ethical and responsible development. Without a diverse development team, technology can perpetuate biases and reinforce systemic inequalities, leading to exclusionary outcomes [10]. For instance, the best speech-recognition software on the market in 2016 was from Google, but the product was excluding women as it had 70% more accuracy for male speech than female speech [11]. When Apple launched their health monitoring system in 2014, introduced as an advanced tracker, they had forgotten to think about the menstrual period, which excluded women from utilising the application fully [12]. Lack of diversity in training sets for machine learning and artificial intelligence (AI) algorithms has led to people not being recognised as humans, e.g., Google Photos tagging people with dark skin as "gorillas", or autonomous cars not recognising people with dis/abilities as pedestrians [13]. According to Wilson *et al.* [14], this issue persists when autonomous cars are detecting people of different skin tones, which implies that an autonomous car also has a greater probability of crashing into people of darker skin tones. Furthermore, no universally accepted methodology or standard exists for testing apps and assessing universal design principles, including techniques and common errors, internationally [15]. These examples show that there need to be diverse development teams to make sure intersectional perspectives do not get overlooked or are seen as an afterthought. Furthermore, studies have revealed that when leaders promote diversity, white male leaders have been praised while female leaders and leaders of ethnic minority backgrounds are penalised for promoting it [10]. This highlights the need to challenge biases and make the CS field more inclusive.

According to Frehill *et al.* [7], there is a great variation related to the participation in CS for women across national contexts and also within nations. This indicates the importance of looking at intersectionality and looking at the problem from

different points of view around the world. There have been many studies related to DEI in CS only focusing on the inclusion of women [16], where several have acknowledged a limitation of the research as many studies ignore the concept of intersectionality [17, 18]. The dearth of literature related to intersectionality in CS is further elaborated by the fact that most of the existing primary studies in the field about the topic have gathered data from the US, leaving a gap of research on a global scale [19, 20]. Addressing this limitation and broadening the geographical research scope of intersectionality in CS is fundamental for a more comprehensive understanding of challenges and success factors related to DEI in CS.

1.2 Project Description

This master's thesis follows an empirical design and creation approach based on interviews and a peer networking website, designed to provide a space for people of different intersectional identities in CS to connect. The research design is based on the findings from the systematic literature review (SLR) written, in the preliminary phase of this thesis, in the autumn of 2022 and published in GE@ICSE 2023 [19, 20]. The research aims to design, implement and evaluate a new tech solution that contributes to solving the problem of DEI in CS and provide new knowledge about intersectionality in CS. The full project description may be found in Appendix A.

1.3 Research Hypothesis and Objectives

The research objective of this thesis is to create a better understanding of DEI in CS by providing more knowledge about intersectionality in CS and designing a website based on an intersectional approach. Very few studies about DEI in CS look beyond one dimension and consider the complexity of intersectionality. These factors motivated the following research questions (RQs):

- **RQ1:** What are the main intersectional challenges in computer science?
- **RQ2:** What factors are important to overcome these challenges and succeed in computer science?
- **RQ3:** How to design and develop digital support to increase intersectionality in computer science?

This research was conducted in both Norway and Brazil to get a more nuanced and diverse understanding of the complexity of intersectionality and answer the RQs.

1.4 Thesis Outline

This thesis follows the IMRaD standard consisting of the following chapters. Chapter 1 introduces the thesis' motivation, context, and research objectives. The background is presented in Chapter 2, which elaborates on DEI in CS. Chapter 3 presents a summary of the SLR written in preliminary phase of this thesis. Chapter 4 explains the research methodology, theories and processes used in this research. Chapter 5 analyses the findings from the interviews and prototype iterations. The findings from the interview analysis and the prototype's potential are discussed in Chapter 6, and lastly, Chapter 7 concludes the thesis.

Chapter 2

Background

The theoretical foundation of this master's thesis is based on the SLR from the project thesis written in the autumn of 2022 [19]. This chapter presents background theory, essential concepts, and work related to the thesis. Section 2.1, defines the term intersectionality and how the term is defined and researched in Norway. Section 2.2 explains gender through an intersectional approach. Section 2.3 presents the SDGs and the targets to which intersectionality is linked. Section 2.4 provides an overview of the CS field, explaining how the term CS was used in this thesis. Section 2.5 presents an overview of how CS has changed through history and how it affected DEI in the field. Section 2.6 presents the state of diversity in the CS field today. Lastly, Section 2.7 presents existing initiatives to help increase DEI in CS.

2.1 Intersectionality

Kimberlé Crenshaw [2] introduced the term *intersectionality* in 1989, which addressed the intersections between all overlapping segments of a person's identity and how that impacts a person's everyday life through complex forms of discrimination. According to Gendered Innovations [21] at Stanford, intersectionality can be defined as "[...] overlapping or intersecting forms of discrimination related to gender, sex, ethnicity, age, socioeconomic status, sexuality, geographic location, disabilities, etc.". When Crenshaw [2] first used the term, she found that some challenges faced by Black women in the US remained hidden when only considering ethnicity or gender as separate entities in cases of discrimination against these women. One cannot pinpoint how a certain experience comes from a specific part of one's identity. It is necessary to consider the combination of both gender and ethnicity as overlapping segments of identity together. This marked the beginning of the *Theory of Intersectionality* [2].

The complexity of intersectionality and its overlapping factors are visualised in Figure 2.1. The figure illustrates the complexities of a person's identity from an intersectional approach; how religion, gender & sexuality, socioeconomic status, ethnicity, indigeneity, nationality, dis/ability[1], education, and age as factors can overlap, connected to different forms of discrimination. A combination of these factors forms each individual's unique experiences, as well as experienced disadvantages and challenges. It is essential to utilise an intersectional approach to achieve DEI, which ensures sustainable use of human resources and that no one is left behind and, as recommended by the UN [4].

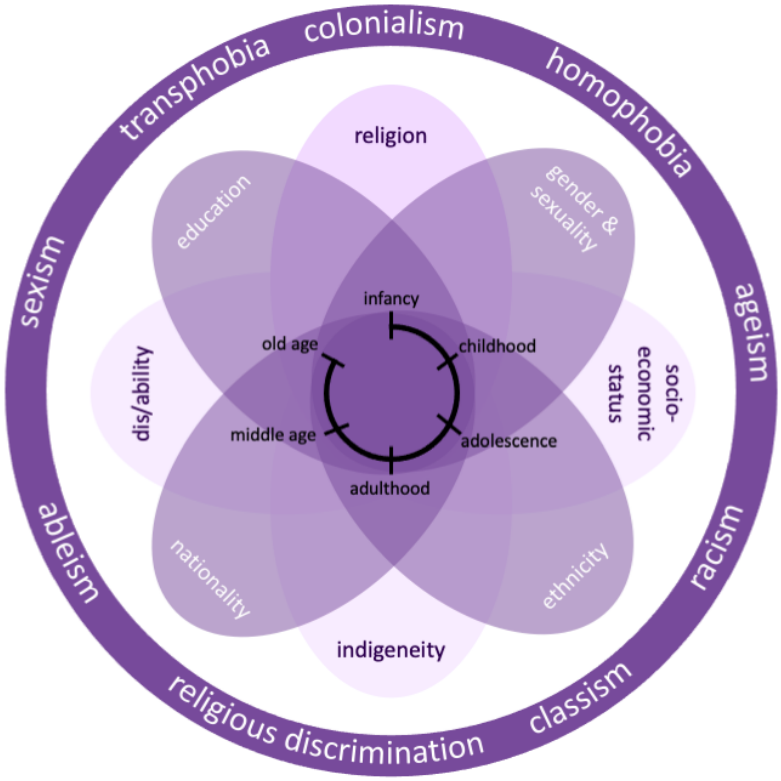


Figure 2.1: Intersectional identities, adapted from the UN [4].

The lack of diversity in CS also concerns identities beyond gender and ethnicity [22]. Therefore, it is crucial to ask questions that identify the problems with ethnicity-only and gender-only approaches to DEI, as more intersectional factors can affect someone's identity. A conceptual framework for intersectional perspectives in software engineering (SE) [22] was developed as an ideal intersectional framework proposed by Sánchez-Gordón *et al.* [22] in 2021 and is illustrated in Figure 2.2. The multilevel model of intersectionality is divided into three levels; social identities, societal processes and organisational practices that shape social categories, and cultural-historical context [22]. At the social identities level, in-

[1]Mental health conditions are grouped in dis/ability [4].

tersectional factors are separated into personal characteristics (marked in blue); such as gender, ethnicity, sexuality, dis/ability, and age; and external characteristics (marked in black); such as immigration, occupation, parenthood, education, class, and language.

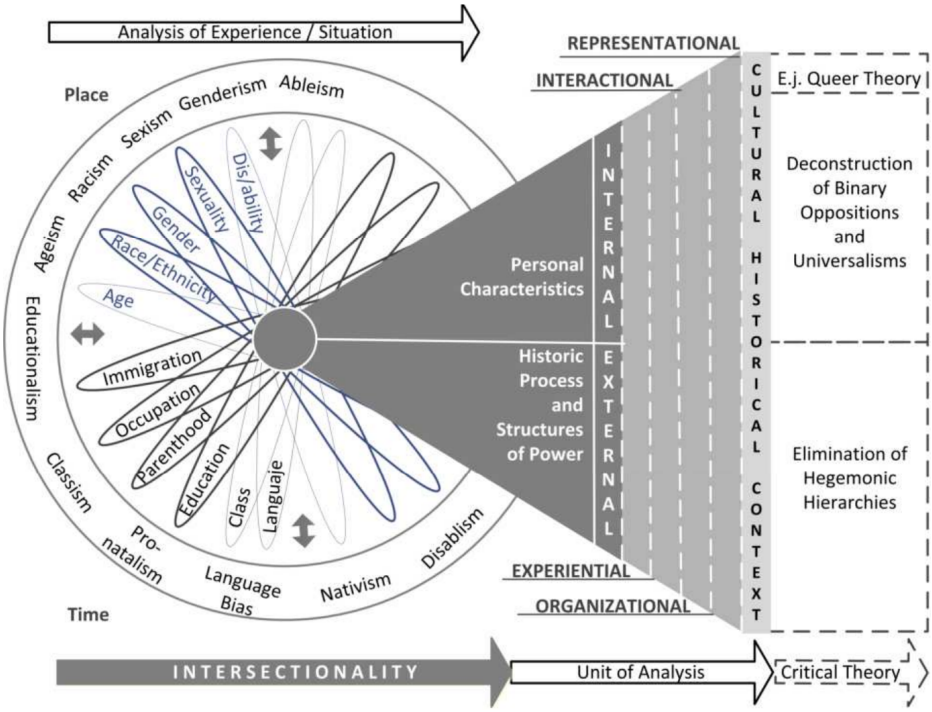


Figure 2.2: Conceptual framework for understanding intersectionality [22].

This framework also acknowledges how these identities may overlap and shape each individual's unique experience, like in Figure 2.1. However, it also takes it a step further by including the intersection between organisational, representational, interactional, and experiential domains, as well as the cultural and historical contexts that situate the intersectional identities, including other theoretical frameworks that could be used in tandem to analyse intersectionality critically [22].

2.1.1 Intersectionality in Norway

The first definition of intersectionality by Crenshaw [2] originated in the US. However, when the term travelled to Europe and Scandinavia in recent years, its definition, philosophy, and methodology have also changed by being in a different cultural and societal context [23]. In a European and specifically Scandinavian context, intersectionality has adopted a broader definition that recognises intersectional identities as the results of social constructs, like "race" and gender, based

on local and historical context [23]. However, in the Norwegian context, intersectionality has not gained much traction in research or debate, and DEI has more or less become synonymous with gender diversity, gender equity, and gender inclusion, whilst diversity in a broader sense has been removed from the discussion [23, 24]. Hence, instead of intersectionality being a part of DEI research, it has become "othered".

During the 90s and early 2000s, the term *minority* became more problematic in terms of policy and rights due to essentially being split into different categories of indigenous, national minorities, and other minorities [23]. The Sámi people have been recognised internationally as indigenous people under the Indigenous and Tribal Peoples Convention since 1989, the same year the Sámi Parliament in Norway was established. Then, introducing the term *national minority* gave protective rights to Jews, Roma, Romani, Kvens, and Forest Finns under the Council of Europe's Framework Convention of the Protection of National Minorities. However, the term *minority* became synonymous with "immigrants from the global south". Thus, how *minority* is used and defined in different settings creates issues since it often ranks people against each other while implicitly defining the majority as "the standard" and the minority as the "anomaly" [23]. Usually, "the standard" is measured against a person's perceived "Norwegianness". An analysis of workplaces within the health sector exemplifies this by finding that even if a workplace has diverse hiring regarding gender, ethnicity, and sexuality, a hierarchy still forms among the nurses being either in the "majority" or "minority" position [23]. In this example, nurses that are perceived as Norwegian are also perceived to be "better nurses" and vice-versa. Another example is the experiences of people of multicultural backgrounds, e.g., a person born in Norway with two immigrant parents. In this case, factors such as gender, religion, and ethnicity all play a central role; however, they are often compared in a hierarchical system based on their perceived "Norwegianess" or "foreignness" [25].

Research about gender, sexuality, ethnicity/minorities, and dis/ability in Norway, more often than not, are seen as independent entities of research, hence, fail to include the complexities of intersectionality. As intersectionality never was widely embraced, most minorities are viewed as static and homogeneous groups, where power and privilege are one-dimensional, failing to recognise the multidimensionality of intersectionality in public debate or research [24]. This also constructs a hierarchy that removes people from gender; this is the most prominent category in the Norwegian context, where intersectional people are reduced to only their ethnicity, sexuality, or dis/ability depending on which is perceived as most dominant [26].

The Norwegian Government established the Equality and Antidiscrimination Ombud (LDO) in 2005, considered innovative in an international context at the time, which merged separate entities concerned with either equality, inclusion, or diversity [24]. However, it is clear that more research is necessary to understand

the multidimensional perspectives of intersectionality in correlation with gender, DEI, "Norwegianess", minority, and majority, and how society constructs, applies, and change the meaning of these terms over time [23–25].

2.2 Gender

The term *gender* was first introduced as a projection of sex, which defined what biologically divides a male and female; however, gender today focuses more on the social constructions that affect norms, identities, and relations that shape behaviours [27]. According to the National Academies of Sciences, Engineering, and Medicine, gender is defined as:

> [A] multidimensional construct that links gender identity, which is a core element of a person's individual identity; gender expression, which is how a person signals their gender to others through their behavior and appearance (such as hairstyle and clothing); and cultural expectations about social status, characteristics, and behavior that are associated with sex traits. [28]

For this thesis, the authors are interested in gender in the social and cultural aspects, not in the biological sense. This aspect of gender is tightly coupled to intersectionality, as it is multidimensional and complex. Research still tends to describe gender within the gender binary, male or female, and the constraints of an existing masculinity-feminity spectrum [27]. However, this practice is exclusionary as individuals who do not identify within this constraint are not recognised.

Gender consists of gender identity, gender expression, and sexuality, thus also closely related to the LGBTQIA+ community. Although LGBTQIA+, in many instances, is assumed only to regard sexuality, they do also recognise persons that do not identify as cisgender, including transgender, non-binary, and gender-fluid persons. When looking at gender in research, it is essential to recognise biases and assumptions about gender correlating to biological sex and that no gender identity is homogeneous [27, 29]. Hence, researching gender through an intersectional approach recognises that gender is a multidimensional umbrella term that goes beyond the conventional gender binary.

2.3 The Sustainable Development Goals

The *Sustainable Development Goals (SDGs)*[2] by the UN are a part of the *2030 Agenda for Sustainable Development*, and all UN member states adopted these in 2015. The 17 SDGs are an urgent call to action that recognise the complexities of creating a sustainable and equitable future for everyone globally. The goal is for the SDGs to be reached by 2030. The research in this thesis, intersectionality in CS, will provide relevant contributions to SDG 4, 5, and 10, which all focus on diversity and inclusion, and where education and industry alike are essential stakeholders for reaching these goals.

SDG 4, is to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" [30]. This thesis contributes to research and knowledge that promotes intersectionality and DEI in CS; therefore, the following target from SDG 4 is of relevance [31]:

> **Target 4.7:** By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development

SDG 5, is to "achieve gender equality and empower all women and girls" [30]. Since gender is a factor of intersectionality, and the fact that gender diversity is a byproduct of intersectionality, the following three targets of SDG 5 are areas of contribution for this thesis [32]:

> **Target 5.1:** End all forms of discrimination against all women and girls everywhere
>
> **Target 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
>
> **Target 5.b:** Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women

[2] https://www.sdgs.un.org/goals

SDG 10, is to "reduce inequality within and among countries" [30]. Research on intersectionality in CS directly contributes to reducing inequalities in the field. As well as providing knowledge, the thesis also contributes to promoting intersectionality in CS through the design and development of a prototype that aims to increase DEI in CS. Thus, the thesis also contributes to the two following targets of SDG 10 [33]:

> **Target 10.2:** By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status
>
> **Target 10.3:** Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard

From 2015 to 2030, the UN provides annual reports on the status of all the SDGs [30] and on gender equality across all the SDGs [34]. The 2022 report shows that COVID-19 had severe educational consequences, particularly for women, people with dis/abilities, and ethnic minorities, or due to socioeconomic status [30]. Discrimination is another hindering factor that is more likely to affect women and persons with dis/abilities, and the report found that women were twice as likely than men to experience discrimination based on gender alone and that one in five people of intersectional identities has experienced discrimination [30]. Having diversity within the STEM field is known to be beneficial for everyone. Still, numbers show that only two in ten people working in STEM globally are women [34]. The reports also show that women in leadership positions across industries manage to prioritise issues that address vulnerable groups in society [30]. However, only one in three managers and supervisors are women globally, and at this rate, equality in leadership positions will not be reached for another 140 years [34]. Furthermore, only two in ten working in STEM globally are women [34]. Overall, it might take 286 years to reach gender equality, which is long overdue from 2030 [34].

2.4 The Computer Science Field

The term computer science (CS) will be used in this thesis to refer to all fields within computing, computer science and their adjacent fields. The term *tech* is also used interchangeably when talking about people who work within the CS field.

CS is defined as "the study of computers and computing, including their theoretical and algorithmic foundations, hardware and software, and their uses for processing information" [35]. CS is a part of the computing discipline, which consists

of CS, computer engineering (CE), information systems (IS), information technology (IT), cyber security, software engineering (SE), and data science. CS is also an umbrella term for its disciplines consisting of algorithms and complexity, artificial intelligence (AI), computer systems architecture (CSA), computational science, human-computer interaction (HCI), information management (IM), operating systems (OS), SE, computer networking, and parallel and distributed computing (PDC).

2.5 Gender and Diversity in Computer Science from a Historical Context

CS is mostly assumed to be a traditionally male profession. Historically, however, CS was one of the few fields within STEM with high female representation and diversity. Since the 18th century, women have been employed to do mathematical calculations (the predecessor to computing), which later evolved to computer programming and SE. The world's first programmer, Ada Lovelace, wrote the first computing algorithm for the Bernoulli numbers [36, 37]. Although Ada Lovelace and other women throughout history made significant contributions to what later became academic CS and SE, men were still more prominently publicised and received the credit for important technological advancements in CS, as hardware and inventions of new machines were regarded as more important in the early stages of CS [37]. Historians have uncovered that men were not only recognised for their own work; they also received credit for the work of others through publications, awards, and being the historical focal point in CS. An example is the case of Dr Gertrude Blanch, a doctorate in mathematics, who was a leading contributor to new approaches for computing in scientific publications [38]. However, she did not appear as an author in her papers; instead, Blanch's supervisor Arnold Lowan received the honour and credit for her scientific work in CS [38].

Until the late 1940s, post-World War II (WWII), computing and computer programming was considered a female profession, and thousands of women were working as computers both in the US and the UK [37, 39, 40]. During WWII, people of colour and people with dis/abilities were also part of the computing workforce. Thus, at this time, traditionally marginalised people were at the forefront of computing, where large operations, such as the Bletchley Park operation, had a workforce of 75% women [41]. After the end of WWII, however, people of colour and people with dis/abilities were actively pushed out of the CS field, followed by women (of European descent); so by the 1960s, CS consisted of between 50% to 30% women [6, 39]. This resulted from wanting to elevate the computing industry by making it more "professional" through the creation of formal academic programs, professional journals, and certification programs, which ensured that male programmers would get better wages and increased social status. High-tech

companies also began to prefer masculine traits systematically, further pushing out the women who managed to remain in the field [6, 39]. This was the beginning of how CS, through the hiring process, helped create an ideal image where the programmer was intelligent, socially inept, and, most importantly, a man.

The lack of historical, scientific, and contribution acknowledgement in CS are all parts of the continuous erasure of women, people of non-European background or decent, Indigenous people, people in the LGBTQIA+ community, and people with disabilities; who have made key contributions in STEM and CS [39]. Furthermore, there is very little historical coverage of women in CS outside of the US and UK [37], and even less when considering intersectionality from a global perspective. This has been detrimental to society's view of CS, and also to the individuals since they were intentionally unrecognised and uncompensated, not because their work was less valuable but because the identities of these individuals were deemed as less influential and valuable in early computing, and later modern CS. This is also evident in the fact that CS became more prestigious whilst simultaneously pushing others out through the means of discrimination [6, 39, 41]. This explains today's distorted perception of the stereotypical computer scientist, built on patriarchal ideals. "Erasure is not merely an issue of representation, but a foundation on which systematic racism, misogyny, and inequity rely" [39].

2.6 Diversity in Computer Science

By the 21st century, technology has become ubiquitous, affecting multiple aspects of people's everyday lives. Today, CS is considered to be a homogenous field made up of professionals who are predominantly young, white, male, cis-gendered, heterosexual, middle-class, and from the global north [42], built on the patriarchal ideal of the stereotypical computer scientist. However, studies show that diversity leads to greater creativity and success [43]. Therefore, having a diverse development team is essential to make existing and new technology fit every user. A team lacking diversity will likely produce technical solutions, whether software, algorithms, AI, hardware, etc., based on or maintain bias. There have been many instances of technical solutions being developed for everyone where women, people with non-eurocentric features, and people with dis/abilities were not taken into account but instead were later included as an afterthought. One example of this is from face recognition in AI, where women, especially women with a darker skin tone, were left out. Multiple face recognition algorithms were classified to have high accuracy, meaning an accuracy over 90%, but this was only true for men with lighter skin tones. When face recognition was tested on women with darker skin tones, the accuracy was up to 34.4% worse [44]. Diversity in CS is crucial to ensure that technical solutions and products created are universally available and suitable for a diverse and wide range of users. To be able to overcome this technical and social problem, an intersectional approach would be necessary.

2.7 Existing Initiatives for Diversity and Inclusion

As discussed in Section 2.5 and Section 2.6, DEI in CS is generally low. Furthermore, intersectional identity factors are more often collected and analysed in isolation, e.g., statistics on gender, dis/ability, etc., so no consistent data exist on intersectionality in CS at a global scale. To illustrate the disparity of intersectionality in CS in accordance to the SDGs, presented in Section 2.3, the authors looked at gender diversity in CS degrees across the world, as this was the most consistent metric found at a global scale. As seen in Figure 2.3, in most countries, less than 40% of graduates at any degree level in CS were women. Statistics from 2019 show that on average, 20% of bachelor's, 26% of master's, and 19% of PhD graduates were women [45].[3]

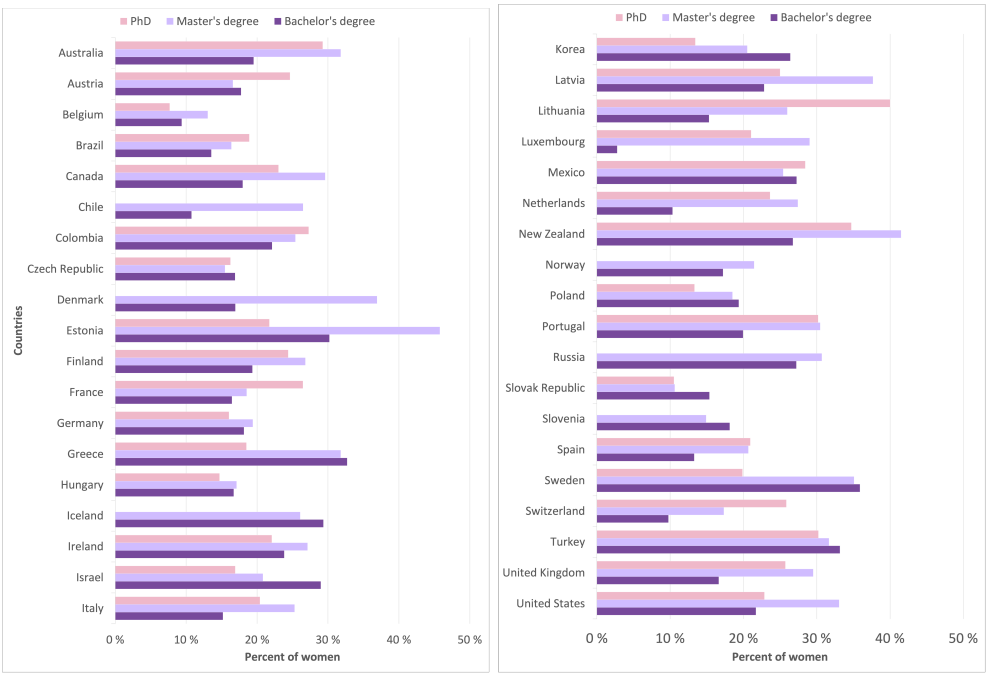


Figure 2.3: Percentage of women graduates in CS in 2019 by country [45].

Table 2.1, presents enrolment data from Database for Statistics on Higher Education (DBH) for selected CS degrees at the Department of Computer Science (IDI) at Norwegian University of Science and Technology (NTNU). This data supports that there are a significantly higher number of men than women studying CS, with the exception of PhD, which had gender balance in both 2017 and 2022.

[3]The Organisation for Economic Co-operation and Development (OECD) Education Statistics had missing data for CS graduates in most countries outside of Europe.

Table 2.1: Enrolment of students to a degree in Computer Science or Informatics at IDI in 2017 and 2022 [46].[4]

Programme of study at IDI[6]	2017[5]		2022	
	Women[7]	Men	Women	Men
Informatics (BSc)	20	115	40	125
Informatics (MSc)	10	85	25	95
Computer Science (MSc - 5 years)	40	130	85	140
Computer Science (MSc)	0	20	5	45
Computer Science and Informatics (PhD)	10	10	5	5

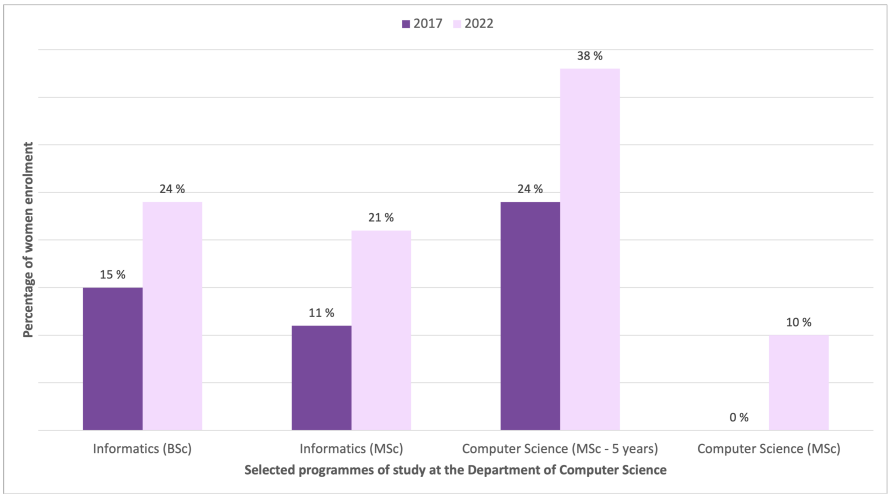
Figure 2.4 presents bachelor's and master's degree enrolments and graduates in 2017 and 2022. When comparing Figure 2.4a and Figure 2.4b, there is a positive trend in the retention of female students since there is an increase in both enrolments and graduates overall.

[4]DBH tables: *Søkertall og møtte*, *Doktorgradsavtaler (nye avtaler)*

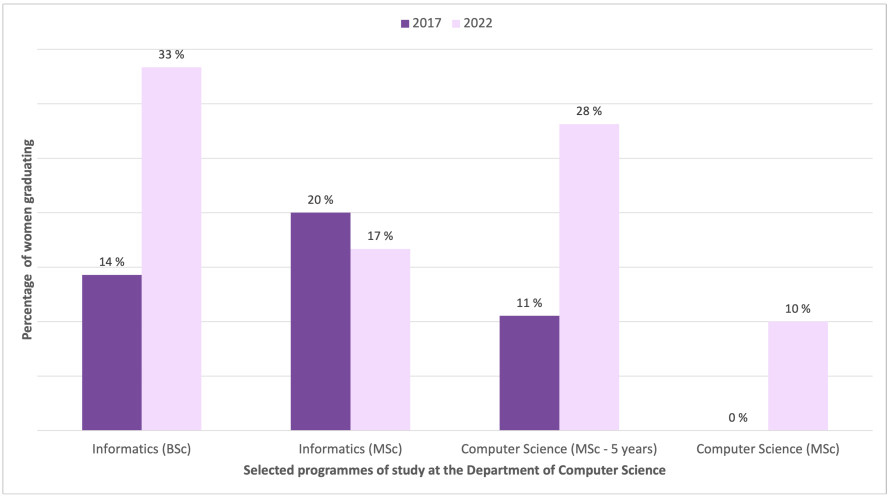
[5]Since a 5-year integrated master's degree is included, 2017 was chosen as the starting point to ensure that each degree had completed at least one cycle.

[6]The data is rounded to the nearest 5 and has a margin of +/- 2 persons due to EU General Data Protection Regulation (GDPR).

[7]Per 2023, the legal genders recognised in Norway are binary; "woman" or "man", which is reflected in the statistics [47].



(a) Percentage of women enrolments at IDI.[8]

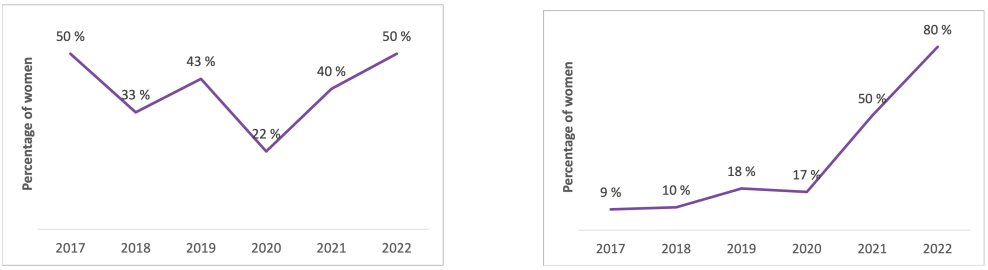


(b) Percentage of women graduates at IDI.[9]

Figure 2.4: Women BSc and MSc enrolments and graduates in 2017 and 2022 [46].

Figure 2.5 visualises the trend for female PhD candidates from 2017 to 2022, which shows a clear positive trend in the percentage of women graduating with a PhD. The PhD candidates also positively affect the gender balance at the department level by helping increase the trend of female full-time equivalent persons at IDI as shown in Figure 2.6.

[8]DBH table: *Søkertall og møtte*
[9]DBH table: *Fullført vitnemålsgivende studieprogram (uteksaminerte/kandidater)*



(a) Enrolments at IDI.[10] **(b)** Graduates at IDI.[11]

Figure 2.5: Women PhD enrolments and graduates from 2017 to 2022 [46].

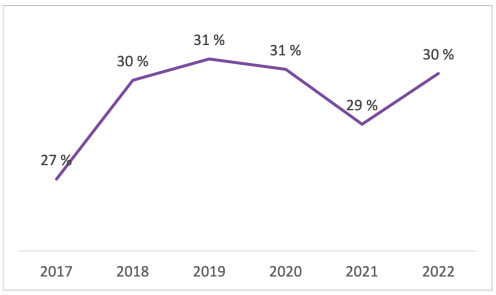


Figure 2.6: Percentage of full time equivalent persons[12] (women) at IDI [46].[13]

Since binary gender diversity in CS is the most common metric when looking at DEI, the lack thereof has led to many different action initiatives internationally, in Europe, and at NTNU. Although intersectionality has a much broader approach, these initiatives are still important as they also help increase awareness and research to solve issues related to intersectionality.

[10] DBH table: *Doktorgradsavtaler (nye avtaler)*

[11] DBH table: *Avlagte doktorgrader*

[12] *Full-time equivalent persons* are the number of persons full-time employed, plus the number of persons part-time employed recalculated to full-time equivalent basis.

[13] DBH table: *Årsverk tilsatte*

2.7.1 Initiatives Started at the Norwegian University of Science and Technology

This subsection presents initiatives started at NTNU aiming at increasing gender diversity, inclusion, and international cooperation.

Ada

Ada[14], started in 2010 [48], is an initiative at NTNU that contributes to graduating more women from STEM studies at NTNU, where they are underrepresented, through peer community and a supportive network. This initiative is the successor of The Women and Computing Initiative (WCI), which lasted from 1997 to 2000 [48].

The focus on recruitment, retention, and dropout prevention are success factors of the project. After 2010, degree programmes that are a part of Ada had a steady and significant increase in the number of girls, and the probability of dropout amongst women in these degrees decreased significantly [48].

IDUN

IDUN – from PhD to professor[15] developed a mentorship program for women researchers, at master's to associate professor level, in the time period 2019 to 2022. The overall goal of IDUN was to help increase the number of women at all levels in STEM through increased recruitment and retention of women in PhD to professor level at the Faculty of Information Technology and Electrical Engineering (IE) at NTNU.

The trend in Figure 2.5 after 2020 is significantly increasing. Lessons learnt from Ada were applied to this project since Ada experienced success factors regarding the prevention of dropouts and recruitment. Both IDUN and Ada are relevant initiatives within this thesis, as both projects have experienced success factors related to inclusion in CS.

[14]https://www.ntnu.no/ada
[15]https://www.ntnu.edu/idun

SENOBR

During the time period 2021 to 2024, Software Engineering Practices and Experiences Exchange between Norway and Brazil (SENOBR)[16] aims to link research and education of future researchers from Norway and Brazil to promote excellence in SE. In April 2023, a mobility trip was organised from NTNU to the Federal University of Amazonas (UFAM), in which the authors of this thesis participated. Interviews and usability tests were conducted in Manaus, Brazil to achieve space triangulation in the research. Professor Tayana Uchôa Conte at UFAM helped facilitate the data gathering in Brazil.

2.7.2 International and European Initiatives

This subsection presents international and European initiatives, with the involvement of NTNU, which aim to increase diversity, inclusion, and international cooperation in CS.

Trondheim ACM-W Chapter

ACM-W[17], a sub-group of the international organisation Assosiation for Computing Machinery (ACM), has the mission to celebrate, inform, and support women in computing. In Trondheim, where NTNU is located, there has been established an *ACM-W Chapter*[18] in 2020. The chapter is built on lessons learnt from IDUN (see Section 2.7.1) and has the vision to facilitate the improvement of the gender gap in computing fields and professional sectors in Trondheim. This supportive network promotes a peer community for women in Trondheim within the CS field. In September 2023, the 10th ACM celebration of women in computing, womENcourage[19], will be hosted by Trondheim ACM-W Chapter with the theme *Computing Connecting Everyone*.

The first idea for this thesis, and the project thesis written in the autumn of 2022, was the extended abstract, in Appendix B, submitted to the womENcourage conference in Cyprus [20].

[16] https://www.ntnu.edu/idi/senobr
[17] https://www.women.acm.org/
[18] https://www.trondheimwomen.acm.org/home/
[19] https://www.womencourage.acm.org/2023/
[20] https://www.womencourage.acm.org/2022/

Women STEM UP

Women STEM UP is an Erasmus+ program focusing on education and built on IDUN (see Section 2.7.1). The goal of the project is to make STEM education more gender inclusive, through training programs, resources and mentorship programs. It started in 2023, where NTNU is one of five partners. Through creating training programs for professors and promoting role models, the project aims to eliminate gender stereotypes and prejudices hindering women from successfully completing their STEM degrees and further developing in academia or the industry.

EUGAIN

Another EU-founded project is European Network For Gender Balance in Informatics (EUGAIN)[21], which through creating and strengthening a multicultural European network, aims to improve the gender balance in CS. This is a larger project with people from most EU countries. The duration of the project is four years, from 2020 to 2024. Necessary actions here are to network and share knowledge that can be transferred to other institutions and countries. In addition to acknowledging supportive networks and peer community as important, mentorship and role models are also emphasised. The project concentrates on education and links research and academia with policy-making and the industry. The Action Chair of this EU project is Letizia Jaccheri, a professor at NTNU and the supervisor of this thesis. This initiative is relevant to this thesis as both have the aim to increase diversity through networking.

[21] https://www.eugain.eu/

Chapter 3

Systematic Literature Review

In the project thesis [19, 20], the first phase of the master's thesis, a systematic literature review (SLR) was performed to identify current studies and the research gaps on intersectionality in CS. The SLR's objective was to provide knowledge about intersectionality in CS at the university and professional level while contributing to research that considers the complexities of intersectional challenges beyond the one-dimensional narrative that is most prevalent presented within CS research in terms of DEI. Intersectionality in CS was investigated by examining what research existed on the topic and further analysing recurring patterns of intersectional challenges and success factors throughout the CS field identified in the papers. In total, 16 papers were selected as primary studies for the SLR.

3.1 Research Method

An SLR is a research method that evaluates and interprets all available research related to a RQ, topic area, or phenomenon of interest [49], which helps identify gaps in current research and suggests areas of future research activities. This method also synthesises existing research fairly [49]; thus, reproducibility of an SLR is enhanced and bias is reduced. The SLR from the project thesis was the basis for utilising the *design and creation research strategy* in this master's thesis, as presented by Oates *et al.* [50]. Research is the first phase of this design and development process. The SLR for the project thesis followed the guidelines and principles established by Kitchenham [49].

The following five steps were completed during the research process [49]:

Step 1: Identification of Research
This step identified a search strategy to gather primary studies. A search query was formulated in alignment with the RQs, which was used to find the primary studies through a database search.

Step 2: Selection of Primary Studies
This step validated the primary studies identified by assessing their relevance to the study selection criteria. This was the first step in reducing the number of papers by screening titles and abstracts.

Step 3: Study Quality Assessment
This step defined the quality criteria to help minimise bias while maximising internal and external validity. The studies were included or excluded based on the quality criteria, and the included papers were prioritised by relevance. This was the second step in reducing the number of papers through more detailed text screenings.

Step 4: Data Extraction and Monitoring Progress
In this step, the data extraction forms were designed to obtain information from the primary studies. All remaining papers of relevancy were read, where the main findings and other relevant variables were organised in a table.

Step 5: Data Synthesis
This final step collated and summarised the results of the included primary studies. A table was created in this phase to analyse the results from the SLR.

3.1.1 Identification of Research

The purpose of the SLR was to compile data about intersectionality in the CS field. The RQs were designed to consider the three viewpoints: intervention (RQ1), population (RQ2), and outcomes (RQ3), which ensured the robustness of the SLR [49]. Table 3.1 presents the RQs and the corresponding motivation for each question.

Table 3.1: Research questions from SLR [19].

Research Question	Motivation
RQ1: What research exists regarding intersectionality in computer science?	Determine what studies exist related to intersectionality in CS, and the trends over time in terms of number of papers, publication countries, and research methods.
RQ2: What are the main intersectional challenges in computer science?	Determine the types of intersectional challenges, overlapping forms of discrimination and marginalisation people face in CS, to understand how to improve retention and sense of belonging in the field.
RQ3: What factors are important to overcome these challenges and succeed in computer science?	Determine success factors related to intersectionality in the CS field and the outcomes of increased DEI.

The authors used *Scopus*[1], an academic electronic database, to search for and identify primary studies. Scopus supports the usage of complex search queries and provides an exhaustive collection of peer-reviewed studies and published works from most research fields. Four iterations of trial searches were performed in Scopus [49], and the authors identified *intersectionality* as the essential keyword to align the search query to the RQs. This resulted in the search query presented in Table 3.2.

Table 3.2: Search query used in Scopus from SLR [19].

Database	Search Query	Results
Scopus	`TITLE-ABS-KEY ( intersectionality ) AND ( LIMIT-TO ( SUBJAREA , "COMP" ) )`	244

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

3.1.2 Selection of Primary Studies

The search query retrieved 244 possible primary studies (see Table 3.2). These papers were then filtered and screened using the inclusion and exclusion criteria presented in Table 3.3. The inclusion and exclusion criteria were based on the RQs as suggested by Kitchenham [49] and were used to filter papers and screen the retrieved papers' titles and abstracts.

Table 3.3: Inclusion and exclusion criteria from SLR [19].

Inclusion Criteria	Exclusion Criteria
1. The paper addresses the RQs.	**1.** Papers not in English.
2. The paper is published in 2018 or later.	**2.** Papers about computer science or technology that do not discuss intersectionality.
3. The paper has intersectionality as a keyword.	**3.** Duplicated work presenting a similar result by the same author.
4. The paper has subject area computer science.	

Studies from the past five years provided the most relevant and up-to-date research, and including English papers ensured that the SLR was replicable; thus, these criteria were applied as filters for the query. This first filtering retrieved 195 possible primary studies, which were exported to *Endnote*[2], a reference management tool. To minimise any selection bias and ensure reliability [49], the authors performed the title and abstract screening in parallel. All papers that were only deemed as relevant by one author were discussed and screened again by the authors, resulting in 74 possible primary studies.

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

The next step in the selection process was the quality assessment of the retrieved papers, which is found in Table 3.4. Since the quality criteria provided more detailed selection criteria, they helped guide the interpretation of each paper's findings and inferences [49]. The pre-reading questions supported the quality criteria in defining a quality threshold and avoiding ambiguity when assessing the papers. The authors gave each possible primary study a quality score between 0 and 2, where *0* meant the paper was excluded, whilst *2* meant the paper was included. Any paper with a score *1* by both authors or a score *1* and *2* was discussed further based on the quality criteria and pre-reading questions after the parallel screening was complete.

Table 3.4: Quality assesment from SLR [19].

Quality Criteria
1. The study is empirical. **2.** The study is available and complete. **3.** The study discusses intersectionality, diversity, or feelings of belonging in CS higher education. **4.** The study discusses intersectionality, diversity, or feelings of belonging in CS profession. **5.** The study is based on research. **6.** There is a clear aim for the study. **7.** The context is clearly described. **8.** Proper use of English in the paper. **9.** The papers use understandable language.
Pre-Reading Questions
1. What is it going to be about? **2.** What is the purpose? **3.** Who is the intended audience? Why? **4.** What information or ideas might be presented? **5.** How do I relate to it?
Quality Assessment Score
2 – Relevant empirical primary study **1** – Uncertain **0** – Not relevant

After concluding the quality assessment step, 15 primary studies remained for the SLR. Additionally, the authors used the backward snowballing technique [51] to ensure that all relevant papers at our disposal were included in the SLR. Through snowballing, the authors retrieved one additional paper. This resulted in the final number of 16 primary studies. The complete selection process of primary studies is visualised in Figure 3.1.

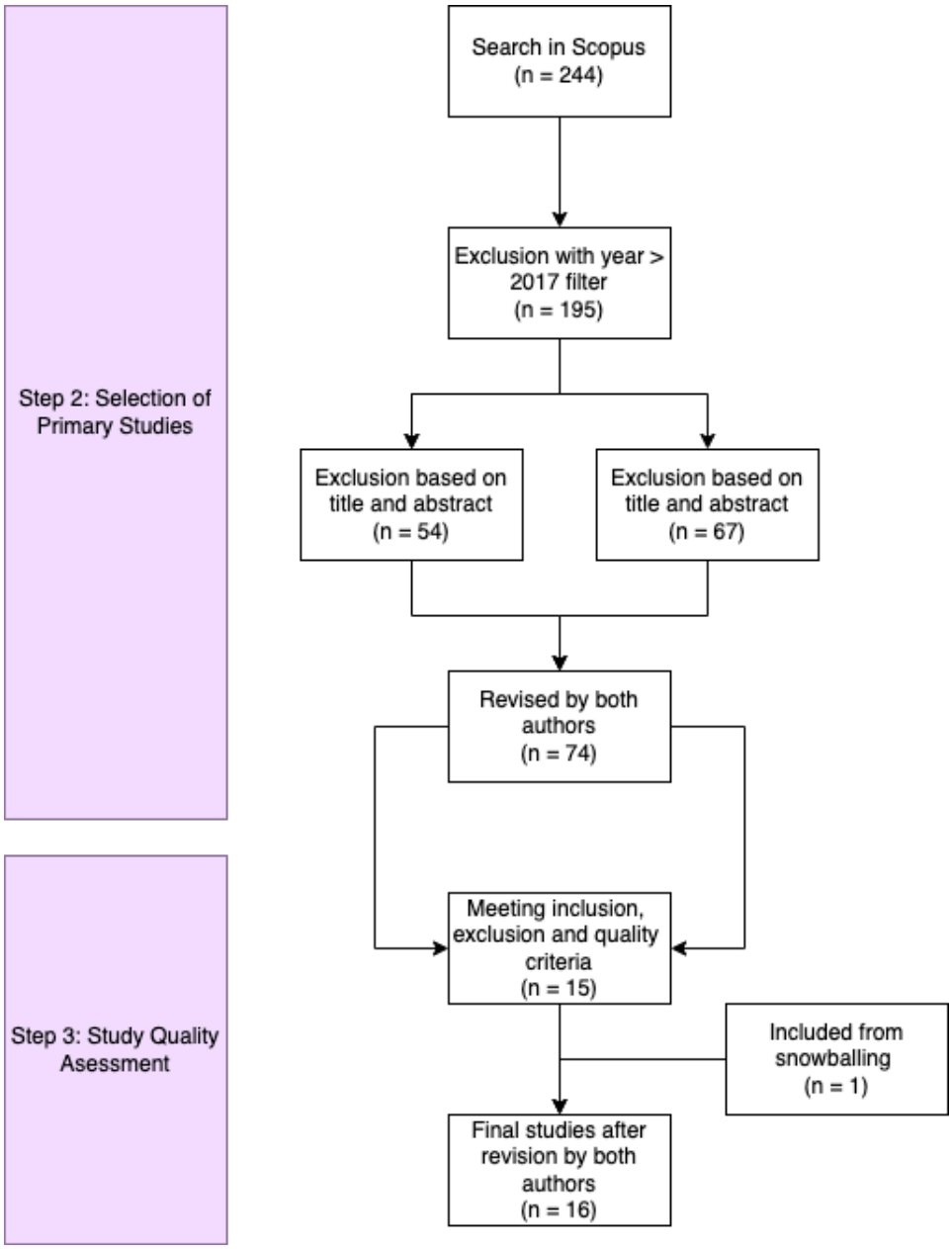


Figure 3.1: Study selection process from SLR [19, 20].

3.1.3 Data Extraction and Monitoring Progress

The data extraction and monitoring progress consisted of creating a data extraction form to record the information obtained by the authors from the primary studies. Due to time constraints, the data extraction process was not done in parallel; instead, the authors reviewed half of the primary studies each. To still promote quality in the process, the form was co-created by both authors in *Notion*[3], a collaborative workspace tool. Each column in the data extraction form (see Table 3.6) was discussed to ensure that all data was extracted consistently. Both authors cross-checked random samples of the primary studies and their results to promote quality [49].

Table 3.5: Overview of primary studies from the SLR [19].

ID	Author(s)	Title	Publishing Journal
S01	S. Dhar-Bhattacharjee *et al.* [52]	A Tour of India in One Workplace: Investigating Complex and Gendered Relations in IT	Information Technology and People
S02	Y. A. Rankin *et al.* [53]	Black Women Speak: Examining Power, Privilege, and Identity in CS Education	ACM Transactions on Computing Education
S03	S. Lunn *et al.* [54]	Exploration of Intersectionality and Computer Science Demographics: Understanding the Historical Context of Shifs in Participation	ACM Transactions on Computing Education
S04	Y. A. Rankin *et al.* [3]	Exploring the Plurality of Black Women's Gameplay Experiences	CHI - Conference proceedings
S05	K. Kramarczuk *et al.* [5]	First-Generation Undergraduate Women and Intersectional Obstacles to Pursuing Post-Baccalaureate Computing Degrees	RESPECT - Conference Proceedings
S06	T. Fletcher *et al.* [55]	Intersectionality at Minority-Serving Institutions (MSIs): A Longitudinal Analysis of Female Student Participation Within Engineering and Computing	IEEE Frontiers in Education Conference (FIE)
S07	C. Mooney *et al.* [56]	Investigating the Impact of the COVID-19 Pandemic on Computing Students' Sense of Belonging	SIGCSE - Technical Symposium on Computer Science Education
S08	S. J. Lunn *et al.* [57]	Need for Change: How Interview Preparation and the Hiring Process in Computing can be Made More Equitable	CoNECD - Conference proceedings
S09	C. Mooney *et al.* [58]	Sense of belonging: The Intersectionality of Self-Identified Minority Status and Gender in Undergraduate Computer Science Students	ACM International Conference Proceeding Series
S10	J. O. Thomas *et al.* [59]	Speaking Truth to Power: Exploring the Intersectional Experiences of Black Women in Computing	RESPECT - Conference Proceedings
S11	K. McGee [6]	The Influence of Gender, and Race/Ethnicity on Advancement in Information Technology (IT)	Information and Organization
S12	M. Ross *et al.* [60]	The Intersection of Being Black and Being a Woman	ACM Transactions on Computing Education
S13	Y. A. Rankin *et al.* [61]	The Intersectional Experiences of Black Women in Computing	SIGCSE - Technical Symposium on Computer Science Education
S14	B. Spencer *et al.* [62]	The Role of 'Intersectional Capital' in Undergraduate Women's Engagement in Research-Focused Computing Workshops	RESPECT - Conference Proceedings
S15	M. A. Jarrell *et al.* [63]	Using Intersectional Representation and Embodied Identification in Standard Video Game Play to Reduce Societal Biases	CHI - Conference proceedings
S16	A. Nguyen *et al.* [64]	Competitive Enrollment Policies in Computing Departments Negatively Predict First-Year Students' Sense of Belonging, Self-Efficacy, and Perception of Department	SIGCSE - Technical Symposium on Computer Science Education

[3]https://www.notion.so/

Table 3.6: Mapping of findings for each RQs from the SLR [20].

ID	Country	RQ1: Research						RQ2: Challenges	RQ3: Success Factors
		Intersectionality			Method				
		Included factors	*Aborted factors*	*Limitations*	*Strategies*	*Data generation*	*Data analysis*		
S01	India, UK	Gender (binary) Socioeconomic Class and caste			Case study	Interviews Observations	Qualitative	Expectations	Paternity leave Equal pay
S02	US	Black women Gender (binary)			Survey	Interviews	Qualitative	Belongingness Expectations Stereotypes Assumed competency Discrimination Exclusion	
S03	US	Ethnicity Gender (binary) Socioeconomic		Non-binary Dis/ability LGBTQIA+	Survey	Documents	Quantitative	Enrollment rates Retention Lack of literature	Sense of belonging Mentorship Peer community Role models Intersectional research
S04	US	Black women Gender (binary)		Non-binary	Survey	Interviews Questionnaires	Mixed	Dehumanisation Stereotypes in games	Sense of belonging Intersectional approach
S05	US	Women and non-binary Socioeconomic First-generation student	Non-binary Ethnicity		Survey	Questionnaires	Quantitative	Imposter syndrome Belongingness Sexism Racism Exclusion	Sense of belonging
S06	US	Ethnicity Gender (binary)			Survey	Documents	Quantitative	Feeling isolated	Sense of belonging
S07	Ireland	Minority Gender (binary)	Non-binary LGBTQIA+ Ethnicity Dis/ability Nationality Religion Mature student		Survey	Questionnaires	Quantitative	Belongingness	Sense of belonging
S08	US	Ethnicity Gender (binary)			Survey	Interviews Questionnaires	Qualitative	Belongingness Sexism Stereotypes Lack of diversity	Sense of belonging Inclusive thinking Mentorship Diverse leadership
S09	Ireland	Minority Gender (binary)	Non-binary LGBTQIA+ Ethnicity Dis/ability Nationality Religion Mature student		Survey	Questionnaires	Quantitative	Belongingness Expectations	Sense of belonging
S10	US	Black women Gender (binary)			Case study	Interviews Observations	Quantitative	Belongingness Expectations Sexism Racism Discrimination Exclusion	Mentorship Intersectional approach
S11	US	Ethnicity Gender (binary)			Survey	Interviews	Qualitative	Sexism Racism Exclusion Stereotypes Expectations Assumed competency	Sense of belonging Mentorship Sponsors Diverse leadership
S12	US	Black women Gender (binary)			Survey	Questionnaires	Quantitative		Sense of belonging
S13	US	Black women Gender (binary)			Survey	Interviews	Mixed	Exclusion	Sense of belonging Mentorship Intersectional approach
S14	US	Ethnicity Gender (binary) Socioeconomic			Survey	Interviews Questionnaires	Mixed	Belongingness Enrollment rates Discrimination Stereotypes Sexism	Awareness Sense of belonging Authentic professional identity Competency Mentorship Peer community Intersectional approach
S15	US	Ethnicity Gender			Design and creation	Observations Questionnaires	Quantitative	Assumed competency Sexism Racism	Awareness
S16	US, Canada	Ethnicity Gender (binary)	Non-binary LGBTQIA+		Survey	Questionnaires	Quantitative	Belongingness Experience Exclusion	Sense of belonging

3.1.4 Data Synthesis

The authors used qualitative data analysis of the primary studies to identify themes and their correlation with the RQs, which then was presented a descriptive synthesis [49, 50]. Table 3.5 and Table 3.6 show an overview of the primary studies, data extraction, and synthesis.

3.2 Synthesised Results

A detailed summary of the findings from the SLR [19], as shown in Table 3.6, are presented in the following subsections. The results are related to RQs defined in Table 3.1.

3.2.1 RQ1: What Research Exists Regarding Intersectionality in Computer Science?

The primary studies included in the SLR were published between 2018 and 2022, which are visualised in Figure 3.2. 75% of the papers were published in the last three years (2020-2022). The SLR was conducted in the autumn of 2022, which justifies why the number of papers was relatively low that year compared to the previous year.

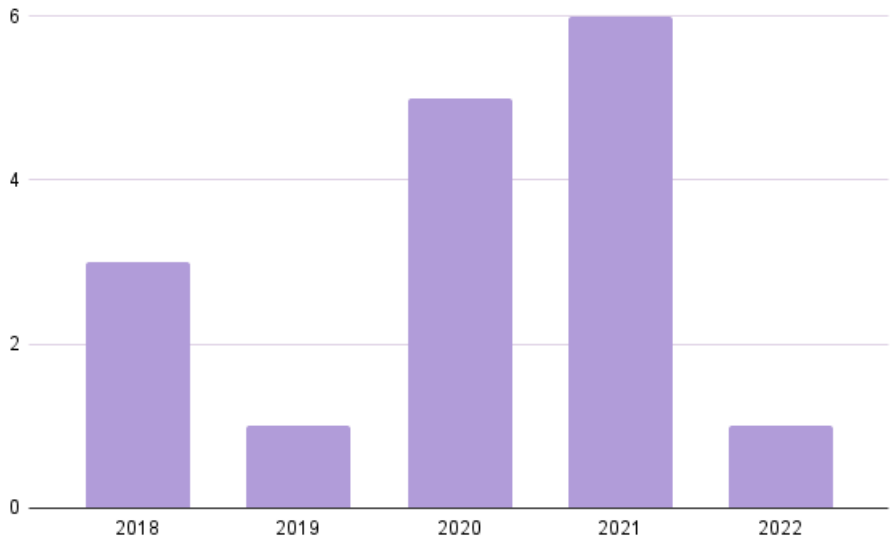


Figure 3.2: Number of papers per publishing year included in SLR [19].

The location of the papers, together with their intersectional factors, are presented in Table 3.7. 81% of the studies used data from the US and were based there. Most of the primary studies focused on the intersectional factors of gender and ethnicity. Four of the studies researched more than two intersectional factors but decided not to include them due to the low sample sizes. These intersectional factors are listed under *aborted factors* in Table 3.7. Two primary studies reflected on some intersectional factors that were not included in their research and deemed these as limitations to the study. These intersectional factors are listed under *limitations* in Table 3.7.

Table 3.7: Location of study and intersectional factors found in each primary study from SLR [19].

Study	Location	Intersectionality factors	Aborted factors	Limitations
S01	India UK	Gender (binary) Socioeconomic Class and caste		
S02	US	Black women Gender (binary)		
S03	US	Ethnicity Gender (binary) Socioeconomic		Non-binary Dis/ability LGBTQIA+
S04	US	Black women Gender (binary)		Non-binary
S05	US	Women and non-binary Socioeconomic First-generation student	Non-binary Ethnicity	
S06	US	Ethnicity Gender (binary)		
S07	Ireland	Minority Gender (binary)	Non-binary LGBTQIA+ Ethnicity Dis/ability Nationality Religion Mature student	
S08	US	Ethnicity Gender (binary)		
S09	Ireland	Minority Gender (binary)	Non-binary LGBTQIA+ Ethnicity Dis/ability Nationality Religion Mature student	
S10	US	Black women Gender (binary)		
S11	US	Ethnicity Gender (binary)		
S12	US	Black women Gender (binary)		
S13	US	Black women Gender (binary)		
S14	US	Ethnicity Gender (binary) Socioeconomic		
S15	US	Ethnicity Gender		
S16	US Canada	Ethnicity Gender (binary)	Non-binary LGBTQIA+	

Table 3.8 presents the research methods used in the 16 primary studies. 81% of the studies chose *survey* as the research strategy. The majority used interviews or questionnaires as data generation methods. 56% of the primary studies performed quantitative data analysis.

Table 3.8: Research methods in primary studies from SLR [19].

Study	Strategies	Data generation methods	Data analysis
S01	Case study	Interviews Observations	Qualitative
S02	Survey	Interviews	Qualitative
S03	Survey	Documents	Quantitative
S04	Survey	Interviews Questionnaires	Mixed
S05	Survey	Questionnaires	Quantitative
S06	Survey	Documents	Quantitative
S07	Survey	Questionnaires	Quantitative
S08	Survey	Interviews Questionnaires	Qualitative
S09	Survey	Questionnaires	Quantitative
S10	Case study	Interviews Observations	Quantitative
S11	Survey	Interviews	Qualitative
S12	Survey	Questionnaires	Quantitative
S13	Survey	Interviews	Mixed
S14	Survey	Interviews Questionnaires	Mixed
S15	Design and creation	Observations Questionnaires	Quantitative
S16	Survey	Questionnaires	Quantitative

3.2.2 RQ2: What Are the Main Intersectional Challenges in Computer Science?

All of the 16 primary studies addressed challenges regarding intersectionality in CS. These challenges extracted from the studies are listed in Table 3.9. Stereotypes, discrimination and bias were common intersectional challenges found in the papers. Many of the primary studies also indicate that the lesser sense of belonging was a significant intersectional challenge.

Table 3.9: Findings of intersectional challenges from SLR [19].

Study	Intersectional Challenges
S01	Class, caste and norms forms the women's work life in India. The awareness of policies are low in India and they are known for long work hours. UK offers better support for working families and often women leave work in India to stay home with family.
S02	Lack of positive experiences with CS in high school. Pressure to assimilate and not exercise agency to ask questions or satisfy their own intellectual curiosity. In undergraduate and graduate CS courses there they are surveilled, subjugated, ignored, and continuously pressured to behave like stereotypical White male computer scientists. Subliminal messages of inferiority and deficiency in personal interactions with classmates and faculty inside and outside of class. Students were assumed to be less capable in the CS field, which enabled discrimination across marginalised groups to view one another as being academically incompetent and/or inferior to each other. This contributed to the feelings of isolation, especially for Black women in CS.
S03	CS tends to struggle with enrolment and retaining students. A dearth of literature on minoritised women in CS and their contributions to the discipline.
S04	90% of Black female game characters and 45% of White female game characters are treated as props or victims of violence in popular games. There is a lack of diversity and cultural accuracy in games. Game characters of colour often have dehumanising narratives or endure explicit acts of racism, suggesting that development of non-stereotypical characters in games is an afterthought.
S05	First-generation and continuing generation report that their gender identities pose the largest barrier to becoming active in the graduate computing community. There is limited exposure to computing learning opportunities, feelings of exclusion and imposter syndrome, sexism and racism within the computing community, and issues of access.
S06	Women are underrepresented in CS education.
S07	Women part of a minority had an increased sense of belonging post-COVID, but not significant. Men part of a minority had the largest drop in belongingness.

Table 3.9 continued from previous page.

Study	Intersectional Challenges
S08	The study found that many females found themselves being the ones in their department in the workplace, and that they have been given different tasks compared to their peers and were talked down to. Women frequently reported experiencing blatant discrimination and feeling alone compared to men. Lack of diversity at the workplace and in the hiring process.
S09	There is a lower sense of belonging in female students who self-identified as being part of a minority group.
S10	Too high or too low expectations, racism, sexism, discouragement, and job dissatisfaction. Black females were often the only ones in academia or industry work. Experienced discrimination in terms of job promotions (where peers with fewer qualifications got promoted over them), and their high aspirations to advance were met with resistance.
S11	Being excluded from informal networks in the company. General gender bias, nationality bias, and leadership behaviour bias, where they constantly tried to disprove others' perceptions. Stereotypical "masculine" traits translate to women being "aggressive" and "angry" instead of assertive, thus often suffering negative consequences even when behaving in the same way as their male colleagues. Racist stereotypes were also used to the advantage of senior staff. The study also highlighted that workplaces wanted diverse people who graduated from prestigious universities, such as Ivy League institutions, to consider their education as valid. People of intersectional backgrounds had their knowledge, credibility, and legitimacy challenged by colleagues and subordinates, hence having to prove to people continuously that they are qualified to do their job. In a predominantly male workspace, cross-gender mentoring could be inhibited by the continuous assumption of sexual relationships.
S12	Black women have a unique social experience in CS.
S13	Disadvantages for Black women and other women of colour.
S14	Few women of intersectional identities earn a bachelor's degree in CS. They face social barriers such as acute isolation or alienation, bias, discrimination and stereotypes. Their intersectional identities may not be fully supported and understood.

Table 3.9 continued from previous page.

Study	Intersectional Challenges
S15	Male player characters rated the female applicant's technical skills lower than the male applicants. Overall racial bias and overall gender bias exist among White male participants. Black female faces the most bias.
S16	Female students have a lower sense of belonging. Black and Latinx have a lower sense of belonging than White students. Students without prior experience have less sense of belonging. Students with prior experience felt that the department was not too welcoming.

3.2.3 RQ3: What Factors Are Important to Overcome These Challenges and Succeed in Computer Science?

The success factors extracted are grouped into three tables; *mentorship* in Table 3.10, *sense of belonging* in Table 3.11, and *other* in Table 3.12. Multiple primary studies from the SLR call attention to the importance of the sense of belonging. Moreover, both mentorships and various forms of formal and informal networks can be used to improve belongingness and increase DEI, both of which were challenges identified in CS.

Table 3.10: Findings of success factors – Mentorship from SLR [19].

Study	Success Factors – Mentorship
S03	Higher education institutions should offer increased mentoring opportunities and peer support through teaching assistants and discussion groups to provide practical activities for more theoretical concepts.
S08	Organisations should support the development of leadership skills, as it is seen as highly effective when a diverse and heterogenous group of people have leadership roles. They are more likely to give back by supporting people of intersectional identities, sharing their experiences, and further mentoring other people of staff.
S10	Mentors have been proactive in sharing information about the culture and politics of CS, which is imperative because it is a patriarchal space, and being prepared with some coping strategies can decrease the shock. Advocacy by mentors was found as an important strategy for overcoming intersectional challenges in CS.
S11	Mentors were identified as crucial for advancement in the CS career journey, especially in the beginning of the career trajectory. This study noted positive mentoring experiences with mentors of a different gender and/or ethnicity. Sponsors were seen as important for advocating for career advancement, since they are at a higher level in the organisation than the sponsored individual.
S13	Mentoring and guidance are important throughout the whole process in school. An open-door policy is important to not be afraid to ask questions.
S14	Intersectional mentoring actively supports mentees' in CS while also having empathy and awareness of their intersectional identities. The mentors were not necessarily matched on the intersectional identities of the mentee, but they had awareness and provided support concerning intersectionality issues, such as systemic barriers. The study found that mentoring showed high ratings in the survey across all intersectional identities.

Table 3.11: Findings of success factors – Sense of belonging from SLR [19].

Study	Success Factors – Sense of Belonging
S03	Supportive peer networks are shown to be critical in high school CS classes.
S04	Using an intersectional lens promoted the inclusion of those who are ignored, often silenced, or feel invisible; hence, inclusion is a by-product of intersectionality.
S05	Women and non-binary hackathon events are important for first-generation women to identify with computing research and develop positive computing identities.
S06	Empowering female student organisations for engineering and CS contributed to increased enrolment. The study also stated that for CS additional academic support, increased scholarship opportunities, and bridge programs would lead to higher enrolment and retention amongst underrepresented students.
S07	Sense of belonging increases with social interaction. Gender and ethnicity impact it too.
S08	A welcoming atmosphere was highlighted as important to CS students in the hiring process and at the workplace. Having diverse interviewers that work in CS in general, not only in terms of recruiters for targeting diversity. Diversifying the engineers and managers asking questions at technical interviews encourages intersectional confidence, as people of diverse backgrounds can see others like them represented in the organisation. To increase retention and persistence in the field, cultivating inclusive thinking was important to reform hiring and workplace practices.
S09	Sense of belonging increases with social interaction, most significant for men but also a little for women. Prior experience also has a positive impact on men, but not on a female sense of belonging.
S11	Having a diverse organisation and CEO/leader-team were important factors in creating a supportive work environment where people could succeed.
S12	CS friends are increases the probability for Black women to pursue a CS career. Home environment support is also a factor that can influence this for all.
S13	A network of support including Black students on campus makes Black women feel less isolated. There needs to be included more intersectionality in research to represent all in computing. It is important that schools care for, mentor and prepare the students to enter computing spaces with confidence.

Table 3.11 continued from previous page

Study	Success Factors – Sense of Belonging
S14	Authentic Professional Identity promoted students to maintain authentic rather than assimilating to fit the CS stereotype, showcasing possible career paths and identifying each student's unique experiences and values in CS to guide them in a professional or academic setting. The study found that "intentional outreach, messaging, and content meant to solicit and sustain participation of a critical mass of students" were important strategies for building a community. Intersectional Peer Community promoter the creation of diverse and mutually supportive student communities, creating a sense of belonging both socially and in CS. The study found that collaborative activities that facilitated social and academic engagement were key factors in creating a peer community.
S16	A sense of belonging is positive for students with prior experience.

Table 3.12: Findings of success factors – Other from SLR [19].

Study	Success Factors – Other
S01	HR roles are less limited if the company does not have a parent company in the US or Europe. Awareness of paternity leave, equal pay reviews and general policies need is important.
S03	Research on women as a homogenous group can be misleading since omits various trends and historical aspects from intersectional groups in CS. Research and literature should formally celebrate women in CS, as this is a way to legitimise and highlight positive role models and their contribution to CS, which in turn encourages others.
S08	Designing a course that prepares students for technical interviews.
S10	An intersectional approach recognises the unfair power relations in CS spaces. The women interviewed in the study had worked up to leadership positions and were now working as mentors for others in CS. As mentors of intersectional identities, they recognise Black women as equals and co-creators of knowledge, which disrupts inequities.
S14	Intersectional capital is the framework presented in the study that encompasses the development of a sense of belonging, mentorship, acquiring technical and interpersonal skills, cultivating meaningful connections, and establishing a strong CS identity.
S15	When participants embody and identify with an underrepresented player character for even a few minutes their societal biases against real people can be reduced by a significant amount.

3.3 Conclusion

There is a dearth of literature on intersectionality in CS, which is essential in providing a more nuanced perspective in DEI research. These nuances were lost when most of the primary studies in the SLR used data from the US. As intersectionality is a very complex topic, not having a more international scope and diverse research from different countries results in a higher probability of meaningful intersectional experiences in CS being ignored; since views, norms, and cultures also impact what successes and challenges people face. Binary gender, ethnicity, and the intersection between them were the most discussed intersectional factors, and only four different factors were thoroughly researched in all of the primary studies. To increase DEI in CS, there needs to be more research on intersectionality in CS, including various intersectional identities, challenges, successes, and more research globally.

At large, the CS field fails to acknowledge the impact intersectionality and intersectional issues have on people depending on their identity. The issue of belongingness was, in most cases, a result of systemic barriers based on stereotypes, bias, imbalanced power dynamics, and sexist and racist assumptions. In practice, these issues led to, e.g., exclusion from informal networks; unrealistic expectations being placed on individuals based on stereotypes and traditional gender roles; lack of support and community; and fewer role models throughout the CS field.

Inclusion is a result of intersectionality, and therefore, increased knowledge about intersectionality is important for CS to achieve DEI throughout education, industry, and academia. Findings from our primary studies primarily suggested mentorships and supportive networks as success factors which addressed the lack of sense of belonging amongst people of intersectional identities in CS. Mentorship, which supports diversity through guidance and personal support, was especially useful in the early stages of a person's career. Professional and peer networks, which support diversity through building social, academic, and industry connections and support career confidence and skill building, helped promote retention and supportive communities in CS. Overall, having understanding and empathy for the intersectional experiences and creating an environment with a low threshold for asking questions, as well as information and knowledge sharing, were all critical factors in increasing diversity in CS through an intersectional lens, which can be achieved through mentorships or supportive networks.

Chapter 4

Methodology

The following chapter presents the research methodology in this thesis, with methods inspired by Oates *et al.* [50], Creswell *et al.* [65], Marton *et al.* [66], Braun *et al.* [67], Ghezzi [68], Recker [69], and Norman [70]. CS is a multi-disciplinary field, and CS research often includes theories and frameworks from areas outside of engineering and technology. The thesis follows the process of evidence-based computing, as presented in Figure 4.1. This is a model of the research process and methodology, highlighting the choices made for this thesis. The basis for this research was the project thesis [19] written in the autumn of 2022, which is visualised in the left rectangle. The initial research process consisted of conducting the SLR (see Chapter 3) and defining a rationale based on the authors' personal experiences and interests, as well as identifying potential gaps in knowledge based on the project description (see Appendix A) and extended abstract (see Appendix B). The research process used in this master's thesis is visualised in the right rectangle, which consists of the *design and creation* strategy, interviews and observations as data generation methods, and qualitative data analysis.

Section 4.1 discusses and validates the RQs for this thesis. Section 4.2 presents the conceptual framework by enlightening theories used in the process of the thesis. Section 4.3 expresses a positionality statement to increase reflexivity in the research. Section 4.4 discusses the *design and creation* strategy and how this strategy helps answer the RQs and aligns with the initial project description. Section 4.5 discusses the data generation methods *interviews* and *observations* and how these align with the chosen research strategy. Section 4.6 describes the qualitative data analysis process. Lastly, Section 4.7 discusses ethical considerations and research validity.

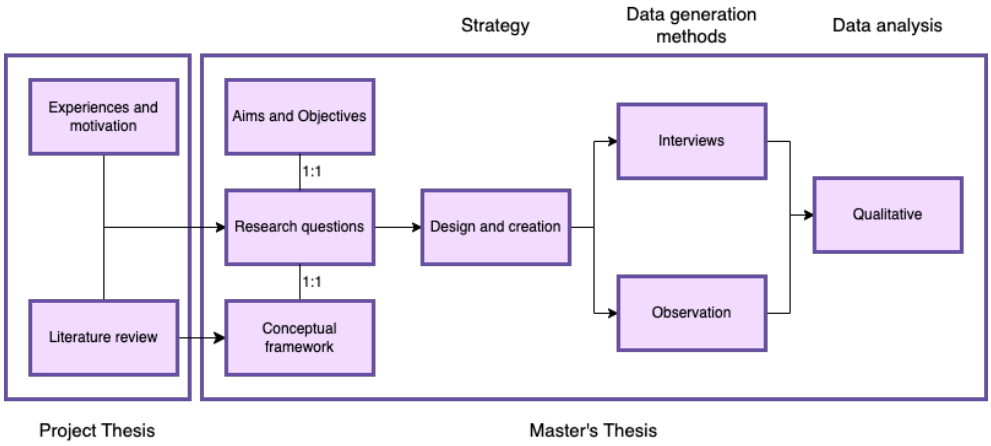


Figure 4.1: Model of the research process and methodology adapted from Oates *et al.* [50].

4.1 Research Questions

As presented in Chapter 3, findings from the SLR show that there is a dearth of literature on intersectionality in CS. Most of the primary studies analysed in the SLR [19, 20] were from the US, which further verified that there is a knowledge gap on the topic of intersectionality in CS at a global scale. The research objective of this thesis is to improve DEI in CS through an intersectional approach, by gaining insight and knowledge from people of intersectional identities in CS in Norway and Brazil. In the existing literature, intersectional challenges, such as bias and discrimination, were addressed, and success factors tackling these challenges in CS were suggested. Since this thesis builds upon the findings from the SLR, two of the RQs from the project thesis were carried over to expand further and gather more knowledge about intersectionality in CS. A third RQ was also added to provide a more tangible answer to the task description; design and develop digital support for inclusion, presented in Appendix A.

The RQs discussed in this master's thesis are the following:

- **RQ1:** What are the main intersectional challenges in computer science?
- **RQ2:** What factors are important to overcome these challenges and succeed in computer science?
- **RQ3:** How to design and develop digital support to increase intersectionality in computer science?

Creswell *et al.* [65] state that the qualitative research process is emergent, meaning that the initial plan for research may change or shift when gaining a deeper understanding of the topic or phenomenon that is studied. After further reflection and research, the authors decided to further research the success factors of

supportive peer networks and professional networks rather than mentorships, as initially stated in the further work section of the project thesis [19]. The authors found multiple emerging and existing mentorship programs, specifically targeting CS or STEM, with the goal of increasing inclusion. Therefore, the authors could contribute more to the areas of intersectionality in supportive peer and professional networks, which were also important factors for increased inclusion and belongingness, according to the literature [19, 20].

4.2 Theory

The core of any research process is theories [69]. Within qualitative research, the theoretical framework provides a filter that shapes the perspectives and influences the research from the beginning [65]. According to Recker [69], there are three types of knowledge; domain and topic of interest associated with a phenomenon, theories that help frame the phenomenon, and research methods that can be applied to generate novel insights to develop new knowledge. The first type of knowledge was presented in Chapter 2 and Chapter 3. The conceptual framework and relevant theories are presented in this section, while the knowledge about research methods is presented throughout this chapter.

Relevant theories together provide a conceptual framework, which facilitates the analysis of empirical data, to identify themes within the qualitative data set and help explain these findings [69]. The research of this master's thesis addresses intersectionality in CS, which is an interdisciplinary research study containing theories from formal, applied, social, and human sciences. Therefore, this research utilises methodology and theories from multiple disciplines, as illustrated in Figure 4.2. This theoretical triangulation increases the credibility of the research [50]. Formal sciences include CS, applied sciences contain HCI, social sciences include sociology, and human sciences contain both philosophy and psychology. The theories that altogether define the conceptual framework for the research process are presented in this section.

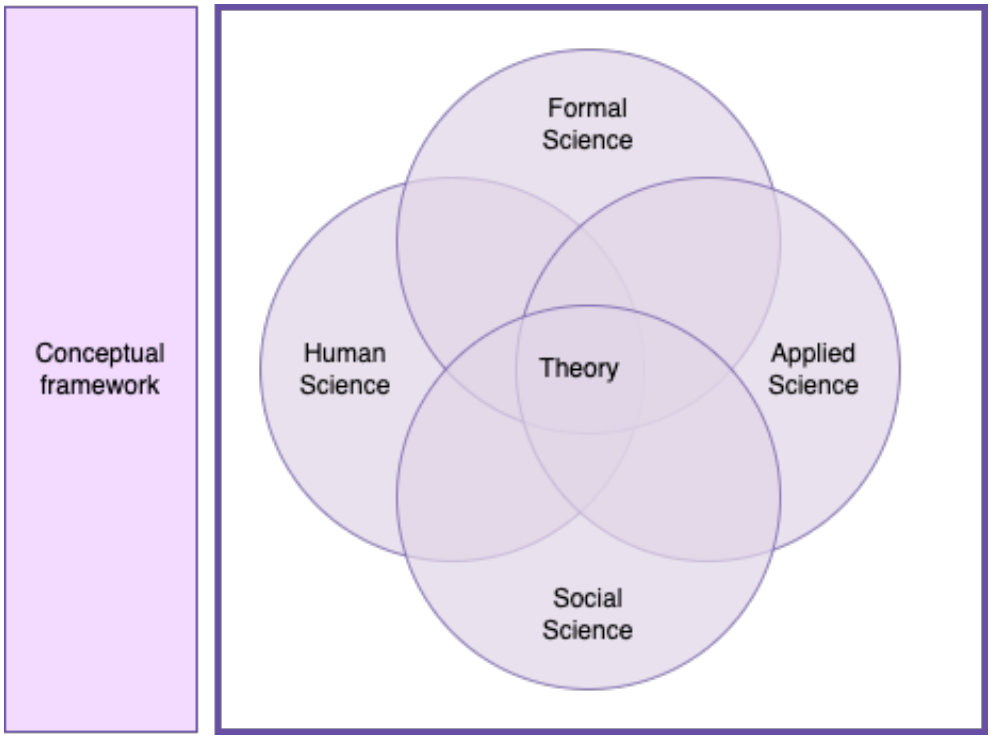


Figure 4.2: Theories that form the conceptual framework.

4.2.1 Interdisciplinary Theories from the Systematic Literature Review

Chapter 2 presented the core theories that form the foundation for this thesis. In the primary studies from the SLR [19, 20], *intersectionality theory* [3, 5, 6, 53–63](see Section 2.1) and *gender theory* [6, 52, 55, 60, 63] (see Section 2.2); both interdisciplinary theories rooted in sociology and psychology, were used as the main theoretical frameworks to research the topic of intersectionality in CS. In S10, Thomas *et al.* [59] theorised *intersectional computing* through their research, which is defined as "a more complex understanding of the experiences of marginalized groups in computing who live at various intersections of racism, sexism, classism, xenophobia, heterosexism, ableism, etc.", where the study aimed to identify strategies that enabled Black women in the US to successfully navigate the CS field at different stages. Research in S02 [53], S05 [5], and S13 [61] utilised this theory in more of a historical and comparative context, which was the basis for theorising how diversity in CS has been throughout history (see Section 2.5) and what the situation is today (see Section 2.6). These theories were put in the context of this thesis by also connecting them to the SDGs (see Section 2.3) and existing initiatives that aim to better DEI (see Section 2.7).

Intersectional Capital

Spencer *et al.* [62] introduced a new theoretical framework in S14, based on science capital [71], called *intersectional capital* [62], which is defined as:

> [A] set of environmental and interpersonal conditions that enable students [...] to pursue STEM and computing by validating and leveraging their multiple interlocking identities as assets [...] describ[ing] a collection of circumstances and experiences that supports the complexity of students' intersectional identities [...] when engaging in computing. The psychosocial, cultural, and economic factors that make women a polylithic group can be understood through the Intersectional Captial lens [...].

This framework includes *intersectional peer community*, *authentic professional identity*, and *intersectional mentorship* that together aims to help students increase their sense of belonging, develop their technical and interpersonal skills, establish meaningful relationships and networks, and develop an empowering CS identity; which can be seen in the other primary studies as well. S05 [5] shows an example of intersectional capital through the framework *intersectional computing identities*, combining the Affinity Research Group model (ARG model) [72] and the intersectionality framework to impact students' computing identities, through workshops that emphasise collaborative peer community development and mentoring in CS research.

Sense of belonging was an essential finding from the SLR, and was prevalent in several primary studies [3, 5, 55–58, 64], as well as being important in the intersectional capital framework [62]. Baumeister *et al.* [73] theorised *sense of belonging* as the subjective experience of feeling connected to others, which arises from shared experiences, values, mutual emotional support, and acceptance. In the context of intersectionality in CS, retention is strongly coupled to a sense of belonging in the field [56, 58, 64], as experiencing a sense of belonging promotes positive emotions and improved mental health [73].

Phenomenography

The qualitative research approach *phenomenography* was utilised by Lunn *et al.* [57] in S08. Phenomenography was theorised by Marton *et al.* [66] to investigate and describe how people experience a particular phenomenon through an empirical process. It is based on the notion that a person's experiences are shaped by their individual background, perspectives, and contexts, where similarities and differences are systematically identified through, e.g. interviews [57, 66], and is grounded in the interpretive research paradigm [74].

The data analysis stage of phenomenography can vary regarding how the transcripts are analysed and processed. To ensure the analysis's reliability and validity, Åkerlind [74] recommends that the researchers are transparent in their choice of analysis techniques since most of them are not uniformly used.

In phenomenography, the researcher asks how well their research outcome corresponds to the human experience of the phenomenon in question; the validity of the research is ensured through the use of *pragmatic validity checks*, providing helpful knowledge as the research outcome [74]. *Communicative validity checks* are also commonly practised within phenomenography. Communicative validity checks depend on feedback from the research community; e.g., through a defence, conference presentation, or peer-reviewed journals; interviewees, or the intended audience. However, according to Åkerlind [74], seeking feedback from interviewees is not deemed appropriate due to the interpretation of the data focusing on the collective, not an individual interview. It is important to take into consideration that each person's understanding of the phenomenon is context-sensitive, and the researchers' interpretation could go beyond each individual's understanding of the interview. The authors' SLR [20] has been peer-reviewed, published, and presented at GE@ICSE 2023 (see Appendix C), and the work done in this thesis has been presented at a workshop in Brazil. Also, this research aims to provide more knowledge about intersectionality in CS. Thus, this thesis ensures both pragmatic and communicative validity.

For ensuring reliability, the *coder reliability check* and *dialogic reliability check* are suggested as possible options in phenomenography [74]. The *coder reliability check* is conducted when two researchers code the interview transcripts independently and then compare their categorisations. The *dialogic reliability check* is conducted when the two researchers discuss and critique each researcher's interpretation of the data until an agreement is reached. Both of the presented reliability checks will be used for the data analysis of this thesis.

Overall, phenomenography aims to develop a nuanced and detailed understanding of the different ways individuals experience the phenomenon under investigation to develop new strategies that take these diverse experiences into account [66, 74].

Standpoint Theory

The term *standpoint theory* is an epistemology first coined by Harding [75], originating from the perspective that traditional research is not objective and has ignored and marginalised women in this space, thus, arguing that people of marginalised positions have a unique standpoint to define important RQs or explain social problems. In Harding's later work, intersectionality has become a more integral part of the standpoint theory because intersectionality also recognises that

people exist in multiple, often contradictory, social positions shaping individual's perspectives in a complex manner [75]. This was used in several of the primary studies from the SLR by providing a *positionality statement*, which requires the researchers to be reflexive of their role and acknowledge any assumptions or biases [3, 6, 53, 59–61]. Standpoint theory also highlights the importance of recognising how power and privilege shape our understanding of the world and how awareness is essential to challenge and dismantle these power imbalances in order to obtain equity [75].

4.2.2 Theory from Philosophy

This thesis will follow the philosophical research paradigm of *interpretivism*. According to Oates *et al.* [50], interpretivism in CS aims to identify, explore, and explain how factors of social contexts are connected or autonomous. This paradigm is aligned with the theories presented in Section 4.2.1 and in Chapter 2, as it shares the characteristics of acknowledging multiple subjective realities, researcher reflexivity, qualitative data analysis, and understanding people and their experiences [50]. The outcome of any interpretive research is not to arrive at a fixed solution but rather to present an outcome that could be beneficial and provide knowledge about complex phenomena based on the findings [50].

To ensure the quality of interpretive research, there is a need for different criteria compared to positivist research. The quality criteria in positivist research are objectivity, reliability, and internal and external validity. Oates *et al.* [50] and Åkerlind [74] agree that objectivity is not possible, from an interpretive approach, since no observations can be made without bias. However, Oates *et al.* [50] suggest trustworthiness, confirmability, dependability, credibility, and transferability as quality criteria for interpretivism, whereas Åkerlind [74] suggests reliability and validity checks. Åkerlind's quality criteria align more with the terms used in the "traditional" positivist research paradigm (see Section 4.2.1), but these are methods specific to an interpretive approach. On the other hand, Oates *et al.* [50] present criteria that "mirror" the positivist quality criteria. *Trustworthiness* mirrors validity in positivism by asking how trustworthy the research is [50]. *Confirmability* assesses whether the findings originate from the data collection, preferably through using an auditor, and mirrors objectivity in positivism [50]. *Dependability* is concerned with how well the research process is documented and if it is possible for others to perform an "audit trail", and mirrors reliability in positivism [50]. *Credibility* mirrors internal validity in positivism and ensures that the subject of research is accurately represented and described, which could be achieved through, e.g., method, space, and theory triangulation [50]. Lastly, *transferability* questions if the research can be transferred to another case by letting the reader judge whether the findings could be relevant to them based on the details provided in the research, and mirrors external validity in positivism [50]. Oates *et al.* [50]

highlight *trustworthiness* as the most important quality criteria for interpretive research.

Oates *et al.* [50] state that "interpretive research offers a way of understanding computing as a practice constructed and developed by humans". Still, interpretive research is not widespread in CS, as it looks for *plausibility* rather than "proof" as in positivism [50]. Since this thesis aims to get a complete picture of intersectionality in CS and not only examine an IT artefact, interpretivism is more fitting as the philosophical research paradigm compared to positivism.

4.2.3 Theory from Psychology and Sociology

This subsection presents the theory related to qualitative analysis and methods for analysing data. The method used for data analysis are from psychology and sociology.

Qualitative Research and Analysis

As stated by Creswell *et al.* [65], "[q]ualitative research is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem". This master's thesis follows this approach through the use of qualitative theories and methods, such as phenomenography and standpoint theory (see Section 4.2.1), interpretivism (see Section 4.2.2), and design and creation (see Section 4.4).

According to Creswell *et al.* [65], "the key idea behind qualitative research is to learn about the problem or issue from participants and to address the research to obtain that information". This is obtained through conducting interviews and usability tests (observations). Qualitative data analysis is used in order to code and identify themes and patterns from the data collected. Creswell *et al.* [65] introduce a general five-step data analysis process:

1. Organise and prepare the data for analysis.
2. Read or look at all the data.
3. Start coding all of the data.
4. Generate a description and themes.
5. Representing the description and themes.

Thematic Analysis

Thematic analysis is a widely used method for qualitative analysis in psychology, for identifying, analysing, and documenting patterns or themes within qualitative data sets [67]. According to Braun *et al.* [67],

> [...] thematic analysis should be seen as a foundational method for qualitative analysis. It is the first qualitative method of analysis that researchers should learn, as it provides core skills that will be useful for conducting many other forms of qualitative analysis.

Furthermore, the method follows a flexible and accessible approach that can be applied across various RQs, research designs, and research methods; thus is useful beyond the field of psychology [67].

Both Oates *et al.* [50] and Creswell *et al.* [65] propose grounded theory or narrative analysis as popular qualitative analysis approaches.

Grounded theory is a more theory-driven approach to analysis and is typically used when the research focuses on developing a theory for a particular phenomenon grounded in the data collected [50, 65, 67]. Braun *et al.* [67] also highlight that grounded theory operates at a higher level of abstraction and identifies and develops broader categories and themes based on the data, compared to thematic analysis, which focuses more on the specific patterns found within the data. Thematic analysis also offers more flexibility as it can be used with both inductive and deductive approaches [67].

Narrative analysis focuses specifically on the analysis of stories and narratives, seeking to understand the structure and content of individual narratives and exploring how the stories are constructed and what they reveal about the experiences and perspectives of the narrators [50, 65, 67]. When comparing this to thematic analysis, Braun *et al.* [67] state that narrative analysis tends to be more interpretive since it draws on literary and narrative theory to further explore the significance and meaning of the data being analysed, whereas thematic analysis focuses more on identifying themes and patterns across multiple narratives and is more closely aligned with empirical and deductive approaches.

Thematic analysis provides both rich insights into the perspectives and experiences of individuals and groups, like narrative analysis, and generates a comprehensive insight into a complex phenomenon, like grounded theory. Furthermore, thematic analysis aligns well with phenomenography due to analysing the experiences of a complex phenomenon. This is why the authors found this method of analysis to be the most fitting for this thesis.

Although thematic analysis is flexible, it is also rigorous and systematic. Thematic analysis follows a recursive process and Braun *et al.* [67] introduce an outline guide of the six phases of analysis:

1. Familiarising yourself with your data.
2. Generating initial codes.
3. Searching for themes.
4. Reviewing themes.
5. Defining and naming themes.
6. Producing the report.

The authors used this method to analyse the interview data. The data analysis process of this thesis is explained in detail in Section 4.6.

4.2.4 Theory from Computer Science

The theories used from CS directly support Recker's third type of knowledge; "[k]nowledge about relevant research methods that you can apply to develop new knowledge, build innovative artefacts, or articulate new questions" [69]. Since RQ3 explores the development of an innovative artefact, theory from CS provides the foundation for how the design and development process was conducted and analysed.

Ghezzi [68] refers to an artefact or a discrete unit of knowledge; that might be of interest to others seeking to enrich their existing knowledge to use in further research; as a result of research. There are three components that describe the research result; *originality*, *rigour* and *significance* [68]. *Originality* informs how the product provides new insights. This thesis aims to get new insights through interviews and suggest a new prototype to enhance DEI. *Rigour* is gained through following the methods and justifying choices made. In a research process, theory adds rigour [69]. Lastly, *significance* is evaluated by considering if the product has enough intellectual depth to exert influence. This thesis aims to increase awareness and provide new knowledge about intersectionality in CS.

Agile Software Development and Prototyping

Oates *et al.* [50], Recker [69], and Ghezzi [68] all argue for the importance of research and theory supporting the design and development of a digital artefact. From CS, both agile development and prototyping are utilised in the development process.

Agile development is based on the agile manifesto principles, which emphasise being open to changes in requirements and the user's interaction with the artefact [50, 76, 77]. The authors took inspiration from *Scrum* and *eXtreme Programming* by using sprints for an iterative workflow and a Kanban board for organising tasks and the backlog.

Prototyping is a software development approach focusing on creating a preliminary version of a system or application, in order to test and refine its design and functionality [50]. The digital artefact that was developed for this thesis follows this prototyping approach.

4.2.5 Theory from Human-Computer Interaction

Theory from HCI has, together with CS theory (see Section 4.2.4), been used in the design and development process, as well as providing theories for data generation that specifically support the creation of a digital artefact.

Don Norman's Design Principles

Sharp *et al.* [77] present five design principles, adapted from Norman's "*The Design of Everyday Things*" [70], as a tool for the interaction design process to be aware of different aspects of the design:

Visibility
The more visible an operation is, the more likely the user will know what to do. Looking at visibility from the opposite perspective, if functions are out of sight, it becomes difficult to find or know how to use those specific functions.

Feedback
The user should receive feedback informing them on which actions have been done and what has been accomplished.

Constraints
Identifying methods for limiting user interaction types that can occur at a given moment.

Consistency
Elements that look the same should have the same functionality. The user can then use previous experience to use similar products.

Affordance
An object should be designed to enable users to understand how to utilise it.

Usability and User Experience Goals

Usability and user experience (UX) goals are guidelines to help define the primary objectives of developing a prototype [77]. Understanding and recognising the relationship between usability and UX goals is central to good interaction design, as they make the designers aware of the outcomes of the different combinations and highlight potential trade-offs and conflicts [77].

The *usability goals* help optimise the interactions users have with an artefact, through evaluating the different aspects of the user interface (UI) and its operations [77]. Additionally, these goals can be turned into quality attributes (see Table 4.2), providing quantitative measures of how the user interacts with the UI. Sharp *et al.* [77] present the following six usability goals:

1. *Effectiveness*: Is the product capable of allowing people to learn, carry out their work efficiently, access the information that they need, or buy the goods that they want?
2. *Efficiency*: Once users have learnt how to use a product to carry out their tasks, can they sustain a high level of productivity?
3. *Safety*: What is the range of errors that are possible using the product, and what measures are there to permit users to recover easily from them?
4. *Utility*: Does the product provide an appropriate set of functions that will enable users to carry out all of their tasks in the way they want to do them?
5. *Learnability*: Is it possible for the user to work out how to use the product by exploring the interface and trying certain actions? How hard will it be to learn the whole set of functions in this way?
6. *Memorability*: What types of interface support have been provided to help users remember how to carry out tasks, especially for products and operations they use infrequently?

The *UX goals* are concerned with the subjective experience a user has when interacting with a product, how the system feels, and are often subtle elements that shape a desirable UX [77]. Table 4.1 presents the UX goals that the authors found relevant to the thesis.

Table 4.1: UX goals categorised into desirable and undesirable aspects, adapted from Sharp *et al.* [77].

Desirable aspects	Undesirable aspects
Engaging	Frustrating
Helpful	Making one feel guilty
Motivating	Unpleasant
Enhancing sociability	Patronising
Cognitively stimulating	
Provocative	
Emotionally fulfilling	

Usability Testing

The observations conducted for this thesis were also rooted in HCI in the form of usability testing. This form of observation aligns with the iterative process of software design and development (see Section 4.2.4) and the thesis' research strategy (see Section 4.4), as well as being complementary to the interviews [50, 78]. According to Gomoll *et al.* [78], "[u]ser observation should be an integral part of the design process – from the initial concept to the product's release".

The authors utilised the *10 steps for conducting a user observation* introduced by Gomoll *et al.* [78] as the guideline for the usability tests:

1. Introduce yourself.
2. Describe the purpose of the observation and set the participant at ease by stressing that you're trying to find problems in the product.
3. Tell the participant that it's okay to quit at any time.
4. Talk about the equipment in the room.
5. Explain how to "think aloud".
6. Explain that you cannot provide help.
7. Describe the tasks and introduce the product.
8. Ask if there are any questions before you start; then begin the observation.
9. Conclude the observation.
10. Use the results.

4.3 Positionality Statement

Following the epistemology of *standpoint theory* [75, 79], the authors include a positionality statement indicative of the research team.

As researchers conducting a study on intersectionality in CS, we acknowledge and describe our positionality to provide transparency and recognise the potential influences on our research. Both of us are Norwegian women currently pursuing our master's degrees in computer science at a Norwegian university.

We recognise that our identities as Norwegian women may shape our experiences, biases, and perspectives related to DEI in CS. Our limited prior knowledge of Brazilian culture and the specific context of CS in Brazil also highlights the potential for cultural bias and the need for continuous learning throughout the research process.

We approach this research with a commitment to understanding and exploring intersectionality in CS. We aim to be sensitive to the unique experiences and challenges faced by individuals from different backgrounds in both Norway and Brazil. We acknowledge the importance of reflexivity, continuous self-reflection, and engaging in dialogues with participants and experts to ensure an inclusive and comprehensive exploration of intersectionality in CS.

By disclosing our positionality, we strive to provide transparency, foster trust, and invite critical engagement with our research findings. We are open to feedback and recognise that our positionality may shape our research process and interpretation of data. We are committed to addressing any biases that may arise and contributing to a more inclusive and nuanced understanding of intersectionality in CS.

4.4 Design and Creation

The chosen research strategy, *design and creation*, focuses on developing new technology, which is digital support for inclusion within the context of this thesis. According to Oates *et al.* [50], the design and creation strategy is grounded in the idea that knowledge is not only discovered but also created and that research can be a creative process where the results are new knowledge and an artefact. The strategy is the normally expected mode of research in CS, as a technological artefact is produced to show the researchers' effort rather than only abstract theories and other knowledge. The artefact then has a greater potential beyond the academic community. On the other hand, it is also important to show academic qualities and evaluate the product, not only technical skills [50]. Usability tests are applied to evaluate the product to ensure its quality. A challenge with the strategy

regarding the evaluation is that the limitations should be acknowledged, as it can be difficult to generalise all user cases from a single test case [50]. For this reason, space triangulation was used to increase the validity of the evaluation.

The design and creation strategy is considered an iterative process for problem-solving [50], which is visualised in Figure 4.3. This model shows how the design and creation strategy is implemented with the development methodology. The development and continuous evaluation of a digital artefact is an iterative and cyclical process, which consists of designing, testing, refining, and re-evaluating the prototype based on user feedback [50]; where prototyping and usability testing help provide a product that is more effective, efficient, and user-friendly [50, 77, 78, 80].

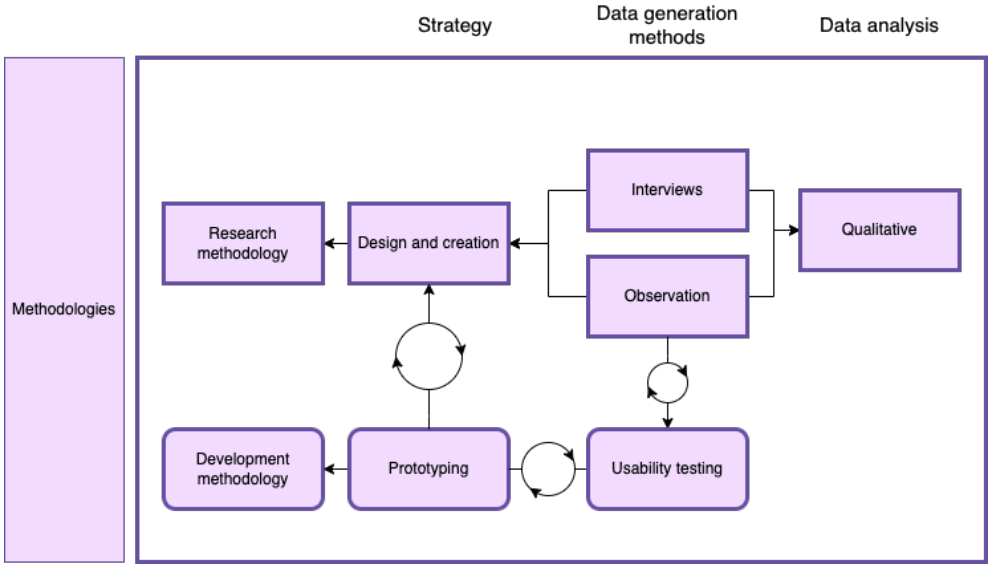


Figure 4.3: Model of the research methodology and development methodology adapted from Oates *et al.* [50].

The development of the prototype followed the five steps visualised in Figure 4.4. Further in this section, each phase from the figure is presented together with how the phase correlates to the process of this thesis.

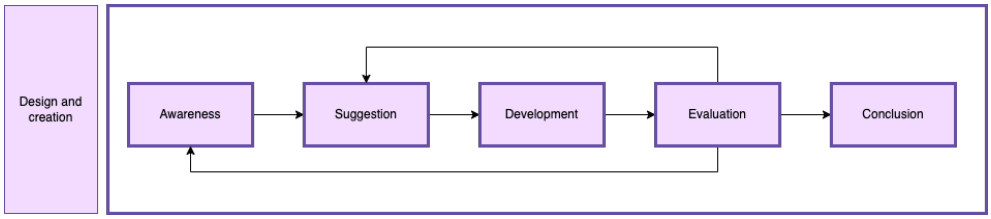


Figure 4.4: The planning phase visualised.

Awareness
This step revolves around acknowledging and expressing the existence of a problem, which can be obtained through further research in studies, findings from another discipline, the expression of the need for something, field research, or new developments [50]. Based on the findings in the SLR, summarised in Chapter 3, the CS field fails to acknowledge the impact of intersectionality, and there is a dearth of literature about intersectionality in CS. Both the SLR and the interviews, presented further in Section 4.5.2, relate to the awareness in this context.

Suggestion
This stage further builds upon the curiosity about the problem, from the awareness stage, to suggest a preliminary idea of how to address the problem [50]. The SLR (see Chapter 3) was the base for the suggestion as it presented success factors to help overcome challenges related to intersectionality in CS. Feedback from the usability tests, presented in more detail in Section 4.5.3, also added more to the suggestion phase through the different iterations.

Development
The implementation of the suggested design concept is conducted in this step [50]. A high-fidelity prototype was developed in *Figma*[1], and the prototyping is described in more detail in Section 4.4.1. Given that Figma enables prototypes to operate in the same manner as coded prototypes, the authors posited that Figma should be classified as a constituent of the development phase rather than the suggestion phase.

Evaluation
The developed artefact was evaluated based on its value and variation from the expected outcome [50]. After each iteration, the prototype was tested through a usability test with relevant end-users, which provided new suggestions for improvements that looped the process back to the suggestion phase until all prototype iterations and usability tests were completed. This aligns with the theories found in agile development, usability and UX goals, and usability testing (see Section 4.2.4 and Section 4.2.5), that highlights the importance of testing on relevant users and using the feedback provided to change and improve the requirements, UI, and UX [76–78].

[1]https://www.figma.com/

Interviews were also conducted with the usability testing, and the evaluated results looped the process back to the awareness phase. Even though the interviews were not conducted in the first of the five steps, the results from the interviews assess the awareness stage as the interviews reflect on intersectionality in CS and address correlating challenges. This is supported by Sharp *et al.* [77] and Sommerville [76], which present interviews as a method of receiving feedback from the user in HCI and CS that could further help define the requirements of a product. In addition to this, the interviews can be considered in the suggestion phase as success factors have been suggested.

Conclusion
In this last step, the results from the entire process are consolidated and documented, and the new knowledge is identified and discussed together with suggestions for further research [50]. Data from the usability testing are presented and analysed in Section 5.3, and the product of this thesis is discussed in Chapter 6.

The methodology used in the design and creation process was a combination of methods from agile software development and prototyping, rooted in theory from CS and HCI (see Section 4.2.4 and Section 4.2.5). A key element in the agile process is the *sprints*, several small iterations, where the prototyping focuses on gradually modifying a product until a satisfactory implementation is produced [50]. Figure 4.5 visualises the development phase with the iterations. The prototype was improved after each iteration of data gathering, which can be considered sprints, before being tested again and improved for the next sprint. The figure also illustrates that the usability tests were held in Norway and Brazil, implying the space triangulation further discussed in Section 4.5.

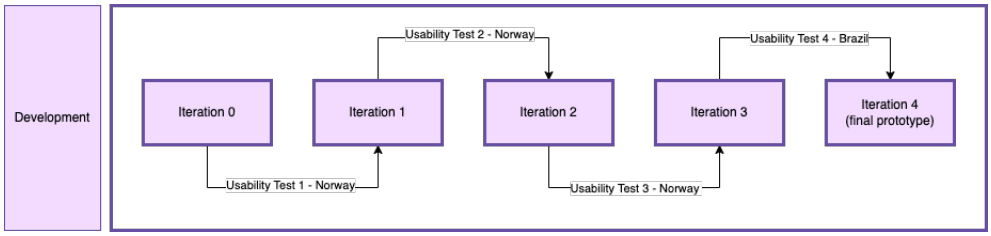


Figure 4.5: Development iterations for the prototype.

Due to time constraints, the authors decided to focus on making a high-fidelity Figma prototype as the artefact of the design and creation strategy. The time limitation made it not achievable to code a complete project that also could be viable after the completion of this thesis, which is a challenge with the design and creation strategy since the success of the artefact may depend on the researchers being present [50]. However, a complete Figma prototype opens up for other researchers to get inspired by the findings and create solutions based on this. In addition to the prototype, conducting interviews to provide more knowledge about intersectionality in CS was also a time-consuming priority during the research

period. The provided knowledge from the interviews and the prototype evaluated to increase diversity justifies the prototype as a piece of rigorous research since it provides new knowledge and helps increase the awareness of intersectionality in CS.

4.4.1 Prototype

The development of the prototype started with iterations of brainstorming, a technique for generating ideas that are widely used in interaction design for suggesting new concepts to support users [77]. During the brainstorming sessions, the success factors from the SLR were in focus (see Chapter 3), especially, supportive peer community and mentorship programs. There is a greater gap in the market for a technical solution providing a supportive peer network with a foundation in DEI in CS, but there are some existing and emerging mentorship programs, e.g., Women STEM UP and IDUN (see Section 2.7.2 and Section 2.7.1) with the vision to increase DEI in tech and/or STEM. Based on this, the authors decided to go further with brainstorming a solution that could supplement mentorship programs and focus more on the success factors related to supportive networks. As the field is small and there still needs to be conducted more research on intersectionality, supporting other already existing initiatives is important. This new insight led to a change in the main focus of this research strategy compared to the initial focus on mentorship programs [19], and as stated by Creswell *et al.* [65], in qualitative research, the plan can change since it is emergent.

The brainstorming of a possible technical solution to support DEI in CS resulted in a prototype of a website. *DiversIT* aims to help increase DEI in CS by facilitating a supportive network through an online peer community. It is a website where users can ask questions, share information, and interact with others in CS of different intersectional identities. An important factor of the website is to increase awareness about intersectionality, which is done by encouraging DEI through the promotion of intersectional role models in the field.

A prototype provides a tangible expression of an idea in a way that users can test out and interact with [77]. The prototype was created as a high-fidelity prototype using Figma as the development tool. An advantage of a high-fidelity prototype is that it looks and feels like the intended product [77], thus emulating a realistic UI and UX. The aim of creating the prototype is to test if the concept has the potential to be further developed into a fully functional website as a substantial initiative and success factor that helps increase DEI whilst tackling challenges related to intersectionality in CS, as found in the SLR. The usability tests held between each design iteration were both in-person and online, and as a high-fidelity prototype is user-driven and can be used as a marketing tool for the product compared to a low-fidelity prototype, a high-fidelity prototype was chosen [77].

When a user opens DiversIT, they are first presented with the front page with an overview of the website and its purpose. The website has two main sections, *community* and *articles*. *Community* represents the peer community discussed in the brainstorming. The user must register with an account to access the website's content and interact in the *community*. DiversIT also wants to increase the awareness of intersectionality by promoting inspiring role models with diverse backgrounds working in CS through an *articles* section. Screenshots from the prototype and improvements done in Figma for each iteration are presented in Section 5.3.

Existing Products

The authors also looked at the existing market of digital solutions to identify how DiversIT could impact society and the market [68], but also to identify different design and development perspectives that have similarities to the prototype in development [77].

Existing digital products that the prototype DiversIT can be compared to are *LinkedIn*[2], *Reddit*[3] and *Stackoverflow*[4]. LinkedIn is a social media focusing on business and employment and is primarily used for professional networking. Reddit is another social media site primarily focusing on peer communities, where users can post content in different communities or topics, and others can upvote and respond to these posts. While Reddit is very open and broad, Stackoverflow focuses on CS, where people can ask technical questions and help others.

However, even if all of these are community-driven online networks, none of them applies an intersectional approach intentionally targeted towards DEI. Moreover, DiversIT's design and concept take inspiration from all of these existing solutions by providing a supportive and intersectional peer network for people in CS.

Some companies and universities may also use, e.g. *Slack*[5] or *Microsoft Teams*[6] which also could be considered similar existing solutions since they promote communication and discussion online. In contrast, DiversIT aims to be a platform that reaches peers across companies and universities and people within the same organisation. Another difference is that the prototype, as opposed to these platforms, is not intended to be used for video calls or meeting purposes.

The authors also found the *Intersectional PhD Support network (IPPSnet)*[7] with the purpose to support and create an intersectional community for physics PhD students across different universities in the UK. This initiative utilises Slack for its on-

[2]https://www.linkedin.com/
[3]https://www.reddit.com/
[4]https://www.stackoverflow.com/
[5]https://www.slack.com/
[6]https://www.microsoft.com/en-gb/microsoft-teams/
[7]https://www.sepnet.ac.uk/ippsnet/

line community and does not provide its own technical solution, which could further inspire the development of DiversIT. However, the purpose and target group is almost identical to DiversIT, where DiversIT focuses on CS and has a broader approach in terms of users, including professionals and students.

User Group

The targeted user group is CS students or professionals working within the field. As the website aims to increase DEI and intersectionality awareness, the product is targeted towards people of intersectional identities. Since intersectionality is complex in itself, it is up to each user if they feel a connection to intersectionality. The interviews and observations were conducted with this user group, where one subgroup connected to Norway and the other to Brazil (see Section 4.5.1).

Conceptual Model

A conceptual model is often used in interaction design to give a simplified description of the problem and design space [77]. Figure 4.6 visualises the conceptual model for the *community* part of DiversIT through an ER diagram.

Metaphors and Analogies

Metaphors and analogies help communicate the conceptual model as a connection to something the user is familiar with, and the user can understand what and how to use the product through these components [77]. The *community* represents the subcommunities and different conversations happening in parallel. Each *Prompt* starts a new conversation, and because of the responses, it becomes a dialogue between two or more people. Each *Prompt* also contains a topic, which signifies what subcommunity this conversation belongs to.

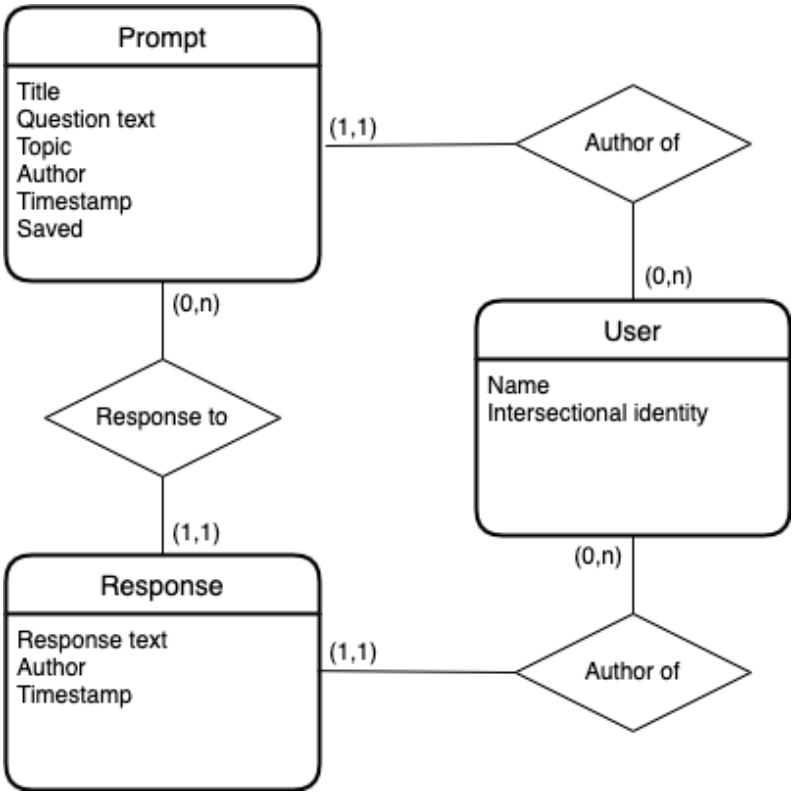


Figure 4.6: ER diagram of the conceptual model.

Concepts
A concept is an object that can be created and manipulated. There are attributes and operations that can be performed on the concepts [77]. In Figure 4.6, each box is a concept. There are three concepts related to the *community*, which are presented below with their corresponding attributes and operations:

Prompt

Attributes: Title, Question text, Topic, Author, Timestamp, Saved
Operations: Post new

User

Attributes: Name, Intersectional identity
Operations: Register, Post Prompt and Response

Response

Attributes: Response text, Author, Timestamp
Operations: Post response to Prompt

Relationships
The lines connecting the concepts in Figure 4.6 are the relationships.

A *User* is the author of a *Prompt*. Each *Prompt* can only be written by one *User*, but a *User* can have posted zero to n *Prompts* to the community.

The concept *Response* is a response to a *Prompt*. Each *Response* can only be connected to a single *Prompt*, but the *Prompts* can have zero to n *Responses*.

The last relationship is between *User* and *Response*, where a *User* is the author of a *Response*. A *Response* must be written by one *User*, and a *User* can write zero to n *Responses*.

Mapping
How the metaphors, concepts, and their relationships are mapped determines the UX the prototype is intended to invoke [77].

A person who registers a user in DiversIT will have the experience of joining a community of people. When a user shares a prompt, the person will have a similar experience to asking questions or starting a conversation with friends. When another user responds to a prompt, it is equivalent to when a person engages in a conversation.

Quality Attributes

The purpose of developing the prototype is to evaluate and further reflect upon the success factors from the SLR. As this part of the development process, where the design and purpose of the product are in focus, usability is essential when it comes to the architecture. This quality attribute was also presented in the HCI theory through the usability goals by Sharp *et al.* [77] (see Section 4.2.5). *Usability* is the primary quality attribute of the website, which considers how easily a desired task is accomplished by the user [80]. Overall, the website should be understandable to use, and without requiring any prior knowledge of the website, the user should be able to understand the purpose of DiversIT and know if they identify themselves as part of the target group for the website. The quality attribute in Table 4.2 is tested in the usability testing, as quality attribute requirements should be unambiguous and testable [80], and these are the basis for the test cases (see Appendix D.4).

Table 4.2: Quality attribute requirements.

(a) U1 - First time using the website.

ID	U1
Source of stimulus	User
Stimulus	First impression of the website
Environment	Runtime
Artefact	System
Response	Look at the front page to understand the purpose of the website
Response measure	Within 2 minutes looking at the front page and read *About*, the user understands the website's aim and who is the target group

(b) U2 - Register a new user.

ID	U2
Source of stimulus	User
Stimulus	Wishes to register as a new user
Environment	Runtime
Artefact	System
Response	A pop-up window appears when the user presses log in. Here the user follows the steps to create a new user
Response measure	The user has followed the steps and created a new user within 3 minutes

(c) U3 - Add a new prompt.

ID	U3
Source of stimulus	User
Stimulus	The user has a question and wants to post a new prompt to the community
Environment	Runtime
Artefact	System
Response	The user presses the button "Add new prompt" and then formulate the question to be posted
Response measure	A new prompt is posted to the community within 2 minutes from starting adding a new prompt until it is done formulated and posted

(d) U4 - Respond to a prompt.

ID	U4
Source of stimulus	User
Stimulus	The user wishes to give a response to a prompt
Environment	Runtime
Artefact	System
Response	The user formulates an answer and posts a response to the prompt
Response measure	A new response to the prompt is added within 2 minutes

4.5 Data Generation Methods

Both interviews and observations were chosen as data gathering methods to collect the qualitative data, as both methods are fitting for the strategy. The phenomenon of interest was examined from two different perspectives, increasing the validation due to the triangulation [50]. During a one-hour session, the participants were both interviewed and observed. The first half was the interview, and the second part was observation through a usability test. The interviews were conducted with the aim of answering RQ1 and RQ2, while both interviews and observations assisted RQ3. RQ2 looks into success factors, and the participants were asked to reflect on this in the interview. Through the usability test, the participant could test a high-fidelity prototype based on suggested success factors from the SLR in Chapter 3, straight after they had reflected upon RQ1 and RQ2 to give feedback if this prototype has potential to increase DEI in CS. The interviews and observations work together as a "top-and-tail" approach to the design and creation strategy as it generates data for the requirements specification and provides user feedback on the prototype [50].

Another takeout from the SLR was that it is a problem that most of the literature is related to the US. The interviews in the thesis aim to cover a more diverse area located outside the US when collecting data. Space triangulation is used to overcome the parochialism of the study as there will be two data gatherings from two countries [50]. As this thesis is written at a Norwegian university, one portion of the interviews and observations were conducted in Norway. Data gathering was also conducted in Brazil through collaboration in the SENOBR project, presented in Section 2.7.1. Brazil has a greater diversity than Norway when it comes to ethnicity, as it has one of the world's most diverse cultures.

4.5.1 Recruitment of Participants

Due to the fact that the interviews required sensitive information, such as ethnicity, sexuality, religion, etc., the recruiting process was time-consuming, and precautions needed to be taken. A post was posted to LinkedIn[8] to recruit participants, where in the post, they could sign up to receive more information regarding a possible interview. The sign-up process was through *Nettskjema*[9], Norway's most secure and used software for data gathering in research. In addition to LinkedIn, possible participants were personally contacted because, in qualitative studies, the participants can be selected as they possess certain properties of interest to help best solve the RQs [65, 69]. The participants from Brazil were recruited through the SENOBR project with the help of Professor Tayana Uchôa Conte, who assisted in the publication of the published version of the SLR [20].

[8] https://www.linkedin.com/
[9] https://www.nettskjema.no/

According to Creswell *et al.* [65], there is no specific answer to how many participants there should be in a qualitative study. The number of participants followed the saturation principle to find the adequate sample, where the data gathering process stopped when new data no longer sparked new insights or relevant new properties [65]. The resulting number of participants became 17 in total, 11 in Norway and 6 in Brazil. Demographics of the recruited participants are further presented in Section 5.1.

4.5.2 Interviews

The most prominent form of data gathering is interviews, whereas semi-structured interviews are the most common type of interview [69]. In a semi-structured interview, the participant can speak more in detail on the raised issue of introducing other issues they think could be relevant for the research [50]. As RQ1 and RQ2 looks into challenges and solutions, having a more flexible structure depending on the conversation flow can be an advantage. Compared to structured interviews, which are more used for fact-checking, semi-structured interviews open up for more discovery [50]. A pre-set of questions in an interview guide was sent in advance to the participants opening up for further reflection on their views on the topic. This interview guide is attached in Appendix D.3. The interviews were estimated to last approximately 30 minutes. Combined with the usability tests, the time slot was one hour in total, which is the ideal time according to Oates *et al.* [50].

Challenges and weaknesses addressed by Recker [69] regarding interviews as a data generation method have been taken into account. To minimise the weakened reflexivity in the method, a positionality statement has been addressed in Section 4.3. As there are two researchers writing this thesis, the researchers alternated between being the interviewer and note taker. While the note taker focused on the transcription, the interviewer could concentrate on the interview and asking the semi-structured questions and follow-up questions. The bare minimum in an interview is taking field notes, but in addition to this, the interviews were also recorded over Microsoft Teams. Through the audio recording, a complete transcription was provided of everything that was said during each interview [50]. A challenge with interviews is the inaccuracy and poor recall from those conducting the interview, which was minimised by the detailed recording and backup from the field notes.

A limitation with the recording over Microsoft Teams when conducting the interviews digitally was that there was no option only to record the audio. Therefore the interviewee had the option to turn off their camera or keep it on and then be a part of the video. As it already is a challenge with artificiality in interviews, the researchers chose to keep the camera on for the interviewee to get the feeling of having a dialogue with someone and not just talking to a screen [69].

The first question in the interview, "How would you describe your intersectional identity?" is a question open for subjective interpretation. With this question, the authors wanted the participants to self-define the intersectional identity that they relate to, where it was stated that there is no right or wrong answer. A general definition of intersectionality was used to explain and avoid giving a concrete example of an intersectional identity, to minimise the chance that the interviewee would respond in a way they thought was "correct" according to the interviewer [69].

4.5.3 Observations and Usability Testing

After each prototyping iteration, the Figma prototype was evaluated through usability tests. The participants were observed on what had actually been done and not only what they report as a first impression of the prototype, which is an advantage with the use of observations [50]. During the tests, the participants were asked to complete various tasks related to the prototype, e.g. respond to a prompt. The usability testing guide based on the steps addressed in Section 4.2.5, is attached in Appendix D.4. Approximately four or five participants conducted the usability test after each iteration. This number of participants was considered sufficient when using a qualitative approach [77]. The prototype developed in this thesis was to test if the concept had the potential to increase DEI in CS, hence, the usability tests were conducted from an early stage of the development process.

4.6 Qualitative Data Analysis

An important part of thematic analysis is that the authors are transparent about their choices throughout the process [67]. This section will present the qualitative data analysis processes used by the authors.

4.6.1 Interview Analysis

Qualitative analysis, specifically thematic analysis (see Section 4.2.2) and phenomenography (see Section 4.2.1), were the chosen data analysis methods for the interviews. The analysis helps investigate complex phenomena by learning the opinions and views the participants have obtained on the discussed topic, where intersectionality is a complex term [69]. Therefore when looking into intersectionality in CS, qualitative analysis is a good approach, as it sheds light on the phenomenon from multiple perspectives [69]. Possible hidden phenomena being uncovered can lead to a further comprehensive, multi-perspective view, which is good within the context of this thesis' RQs [69], as they look at challenges and

suggest solutions regarding intersectionality in CS.

As there are two researchers conducting this thesis, the analysis was executed in parallel to increase the validity of the results. Braun *et al.* [67] presents a step-by-step guide on how to conduct a thematic analysis:

Phase 1: Familiarising Yourself with Your Data

The interview analysis process began with conducting interviews. Both authors participated as either the interviewer or notetaker during all 17 interviews conducted for this research. This ensured that both authors had prior knowledge and an initial broad understanding of all the data [67].

Transcription is seen as an essential process within interpretive qualitative analysis [50, 67]. Each author transcribed and anonymised half of the verbal data collected through audio recordings of the interviews and read through the finished transcripts transcribed by the other author. Thus, both authors gained a depth understanding of the data and were fully immersed in its contents [67]. During this phase, ideas for the analysis started to form, which were the basis for the next phase.

Phase 2: Generating Initial Codes

For each transcription, codes were generated to identify different patterns in the data. To ensure reliability, the authors used the coder reliability check, meaning that each author performed this phase in parallel [74]. The coding was done manually by first noting down codes with the raw data and then using *Miro*[10] (virtual sticky notes) to identify segments and patterns across the transcriptions.

At this stage, Braun *et al.* [67] recommended:

- Coding for as many patterns as possible, if the time permits.
- Coding data extracts inclusively by being mindful of the context.
- Keeping in mind that individual extracts of data can be coded in many different ways at this stage.

Phase 3: Searching for Themes

After the data was coded and some initial patterns were identified, they were sorted into potential themes for the analysis. Braun *et al.* [67] recommend using visual aids, such as mind maps to group the different codes into themes. Therefore,

[10] https://www.miro.com/

each author used Miro for organising the codes into initial themes, as this tool also made it easy to reorganise codes throughout this phase. At this stage, the authors started looking at the phenomenon under investigation, intersectionality in CS, to develop a broader understanding of the codes, themes, and relationships between them [66, 67, 74]. It can be considered an inductive process as it goes back and forth between the created themes and raw data until a comprehensive set of themes is established covering all the relevant data [65].

Phase 4: Reviewing Themes

At the beginning of this phase, each author had comprised a mind map of themes, subthemes, and sub-subthemes, as well as some codes grouped in a "miscellaneous" theme. The authors then discussed all the themes and codes identified, using the dialogic reliability check from phenomenography [74], until both agreed on the initial themes identified, which was the first stage of refining the themes. The first refinement of themes was organised using tables in *Word*[11].

Next, the authors reviewed the coded extracts in each theme to evaluate whether there was a coherent pattern within each theme. At this stage, the "miscellaneous" theme was removed, some data extracts were reorganised into new themes, and some themes were merged together. Then the authors evaluated the themes to ensure that the new thematic mind map reflected the findings from the entire data set [67, 74].

Phase 5: Defining and Naming Themes

The authors then started the *define and refine* process by finding the essence of each theme and the *story* they are telling about the RQs and the overarching phenomenon that is being analysed [67, 74].

By the end of this phase, the researchers identified and grouped all the final themes and created a final thematic map of the analysis.

Phase 6: Producing the Report

The authors identified 12 main themes and 14 subthemes in the Norwegian analysis and 10 main themes and 9 subthemes in the Brazilian analysis. The final analysis and thematic map can be found in Chapter 5.

[11] https://www.microsoft.com/en-gb/microsoft-365/word

4.6.2 Observation Analysis

After each iteration, usability tests were conducted to evaluate the high-fidelity prototype. The observer took field notes on the behaviour and activities of individuals during the research [65]. The notes were taken based on the usability test guide tasks and questions. These observations and feedback on the prototype were used to improve the prototype further in the next iteration. Notes from each iteration and corresponding improvements to the iteration are presented in Section 5.3.

4.7 Ethics

Before recruiting participants and gathering data, an application was sent to the Norwegian Centre for Research Data (NSD) to be able to process personal and sensitive data. Since several topics related to intersectionality are considered sensitive data, the authors did multiple revisions of the interview guide with feedback to ensure that the interview would be a safe experience for all participants. The approved NSD can be found in Appendix D.1. The form explained the purpose of the data gathering and information regarding the participants' participation. The interview guide and consent form was also approved in this process.

Since intersectionality in CS is a complex matter, a brief overview of the research was shared online so that people could express their interest in participating based on whether they themselves identified with having a connection to intersectionality. Participants were recruited using a form in Nettskjema, which complies with the approved NSD application in terms of data storage and has a data processor agreement with NTNU.

Because NTNU has a data processor agreement with Microsoft, and all services are password protected, Microsoft OneDrive was used to store the interviews and results from the usability tests. Only the authors and supervisors of this thesis had access to raw data materials. All participant data was anonymised, and all audio recordings and participant records were deleted after the thesis completion.

Before starting the interviews and usability tests, the participants were reminded that it was voluntary to participate and were informed of their right to withdraw at any time without any negative repercussions. All participants had to sign a consent form for the interview and usability test, which can be found in Appendix D.2. Each participant was informed of their option to go over the consent form with the researchers to answer any questions or concerns before the interview and usability test.

Chapter 5

Results

This chapter presents the findings from the qualitative data analysis and the final prototype based on the generated data. In total, 17 people participated in the interviews and usability testing in Norway and Brazil. Section 5.1 provides an overview of the participant demographics related to their intersectional identities. Section 5.2 presents the thematic analysis and the themes that emerged from the interviews, which addresses RQ1 and RQ2. Lastly, Section 5.3 presents the findings from the usability tests and the resulting prototype iterations from the design and creation process, addressing RQ3.

5.1 Participant Demographics

17 students and professionals participated in the interviews and usability testing for this research, with 11 participants in Norway and 6 participants in Brazil. Table 5.1 presents the ratio between the user groups, students and professionals. Most of the interviewed participants were professionals. One student in Norway, P10, had work experience through multiple internships, which made all participants capable of talking about their experience as a student and as a CS professional. In Brazil, there were four students interviewed and two professionals. All of the students interviewed worked beside their studies or had experience from internships. Therefore, all of the interviewed participants in Brazil could also relate to both user groups, student and professional, when it came to intersectionality in CS.

Table 5.1: User group of each participant.

Table 5.2: Participants in Norway.

ID	User group
P1	Professional
P2	Professional
P3	Professional
P4	Professional
P5	Professional
P6	Professional
P7	Professional
P8	Professional
P9	Professional
P10	Student
P11	Professional

Table 5.3: Participants in Brazil.

ID	User group
P12	Student
P13	Student
P14	Professional
P15	Student
P16	Student
P17	Professional

At the beginning of the interviews, each participant got the chance to describe their intersectional identity. The interviewees identified themselves with the factors presented in the table in Appendix E. Each column in that table, except "Location" and "ID", represents the intersectional factors presented in Section 2.1. A limitation found is that mental health is not a considered factor in either Figure 2.1 or Figure 2.2, but was an important factor found in the analysis of the interviews. Regarding mental health, P2 explicitly commented that it is far too little focus on mental health, which is expressed by this limitation.

A limitation with the existing literature that was found in the SLR is that none of the primary studies contained data or findings about people with dis/abilities, even though this is considered the world's largest minority. Two of the interviewed candidates in this research have a dis/ability. In addition to this, three of the candidates expressed that they are in contact with a psychologist or have a mental condition. It is important to acknowledge both physical and psychological limitations.

Only one participant in Brazil stated that he was not religious, while none of the other participants commented on this as a factor. Another participant informed the researchers about the LGBTQIA+ situation in Brazil. The country is religious, and it can be challenging to be a part of this community. Two of the candidates interviewed in Brazil and two of the candidates interviewed in Norway were a part of the LGBTQIA+ community.

Age is a variable factor that everyone faces, and seven of the participants stated that they had experienced challenges related to their age. Two participants expressed a limitation with being the youngest in the team, and two participants expressed the challenge of being considered too old for new opportunities.

5.2 Interviews

In the analysis process of the interviews, the authors used thematic analysis and phenomenography in tandem with the analysis. The thematic analysis guidelines by Braun *et al.* [67] provided the overall structure to the analysis, from transcribing interviews to identifying the themes and sub-themes included in this analysis. While phenomenography, as presented by Marton *et al.* [66] and Åkerlind [74], helped keep the analysis rooted in the phenomenon of intersectionality in CS, and also helped ensure the reliability of the analysis through the use of coder reliability checks and dialogic reliability checks.

Section 5.2.1 presents the analysis from the 11 interviews conducted in Norway, while Section 5.2.2 presents the analysis from the 6 interviews conducted in Brazil. This ensures that space triangulation is preserved in the themes identified and analysed [50].

5.2.1 Analysis Norway

From the 11 interviews conducted in Norway, the authors identified and analysed 12 themes, as presented in Figure 5.1. The circles in the figure represent the main themes generated from the analysis, and the grey rectangles are the subthemes identified. In addition to the themes, 14 subthemes were identified and analysed by the authors.

Reason to Study Computer Science

When researching intersectionality in CS, the authors wanted to gain insight into how and why the participants chose to study and work in this field in the first place. This theme adds another layer of understanding the participants' backgrounds.

When the participants talked about how they ended up in the CS field, about half of them had a similar experience of having a prior interest in tech or CS before attending university. Most of the participants that had an inkling, childhood interest, or developed an interest during their later years in school, could not really explain what instance inclined them to study in the CS field further, other than that they genuinely thought of CS as a more fun option than other studies.

Both P6 and P7 reflected back on some pivotal moments during their time in school. P6 always saw herself as a computer nerd and decided to pursue CS because of this prior interest in computers, but also recalled not having a supportive career advisor in upper secondary school that did not believe she could get into a good CS degree programme. P7 also had an interest in computers from a young

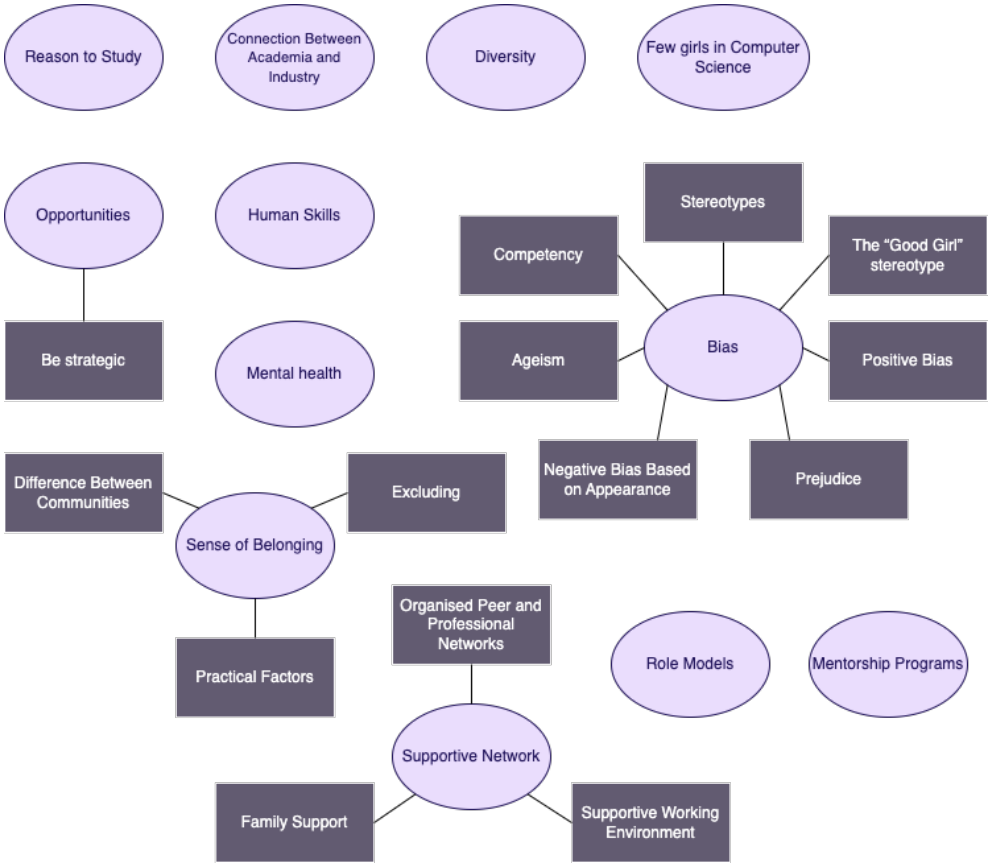


Figure 5.1: Themes after analysing interviews from Norway.

age but wasn't sure of pursuing CS before the end of upper secondary school. When reflecting back, P7 realised that maybe the fact that he was using assistive technology from a young age also impacted his choice to enter the field.

> *Now I don't have any vision, or I can see light now and then, but before, I had about 2% vision, so I could bicycle to school and such. But things like reading books, for example, was a big challenge, and this led me to use a lot of assistive technology in school, and maybe this contributed to me seeing the value in using tech in a meaningful way, which I think influenced my choice of going in this direction.* (P7)

P8 and P9 both expressed that they always wanted to start working in tech from a young age and that they both started university with prior knowledge about CS, which they saw as an advantage. P8 attended a technical college and worked in the field for some years before going to university to pursue a bachelor's degree. He expressed this as a positive and an advantage of already having practical experience before studying.

> *Having a background in working in IT already made half of the study quite easy. I was by far the oldest student in the university, and I was not the only old student, but I was definitely much more experienced than the rest of them. It was not seen as negative. I could contribute to other students and work well with them. They valued my knowledge.* (P8)

On the other hand, the reason why the other half of the participants ended up in the CS field seemed more like a coincidence, and multiple of the participants expressed that; "*I didn't know what my strengths were or where I wanted to go*" (P1). What this half had in common was that they experienced and explored CS at university for the first time.

Some explored different educational paths before finding CS. A couple of the participants attended a technical college and gained practical experience in a different field, whilst others started studying something else first before switching to CS.

> *I did a master's degree in teaching first. It wasn't until I started working on a project with the tech industry that I started studying computer science. I also have a master's degree in information systems management. I actually did this in parallel with working.* (P3)

However, they also expressed being curious about tech when starting their studies. "*I was curious about how technology works and why things work as they do.*" (P10). P1 recalled that she always considered engineering because of having engineer parents, and P10 also started her university career in a different engineering field, while P5 decided to try a CS course because she enjoyed mathematics.

> *Then I did an introductory course in programming, and I thought it was fun. So, it was a bit accidental that I continued with it. I didn't have any experience with computer science prior to starting university.* (P5)

A quote from P11 summarises this theme very well; "*[...] [w]hy I studied computer science, I can't explain. It just seemed more interesting than other studies.*" Those who had a stronger interest in exploring CS prior to university may have had some advantages at the very beginning of their academic careers. However, overall, most of the interviewees expressed that they tried a CS course or practical work involving CS, before deciding to continue with it as a degree and later career path.

Connection Between Academia and Industry

When talking about their academic experience, some participants began to think about the connection between academia and the industry, which is analysed in this theme. P1 stated that students should be much more exposed to the industry

at university, which many of the participants also agreed with through their statements. They emphasised the importance of having open contact between academia and industry since this will aid the students in learning more about their possible career prospects.

However, these participants also reflected upon the fact that they finished university a while ago and that some changes have happened since then. P8 is from Germany and completed his university degree there. He reflected on how the connection between academia and industry in Germany differs from Norway: "*What I like about Norway, and this wasn't the case in Germany, is that it is much stronger initiatives for connecting students with the industry*" (P8). P10, a current student, supported this and explained how her internships have helped her become more comfortable in CS. Having a technical internship during the degree, whether it be during the summer or part-time, was something the participants were positive about, as they then had the opportunity to use their theoretical skills in practice.

The participants with a lot of professional experience also suggested that students should test different enterprises through internships to find out what they enjoy and want to explore further in their studies and career. They also suggested that there should be more types of internships in addition to technical ones.

> *I truly believe that we need to have internships that are not only for our background but we also need to have internships in other businesses to understand more about other businesses or departments, like finance operations, commercial, supply chain etc., so we can become better professionals in what we do.* (P9)

When talking about the connection between academia and the industry, P3 also thought about how students are introduced to CS in school. She had already explained that getting into CS was more of a coincidence for her and shares the perspective as a former teacher. It is also important that CS is widely introduced in schools since not every student has engineer parents or knows what CS is or that it even is an option. P3 emphasised the importance of introducing schools to the "average computer scientist" so that the students get a chance to see themselves in CS, but also form realistic impressions and expectations.

> *If upper secondary schools try to get in touch with companies, they often find the people that get a lot of media attention. Maybe I could be fitting for this as well, but [the students] do get the impression that you must be someone special to reach a certain point. It's important to see that there is a need for just normal people too. [...] Where I was teaching, there was an IT programme, where it would have been very useful and probably favourable to get visits from someone working in the tech industry. Maybe especially from women, since [the students] think there are a lot of men in this field.* (P3)

Diversity

The interviewees shared many general thoughts and experiences that provided important insight into DEI from a CS perspective.

Many of the interviewees moved to Norway to study and work, and have many different experiences with a variety of working cultures. They see the value of working in a multicultural environment. P3 has also experienced that people who were used to working in quite homogeneous teams really appreciated more diversity at their workplace:

> *What I have noticed when I'm working with and talking to colleagues that are much older than me and have worked in the industry for 40 years about their experiences, how happy they are with getting more female colleagues, and that this has a positive effect on both the work environment and professional development. They are happy this field is finally being recognised for what it is and that there is also a need for diversity here.* (P3)

Furthermore, the participants emphasised the importance of diversity in CS and that the lack of DEI still is an issue in Norway.

> *Especially here in Norway, I often experience meetups, events, and conferences, which are 95% 'white' men. I observe this as a lack of opportunity for building well-designed solutions because we have this limitation to access neurodiversity in the end because of the lack of diversity in the people in our industry.* (P8)

Many of the interviewees further highlighted why diversity is important in a development team, especially when considering that all technical solutions should be usable for everyone.

> *If you're developing a system only based on the perspectives of half of the world's population, then you won't get very far. Simply put, there's a lack of consideration for how the other half experiences the same systems.* (P3)

When analysing the experience of being a woman in CS, some differences were visible between the participants. First and foremost, the participants that identified as foreigners felt the effects of being a foreigner rather than their gender. Where most agreed with P4, who said "*In my life, I haven't experienced any major difficulties because of my identity or gender.*"

However, all the women (regardless of ethnicity and nationality) were aware of companies hiring women to "fill a quota". Everyone wants to be appreciated for

their skills and what they can bring to their team. So, having a diverse workplace is important, but so is making everyone feel welcome and valued in their work. "*They don't hire because of your gender, but still, they manage to have a balance between different genders and sexualities.*" (P3). P6 also stressed the importance of an intersectional approach, saying "*I wish there was more that wasn't necessarily just all about women, but more about diversity in general because I think there's a lot of lack of that in the IT world.*" P5 also shared that she only has had positive experiences with being a woman in CS.

> *Never, on the contrary. I feel like you kind of get more positive recognition. At least, that's my experience. Maybe that'll change a bit now that there's a little more gender balance, but as a women and software engineer, you get a lot of recognition.* (P5)

This highlights the importance of an intersectional approach and awareness of different situations people face in CS. It does not mean that everyone in a group has the same experience or has experienced disadvantages because of their intersectional identity, but allows for all these viewpoints to coexist and be valid.

Few Girls in Computer Science

As presented in Chapter 2, there are fewer women than men in the CS field. Four of the participants interviewed talked about this in each of their interviews. When explaining her experience, P1 said

> *I have often been the only woman in the department or one of two women. [...] Earlier, I thought women were not interested in IT and just had different types of interests. Therefore, I didn't think that there were fewer women in the field.* (P1)

Women also internalise these stereotypes they are taught about women, that CS is not something girls typically aspire to do. Some of the participants also recall hearing about initiatives aimed at girls in CS that did not really add much value to them.

> *I remember when I went to [university], there was something called 'girl group'. It's a bit strange to just group people together based on gender. It's like, 'Yes, now you should hang out and be friends'. I never really understood the point of it, so I never participated.* (P5)

However, other participants highlighted the importance of creating a network with the few girls in their degree programmes. P6 experienced a difficult time being accepted by the men in her course.

> *I felt like being a computer science student was very difficult. I was one of two women in my class, and I felt like none of the guys ever wanted to do projects with us. She and I always ended up doing everything together. [...] All of the guys I studied with were like super awkward, nerdy guys that just were not comfortable around women. I don't think they necessarily thought we were stupid or incapable. Because there was such a majority of dudes in our class, I think it kind of created a very 'us and them' culture.* (P6)

P10 also expressed concerns surrounding this topic, but because of her network of girls in the same programme, it is not something that constantly affects her in her studies.

> *What I also think about a lot is the fact that I don't really notice how few girls we are because I mostly hang around girls. I have many friends who are girls and also study computer science, and I mainly gather and meet up with them. When you go to a big lecture, that's when you notice that there are a lot of guys here.* (P10)

She also recalls a specific course where the professor consciously did not split up the girls because they understood the implications of having one or two girls in a team project. She explained that girls are often asked to do the admin tasks of team projects, like writing the report or taking minutes, and sometimes have to argue to get to take a meaningful part in the programming and other technical aspects.

> *I still remember when we were separated into groups, and I ended up in a group with a lot of girls. Then I asked why we were not spreading the girls out, and [the professor] answered that we have to keep them together. I like that a lot that it was intentional.* (P10)

Opportunities

How opportunities are given matters. Many of the interviewees shared experiences of differential treatment, not having access to the same opportunities, or having to work more to achieve the same amount of recognition as their peers.

> *At my previous job, the manager or someone else would often ask in larger meetings if someone were interested in taking responsibility for something or if someone were interested in joining an outing to this or that event. Someone would raise their hand, and often more men than women. Many feel uncomfortable with taking up space regardless of the*

> *situation. You may not want to [volunteer] in those big meetings and miss out on those opportunities.* (P3)

For example, when having a dis/ability, you may feel like you must prove you are not an inconvenience. Although equal working rights exist, it is still difficult for people with dis/abilities to access the same opportunities as able-bodied people.

> *Actually, I have figured out things on my own. Looking back now, I also believe it lowered the pressure a lot for my workplace and the customers I had as a consultant. Showing that 'It's not so scary to employ that blind guy' because many still think that.* (P7)

However, being proactive and knowing how the employer best could accommodate you had been a valuable asset to the participants the authors spoke with. It provided them control over what they wanted in their careers and also created a good dialogue and working environment.

> *I am less likely to change my workplace every 5th year because I am visually impaired. However, I think my experience has grown because of this. I could change tasks instead of a workplace.* (P11)

Accessing equal opportunities has also been an issue across different intersectional identities. Some important examples are not being taken seriously when asking for more challenging opportunities and experiencing unequal pay.

> *The meetings I had with one of my previous employers about salary would have played out differently had I not been a woman. One reason I resigned was that I was never really heard or taken seriously regarding my salary or my work responsibilities. First, after handing in my resignation, I was offered what I asked for, which wasn't anything more than my male colleagues had. I had already spoken to them and knew what they were asking for and what their salaries were etc. This is maybe what annoys me the most. I know that I am a high performer and that I presumably have achieved more than many of my male colleagues.* (P3)

This is a serious issue that would be difficult to detect without openness from colleagues. People who experience a lack of opportunities are more often not even aware of this since these conversations usually happen one-on-one with management. On top of this, the participants also highlighted that higher-ups would assume that they wanted management or human resources responsibilities when asking for more challenging opportunities. This disproportionately affected those identifying as women.

> *They probably had good intentions, but at my previous workplace, there was a lot of focus on getting more women into management positions instead of becoming specialists within a technical area. Those are two completely different career paths, so I think this is an important food for thought for managers and executives when they want to encourage and help boost someone's career, that they don't just assume that people want more human resources responsibilities. But that they rather realise that people want to become a tech-lead or build technical skills and have responsibility for comprehensive infrastructures etc., that this also is a fun career path when you actually enjoy your work.* (P3)

Be Strategic

P1 stated in her interview "*Men are probably more strategic. It was helpful for me to have mostly guys around, helping me learn how to strategically build up a career.*" A majority of the interviewees agreed that men overall had a more strategic and calculated approach to their careers. Furthermore, gender identification seemed to be the common factor regardless of other intersectional identities. Everyone identifying as men had a very strategic approach when talking about career opportunities, challenges, and success. This was particularly prominent for those who also passed for fitting the "traditional computer scientist stereotype". For instance, P8 and P9 talked about the importance of following the objective and the importance of time management in CS.

> *In the end, we work for companies that are results-driven, [...] which happens in Norway or any other country. People always appreciate somebody who is proactive or comes up with a solution. That always breaks all the barriers and all these stereotypes when you bring something to the table.* (P9)

This highlights that some have the privilege of only needing to focus on career prospects and merit when wanting to access more opportunities. Whilst others have to be proactive in not only securing the end goal but also in how to get access to these opportunities in the first place.

Human Skills

Some of the participants talked about the human aspect of the CS field and why this was significant to their experience in CS. This theme analyses the balance between interpersonal and technical skills and the importance of human connection in CS.

P2 stated "*I never had this feeling that technology or computer science was a discipline where you were disconnected from people. For me, computer science is about*

working with people and understanding practices." All participants who discussed this theme agreed with this sentiment. CS is much more than programming, developing software, and having the best technical skills.

> *There's a lot less focus on sharing human experience. I feel like, especially programmers, tend to be a little too methodical, and we're so focused on machines that we kind of turn into machines, and we lose the human connection and human aspect of working. [...] [W]omen's networks are still very focused on technology and the cool things people have done, which is great, but I think that there could also be more focus on the human aspect of the people that work in computer science.* (P6)

Some also emphasised the correlation between good communication with peers or colleagues and getting access to the support you need in your studies or work.

> *Not that I've been very scheming, or it's something that I've done very deliberately, but I do see the importance of having the ability to communicate well with people and also trying to find good solutions that make people want to support you; it works to some extent.* (P7)

Understanding how people use software and how a technical solution could befit society, but also having good communication within and across teams and disciplines are also critical skills. P8 remarked "*More globally, in an ideal world, we would have much better communication between customers, developers and users. Take more time to work together on problems.*" As, e.g. a software engineer, cybersecurity consultant, or data scientist, you are not only a programmer but also expected to communicate with stakeholders.

> *Because when you have a profile that is very IT-focused, you sometimes lack a lot of understanding of what the customer needs, and at the end of the day, I believe it's all about that.[. . .] I believe that understanding the customer and knowing how to apply these skills is important.* (P9)

Mental Health

Mental health was an important theme that emerged during the interviews.

> *It's a bit of a buzzword maybe, but many are talking about psychological safety at work. But being in an environment where you can ask questions like 'I don't understand this, do you mind helping me out?' or work together. Yeah, maybe I have been lucky with the workplaces I've had. But that's definitely a success factor, having a working environment*

> *with people that are willing to share their knowledge and help each other out.* (P5)

A majority of the interviewees discussed the importance of psychological safety in terms of being able to ask for help and being seen and heard by peers, colleagues, and higher-ups. It is also an important factor in supporting mental well-being and preventing burnout and unnecessary stress. "*I'm almost surprised that there isn't more focus on [mental health] in the computer science world.*" (P6).

Although CS is a highly collaborative field, where people essentially are the centre of most technical developments, mental health is not being discussed enough.

> *But I think there is far too little focus on mental health, which I think is a shame. I don't know if maybe a system like this would help, not necessarily with mental health, but in preventing some of these problems from emerging.* (P2)

The outcome of psychological safety is a more inclusive environment for everyone. People with mental conditions especially could benefit from CS having more consideration for mental health. P6 shared "*I think that there are a lot of people that have a negative view of people with ADHD or other mental disorders.*" She shared that she has actively been open about having ADHD to help create a safe environment around her, which has helped others open up as well. Overall, when discussing mental health and CS, neurodiversity is also an important aspect of DEI in CS.

Bias

Bias was a theme discussed by most of the participants during their interviews. This theme was split into multiple subthemes in order to adequately cover all the topics within this theme.

Stereotypes

Stereotypes are still prevalent in CS, and most had experienced or witnessed stereotyping throughout their academic or professional journeys. Those who generally fit the stereotype were aware of their privilege and advantages.

> *I have personally never experienced any form of discrimination, most likely because of that I completely match the typical stereotype that exists in the industry of programmers, being a white man speaking very good English. That gave me a lot of advantages.* (P8)

However, stereotypes can come in many different forms depending on the person and situation. The effect harmful stereotypes have on people also varies in terms of frequency.

> *Stereotypes probably happen all the time. I'm Spanish, so there is a kind of a belief that the Spanish take a nap in the afternoon, or we party all the time, and things like that. But that's not the case. It doesn't affect me at all, but it's out there.* (P9)

The participants who identified as women shared different experiences and expressed how it was more difficult to dismiss the stereotypes placed upon them. In common was the gendered stereotype that women are not technically inclined. "*Many people assumed that you were studying digital economy or something along those lines,*" (P3), and "*[t]here are stereotypes that male software developers are more competent than females.*" (P4). Constantly being seen as inferior to your peers, can have a serious negative effect on an individual's self-worth and confidence in abilities. P4 shared how stereotypes affected her choice of specialisation within CS:

> *During my bachelor's, I had more interest in [computer] networking. At that time, in my country, it was assumed that male software developers or engineers were more competent for networking-related jobs. If it is related to networking, you have to go outside, visit companies and physically go to places. For this reason, it was assumed that male employees were more efficient than females. Because of these reasons and these kinds of stereotypes, I decided to do [software] development rather than networking.* (P4)

The "Good Girl" Stereotype

Some interviewees also explicitly talked about the "good girl" stereotype.

> *Most of us have grown up with this 'good girl' attitude and then you want to do things, you want to be nice, they make you think that it's good for your career; in the end, you are overloaded. So I think that it would be good to create a little bit more awareness of the risk of being overloaded, that's what I normally suggest to young people – do things if there is a benefit for you, not because you want to be nice, not because they need it.* (P2)

This stereotype is often instilled in girls from a young age in the form of getting praise for being a high achiever, rule-follower, passive, or submissive.

> *Very often, when people meet a woman from the tech industry, I think you're often met with the assumption of lacking technical comprehension, but you have good people skills and interpersonal perspectives. Simultaneously, I know it's more likely the opposite, that I have a good understanding of the interpersonal perspectives because I'm well-grounded in my technical skills.* (P3)

Being aware of the stereotype and breaking out of that can be challenging, as well as lead to negative consequences.

> *Now that I'm older and more confident in my abilities, I'm better at making it uncomfortable for the person that makes me feel uncomfortable. I think when you're young, a student or freshly out of college and you just started a new job, I think that's really hard.* (P6)

Another interesting reflection was of how measures put into place to increase DEI may further reinforce this stereotype.

> *I think that some of the measures that sometimes are introduced to support women are actually 'fighting back' because, e.g., that there should be a PhD committee, so you should have at least two women, or in an evaluation committee, you should have an equal representation of both genders. This has really overloaded the few that are there.* (P2)

Women and girls are often expected to take on extra responsibilities in addition to their work, and this is no different in CS. It could be that they are expected to also take meeting minutes or other administrative tasks. Because of this internalised notion of having to do what is expected, being overworked or not getting to properly participate in the technical work is often a result of this.

> *There was a group project. We were some girls and guys, and the guys asked, 'Can't you just write the report?' Then I was like, 'Excuse me, I want to write code,' and that was pretty annoying, but I didn't know how to react to it. It was my first time experiencing that. I didn't do anything about it and ended up writing the report. Now I would have said no.* (P10)

> *I am not sure if it's assumed to handle a higher workload or just being better at organising things, but if we're going to have a team dinner, it is always me who gets asked to arrange it. Maybe I am good at organising things like that, but it feels a little obvious sometimes that I'm the only one that ever gets asked to do things like that.* (P6)

Awareness of how this stereotype has an impact and when to pick your battles has been important in navigating the "good girl" stereotype in the CS space.

> *When you have grown up in Italy, which had a male-dominated culture overall, you learn either not to care or to fight back when it's the case. [...] You have to work on yourself and be strong enough to understand what it is that you want, and then you try to change the system from the inside.* (P2)

Positive Bias
Some of the participants expressed that they had more often than not experienced positive bias because of their intersectional identities. This was either due to being able to easily fit into the dominant group or due to being in the marginalised group. P8 shared "*I fit a typical mode of a programmer, which means it's easier for me to access new jobs, get interviews, and find something new.*" P1, on the other hand, gave an example of positive bias when being considered in the marginalised group.

> *I have sometimes been treated better than the rest. I have got the [best] room because the guys sleep in the same room [when travelling for work]. It can also be a positive bias related to being the only one. The colleges would help carry [my] kid on their back.* (P1)

Regardless of the reason why, they all shared positive examples of having an easier time getting a new job, and feeling included and accommodated at work.

Prejudice
The majority of the interviewees, however, had experienced some form of prejudice or discrimination in relation to CS because of their intersectional identities. Which usually was that part of their intersectional identity that was most visible outwardly.

Some of the participants, all identifying as women, experienced negative comments due to showing interest in or wanting to pursue CS, even those who graduated after 2010.

> *I think I experienced the most prejudice before I started studying computer science. 10 years ago, it was still dominated by men. Back then, people were a bit more sceptical if you even considered working with anything related to tech.* (P3)

Furthermore, some also experienced prejudice during their time at university as well. P6 shared "*I had a very old computer science professor who, I think, was pretty prejudiced towards women when it came to a lot of things. He was very like old school traditional American man.*"

Prejudice was also a topic when talking about job applications and interviews. This can be particularly difficult because it is not something that is explicitly said to you, but rather a pattern that you notice after applying for multiple jobs and attending interviews. P7 shared this about his experience: "*If you have two equally qualified applicants where one is blind, then it's most common to go with the sighted person, or highly uncommon to go with the blind person, really.*"

Although most of the participants were optimistic, they assumed that it would

take years to accomplish DEI across the CS field due to many still not being aware of their own prejudice.

> *There are not only men software engineers and developers anymore, but it's probably still a long way to go. Honestly, I think you have to wait for years and generations before any real change happens in these matters. Many people say that it's all nice and good, but they still might be a part of the problem themselves. Maybe they don't realise it, but they have that prejudice.* (P3)

Negative Bias Based on Appearance

A couple of participants shared some accounts of experiencing negative bias because of their appearance or behaviour.

> *You meet a lot of people who are immediately sceptical when you're young, blonde and kind of like smiley. I think I come across as a little ditzy and therefore don't seem very smart, which I think having ADHD makes you a little ditzy. I always fidget with things and can never sit still.* (P6)

> *But even though I'm married to a woman, I don't look like the 'typical lesbian' in terms of appearance. And I'm aware of how that fact has shielded me from a lot of the prejudice my wife is facing, for example, when she is at work. She also works in IT.* (P3)

These instances are examples of how implicit bias can manifest into harmful and stereotypical assumptions about their intelligence and likeability. In the long term, this could have a negative effect on a person's sense of self.

Ageism

Ageism was also a theme of discussion with several of the interviewees, where both being considered too young or too old were relevant topics. Age is a factor that everyone will experience at some point in their life, and age seems to matter in the CS industry.

> *But I do believe there is some prejudice about age in this industry, even when there are so many skilful developers in their 50s and 60s. That you think they're falling behind or that they don't keep up with the times anymore. And in some cases, maybe that's true. But I think if an employer receives 100 applications, they'd rather go for the 28-year-old with [a lot of] experience, while the older applicants are kind of put in this [stereotypical] box without that actually being true.* (P5)

The participants that have worked in the field for a while shared concerns about automatically being dismissed and ignored in favour of younger peers, especially in the case of applying for a new job.

> *Generally speaking, as a 47-year-old working as a software engineer, I feel leeway to apply for a new position elsewhere is decreasing because many companies rather prefer younger applicants; you stand out negatively in the application pile. But then again, I have been on top of the pile for many years because I'm a woman. So, maybe that's just fair.* (P5)

However, those who had experienced being the youngest in their team also discussed the feeling of being dismissed and ignored by their older peers.

> *I was always the youngest in the room and in a supervisor or manager position, which always played a factor. When you are the youngest in the room, to some people, you don't have the same credit as others.* (P9)

Competency

All the interviewees were highly competent computer scientists; however, many of them had experienced their competency being questioned due to their intersectional identity.

Several shared different occurrences of them being the technical expert but still being ignored or double-checking what they had said with someone else.

> *[...] That I was the one developing the back-end was difficult to understand. I don't think everyone does this consciously, but anytime someone would address the software engineers, they would automatically look to my male colleagues and not me. Even when I was the one who created that feature and I'm the one who can explain it.* (P3)

Some even experienced this so frequently that they became desensitised to the fact that they had to continuously outperform their peers to assure others that they were qualified and knew their work, which the participants agreed could be a serious issue.

A combating factor mentioned by some interviewees was that their study or work environment implemented more of an intersectional approach, with DEI in focus.

> *I work in [a company] where there's a lot of focus on diversity, which is part of the reason I feel competent in my job since I know there is an open attitude towards it. There are different skills development networks and social networks.* (P3)

However, standing out and proving your skills was not always a negative experience, according to several of the participants.

> *Being the underdog, the fact that people assume that you're not very capable gives people a more positive impression of you when you actually prove them wrong. They have a bias towards you, but it turns out that they're very wrong. Sometimes that can have a bigger impact. I think it is easier to make an impact when you stand out in one way or another – people remember you. I think it contributes to success that you're memorable and not just like one of the crowd.* (P6)

Showing that there is a balance between always being doubted and questioned and getting the opportunity to really showcase what you can bring to your team.

> *It's just that sometimes people are afraid of the unknown, or new, or somebody coming from the outside, breaking the rules, or bringing new things. We kind of face a barrier at the very beginning [...].* (P9)

Sense of Belonging

All of the interviewees had experienced a lack of sense of belonging at some point throughout their journey in CS. This was identified as one of the most significant issues in regard to retention in the field. Where a majority agreed that "*[i]f it had been a complete lack of sense of belonging, I wouldn't have managed to stay, but I also think you grow from experiencing this.*" (P2).

Excluding

Those who identified as being a foreigner in Norway discussed how this part of their identity has affected their sense of belonging in CS. "*It is common for someone who doesn't belong to a specific country to, on some occasions, sense a lack of belonging.*" (P4). This sentiment was also shared with those who were international students. "*I think that it felt isolating when I was in college and the fact that I was studying abroad. It makes you be on the search for people to connect with, and that made it hard.*" (P6).

This type of exclusion was often manifested in people trying to assert themselves, resulting in perpetuating an "us vs. them" culture.

> *Norway is a relatively small society, and people with a technical background in computer science have mostly studied at [the same university]. So, when you get into a room, you are not only the only woman (that I never cared much about), but you are the only foreigner without [that connection], and I think that is really part of something that you maybe don't notice when you are a part of the [dominant group]. [...] [I]f there are people there that don't meet every day, people start making sure that you know where they have studied, what they have been studying, with whom etc., and there is always one connection or another; [...] and then you really feel like you will never belong here.* (P2)

Practical Factors

For those with a dis/ability, solving practical challenges on navigating CS through adapting *universal design* was highlighted as important for feeling a sense of belonging in the field.

> *So, I had to spend some energy during my degree to be creative. How do we solve this? Is it ok if I do it this way instead of what is specified in the assignment? Do I have to draw, or could I use this software to illustrate this instead? Yeah, there were a lot of these little solutions I had to come up with by myself. [...] It's more like when you cannot see, you have to use your computer in a different way than most people. And everything is not universally designed well.* (P7)

Another practical challenge discussed by some participants was having a non-traditional CV and how the potential consequences are not nearly talked about enough. This could be an excluding factor in the industry as well as in academia when wanting to pursue certain careers in CS.

When discussing the experience of being a mature student, however, having all the practical technical experiences was perceived as more of an asset.

> *Having a bachelor's degree but quite late on the CV doesn't look typical, and I, therefore, don't have the typical CV; however, that enabled me to come to Norway. To work as a Norwegian employee, I had to have a bachelor's degree. This was the only way to immigrate to Norway. It was not seen as a negative thing but more like a checkmark on the CV.* (P8)

Difference Between Communities
Being aware of and acknowledging the differences between communities was highlighted as a factor in increasing the sense of belonging. This was not only in regard to interpersonal relations with your peers and colleagues but also in terms of teaching and work traditions.

> *Something that really influences the way you work when you come to a certain understanding of what the work is about, and you face different traditions that don't have to do with [your identity]; it's really a part of the different scientific communities and the way they intersect. [...] In Italy, it was very theory-driven. I went to Denmark, and then it was a very case-based focus with a strong emphasis on participatory design. And then I moved [to Norway], where at the time it was very technology and systems-oriented [...].* (P2)

This collective awareness will not only have positive implications for individuals' sense of belonging but also DEI overall. "*[...] [M]y experience now working in tech is that there's a lot more openness and diversity here compared to my prior workplaces.*" (P3).

Supportive Network

"*Networking is important for everything. It is a big part if you want to do a better job in your career.*" (P4). All participants interviewed in Norway discussed the importance of having a supportive network. Based on the findings from the SLR, a supportive network was a significant success factor of the intersectional approach and DEI. The fact that all of the interviewees talked positively of a supportive network confirms the importance of a supportive network to increase DEI; "*[n]etworking is an incredibly important part of creating these connections, and knowing someone that you can reach out to if you have a problem is important.*" (P8).

Organised Peer and Professional Networks
The participants had mixed experiences with organised networks; some had good experiences, others did not find them useful, and some had never been a part of an organised networking initiative.

> *Regarding networking programs, I don't really have a lot of experience with networking programs other than social networks. I am part of some professional associations. But honestly, I don't feel they really add a lot of value in that area; they are more on the technical side. We need to keep ourselves updated, so that's good. But regarding soft skills and getting better professionally on that side, these networks don't really help me.* (P9)

It was emphasised that networking programs provided value when the participants had the opportunity to learn more from others in CS that were in similar situations as them and make connections across different workplaces and even disciplines. A concern highlighted by most of the interviewees was that networking programs, conferences, and similar initiatives and events, were very time-consuming on top of having a full work schedule. Therefore, organised networks that mostly focus on the social aspect were also highly valued as a way to ensure a good work-life balance.

> *Yes, I do have friends etc., but it's really nice to have the queer community that we have. [...] [I]t's very easily accessible, and it could have been any other type of community, but you do feel extra welcome when money is specifically dedicated to creating and maintaining an initiative like this that's just social, but it's social with people that have the same interests as you. Then it's not just that trip thing that could have been with any other colleagues.* (P3)

Supportive Working Environment

A crucial factor for the participants at their university or workplace was having a supportive network of peers. "*I really believe that it depends on the people around you, not only on management and directors.*" (P3). Having that supportive peer network was valuable for an increased sense of belonging, well-being, and motivation.

> *There are two women on my team. One is currently on maternity leave, so right now, I'm the only woman on my team and also the youngest on my team. In my team, there's never been any issues with that. I think they are all great and very respectful. They trust my opinion and are confident that I know what I'm talking about.* (P6)

Strong peer communities also had a positive bottom-up effect on the study or working environment.

> *[I]t really wasn't much at the systemic level, but rather it was at the individual level that I found solutions that worked for me. [...] But the university later stated that they also thought it was fun paying attention to me, and when observing that I was putting in so much effort into [my studies] on my own, then it was interesting for them to put in some effort as well.* (P7)

"*The people and good learning/working environment are important. The learning environment needs to be healthy, and people need to be brought together. The leadership should be aware of diversity needs.*" (P1). Good leadership was also emphasised when looking at a supportive work environment, and it was usually at this

systemic level important change regarding DEI was the most prevalent. Having good relations across different levels, whether it be professors and students or management and software engineers, was an important factor for retention and continuation in the field across all intersectional identities. "*What struck me the most is how important management and directors are for how you are doing at work. The fact that you feel welcome, that's what actually makes you want to stay.*" (P3).

> *Interacting with students is very good, too, and I think that is something that helps you persist in the work. It gives motivation, and I think it's also a continuous mental challenge because you meet people from a different generation. That may be another intersectionality issue as well, that as you get older, you realise that you have something that characterises [a different generation].* (P2)

Family Support

Some of the interviewees also highlighted support from family and friends as an important success factor. "*A good partner is important and a family support system. It makes it much more difficult if you are managing it just on your own. The support system around is important, e.g., childcare or infrastructure such as training close by.*" (P1).

Family support was mainly seen as important in encouraging the individual to pursue CS; "*[...] I have never experienced my family telling me I cannot do this and that. My family have always been supportive of my education, my job [...]*" (P4). While support from friends was found as a factor in retention; "*My interest is what keeps me going. My friends around who are also enjoying it help a lot.*" (P10).

Role Models

Role models were another important finding from the SLR that the interviewees discussed. Role models can be found everywhere, and most commonly, people find role models in their own environment, whether it is peers, professors, management, or directors.

> *I've always looked up to many role models in my company and elsewhere, and I constantly pick up things from people I admire. It's like in life; you pick up good and bad things from your surroundings. Professionally, this has helped me a lot.* (P9)

Some participants used their role models as inspirations for their future career path in CS, not only to build on current technical skills but also to learn new non-technical skills that could help them improve overall.

> *It's important that you know your knowledge and skill gaps. E.g., I'm always straight to the point and don't have many filters. Sometimes, people could get offended or feel pressured by me, but I understood I needed to change that, and I needed to find a role model in that area.* (P9)

"*There is always room for trading experiences and not just focus on technology, development, and things we do in the way we work.*" (P6). Having role models, such as e.g., "*[h]aving female lecturers*" (P10), and identifying with the people that work in CS was really important for retention and intrinsic motivation, but also the sense of belonging.

> *It happens to be that in every company that I've worked with, the top executive of the company, when I've started, has always been a woman, and I've always thought that's really cool to know that it's an IT company that's very technical.* (P6)

However, as found in the SLR, there is still a lack of intersectional role models in CS overall, which the participants also were aware of:

> *We know from research and from talking to people who are not white men that for them, it is really important to find role models. Find people that look like them, speak like them and have a similar background to them in higher or more exposed positions. That enables them to think, 'Oh, I can achieve that as well'. If they look at me, then they think, 'Of course, he has it easy, and I can never do this'.* (P8)

Finding role models that shared some parts of the individual's intersectional identity was something that all participants valued and found encouraging.

> *It's a great working environment at my job, and there are more people like me, in a way, that you have that element of recognition; I think that's important. You shouldn't feel that you're working in like an echo chamber consisting of men 50 plus.* (P3)

Having people to look up to that understands your situation, e.g., P1 shared "*I have this perspective of a good mother at home and work. A role model who has a healthy mixture of both is inspiring to me.*" (P1).

> *We really need to reinforce ourselves and believe in ourselves in what we do. But we also need to surround ourselves with the right people and pick up good things from them, which is not easy since sometimes you don't get the chance.* (P9)

Mentorship Programs

A majority of the participants discussed mentorship programs. "*Mentorship programs can positively impact your career, your learning, and overall.*" (P4). Intersectional mentoring [62] was also mentioned; the importance of seeing yourself in your mentor, also within your intersectional identity. This was important, especially for students, people in their early careers, and people changing jobs to find their footing in a new environment.

> *It was a woman that was probably 10 years older than me that had been doing kind of the same thing. I think that was the idea of that mentor program, finding someone who kind of has the same background as you. I think it was very helpful to have someone older and more experienced who has been through what you're about to go through and tell you that this is what they're going to do to you. You're going to have to put on a tough face. You're going to have to say 'No, I'm not going to go get you a cup of coffee' or 'Go get it yourself'. Having someone who matches your own, someone who knows and has walked the path before, I think, is very important.* (P6)

P7 shared his experience with intersectional mentoring, and that there are existing mentorship opportunities specifically to lift up underrepresented people.

> *[. . .] the fact that they wanted to take the time to nominate me to a mentorship program like this without really knowing what it entails. I won't be a manager or executive tomorrow, but I get to understand more of what that is, and it gives me new opportunities. An opportunity like this may not have been as available had I not had a disability. So that's another aspect.* (P7)

There is a challenge with finding a mentor that the mentees identify with when there are few with the same intersectional background. P6 commented on this concern that she found it hard to find a mentor when there are few women. "*I wish I had had more of that [mentorship programs] when I was a student, but it would probably be hard because there were hardly any women that studied computer science at the school that I went to.*" (P6)

However, some also found mentorship programs to be limiting and excluding at times.

> *My previous employer had a mentorship program that you could apply for. The management would nominate candidates, and then some people would be selected to join. I know you asked about positive experiences,*

> *but I wanted to stress that this instance was a very bad way to go about this. Firstly, it was very limiting who was nominated since you had to apply and get support from the management to be nominated. Even if you got that, there was no guarantee you were selected.* (P3)

The example most frequently highlighted was that mentorships for professionals mostly aimed towards those who wanted to go into management and not necessarily those who wanted to work with more advanced technologies.

> *I work as a developer, and I've never had any ambitions of becoming a part of management, so I haven't had any experiences with mentorship programs either, not even women in tech networks or such. I know they exist, but I don't feel that it's something I personally need.* (P5)

> *"I was in need of mentoring my entire career, but I never found the mentors that I needed. I was compared to the people around me, where I was living, as more or less one of the most experienced engineers. [...] Nobody is doing what I am doing, so it makes it really hard to find a mentor."* (P8)

The interviewees also discussed the lack of mentorship opportunities overall that connect students with professionals.

> *Having someone to tell you about your future possible directions and possibilities, e.g. after my bachelor's, I never thought about becoming a researcher [...] Having someone, e.g. seniors, teachers or role models to talk about possible paths you can go if you don't want to do programming would be good.* (P4)

A majority talked about how such a mentorship could have been beneficial to finding their current path in CS sooner.

> *After a company presentation at a university, there could have been some form of mentorship program or contact with someone in the industry for a longer period of time. I have represented my company at university events and think it's very fun to talk to students about things they worry about that you don't necessarily think about when you start working and things you don't know that will be important when working in the industry. This may be what's holding some people back.* (P3)

5.2.2 Analysis Brazil

In the analysis process of the 6 interviews conducted in Brazil, the authors identified 10 themes and 9 subthemes, as presented in Figure 5.2. The main themes are illustrated as circles, and the subthemes as grey rectangles. The Brazilian interviews and analysis followed the same procedures as the Norwegian interviews and analysis.

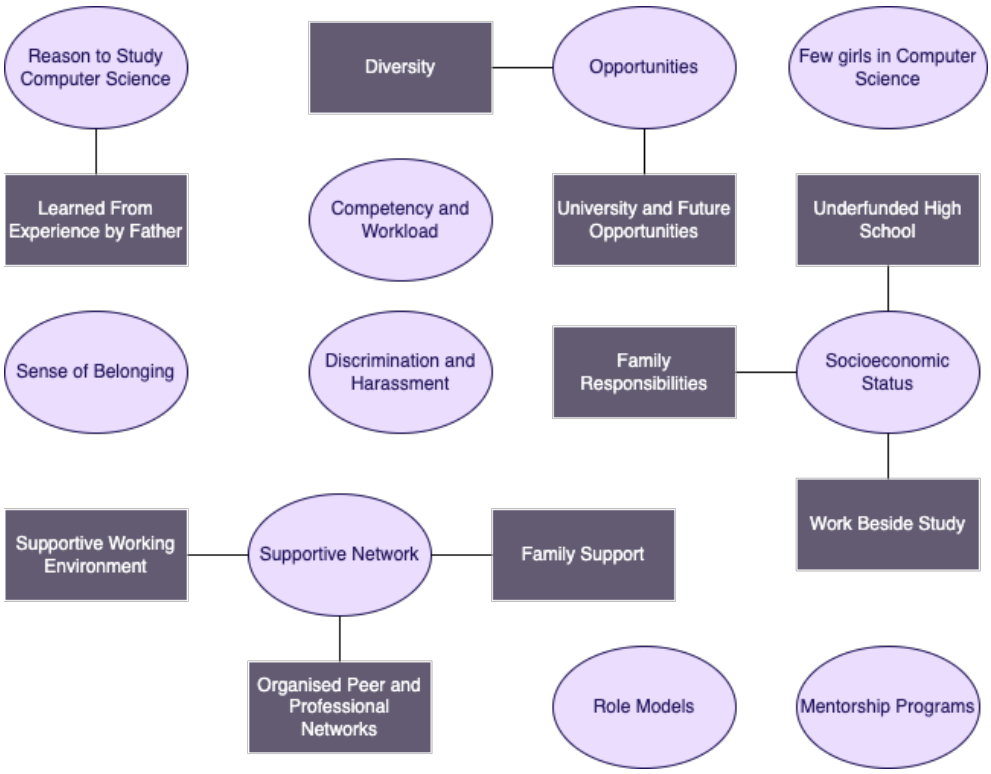


Figure 5.2: Themes after analysing interviews from Brazil.

Reason to Study Computer Science

Firstly, the researchers wanted to gain insight into how and why the participants chose to study and work in the CS field. All participants had general experience with computers and technology prior to studying CS, and a majority of participants stated that they always had an interest in technology and the field of CS prior to starting university. Some of the participants stated that an important factor of why they chose the CS field was because of the access they had to computers and video games from a young age; "*I was interested in programming, and I really liked that area. Then I thought I should try to get into that course and try it.*" (P13). Others found the field through other mediums:

> *[. . .] I have always liked to watch movies and documentaries. Then I saw one about Nicolas Tesla and got interested in electrical engineering. I watched other videos about technology, and I could see myself working in this area.* (P12)

Half of the participants had practical experience with different aspects of CS, e.g. programming, from school or hobby projects. Both P14 and P16 attended technical high schools, which is where they were introduced to CS. P16 stated "*[...] You had to choose an area, and I thought computer science sounded cool. And I really liked it, so I continued in university.*" While P14 explained "*[...] I went for informatics because electronics seemed more for the guys.*" P15 was exposed to the CS field at a young age due to his father working in the field and he always considered this the path he wanted to pursue. "*[...] I started programming at 12 in C and Java, inspired by my father.*" (P15).

Regardless of having prior experience, family encouragement was an essential factor mentioned during the interviews.

> *[My father] always gave me the chance to choose the field I wanted myself, and he never imposed it. It was like this for me and my sister. I always liked that because it is not common. I don't see it that often with my peers who faced difficulties when choosing the field that they wanted.* (P12)

> *My first option when I finished high school was biology, but fortunately, I did not pass the entrance exam. I passed the entrance exam for software and data analysis. [...] My uncle always motivated me to stay in the area, and my mother did too. They told me it was a great area for the future and told me: 'You are smart.' They thought that I would like it, and I did.* (P17)

Influence of Father's Experiences

Half of the participants specifically stated that they started studying CS because of what their fathers had experienced.

> *My dad has a PhD in computer science and works with data and statistics, and I always found this interesting. I really loved statistics in high school. [...] I'm from a poor family, and my father was the first in our family to go to university.* (P15)

Having a good education was something their families really valued, and getting a university degree was important to both the participants and their families.

> *My mother never went to university, but my father did. [...] My father was a lawyer, and he graduated when he was 50. [...] My mother and father did not have many opportunities in life. His strength inspired me, and he always encouraged me to study.* (P12)

Additionally, having adaptable skills that can secure better opportunities for them in the future and being open to life-long learning was also an aspect highlighted by the interviewees.

> *When I was a teenager, my father worked in the bank. He was promoted [...] until he became the manager. It was hard for him to find another job when the bank went bankrupt, and it was hard for him to find a new job with the same salary for the skills that he had. I thought that I had to catch all the opportunities to diversify my knowledge. [...] I have to have knowledge in as many areas as I can so I can have more opportunities in case it is necessary.* (P14)

Opportunities

An important theme of reflection for the participants was how their scope of opportunities affected their journey in CS. Those who identified as men were forthcoming with the fact that there is a disparity between opportunities available based on perceived gender and other intersectional factors.

> *I don't see any barriers because of my intersectional identity. [...] I know it happens because my friends have experienced it. But for me, in my experience, I don't have these barriers.* (P15)

The stereotype that women only advance in the field due to "favours" is still a common bias and practice, and it was emphasised that those who are in a more privileged position also should be aware of what's happening by showing up and listening to others' experiences.

> *As a man, I think I've had easier access to opportunities than women. Girls are asked to do favours and other things for men to get better opportunities. This is still common here in Brazil, which is sad because they deserve the same opportunities as me. Projects [focusing on networking for girls in tech] create an arena for women and girls to share their experiences. Here I also participated, not as someone who was speaking, but I was there to listen to women's experiences. And I believe these initiatives really make a difference for them as well.* (P13)

Diversity
Some participants expressed how having a diverse student body in CS positively impacted most students, especially when finding people to whom you could also relate.

> *At [my university], I see not only women and men, but also non-binary and asexual people being accepted, and they are motivated to study here. I expected this acceptance because people here are adults and should treat everyone professionally. But I know there are some religions and groups of people that are more isolated and should be respected as well.* (P13)

Upon further discussion, the importance of diversity and applying an intersectional approach was explained as ways to ensure more equal opportunities and awareness of harmful bias.

> *I have worked on a project that helped students finish their degrees, and they researched what was difficult about the degree programme. But in this research, they did not consider intersectional factors, which I think have a great effect. [...] I also like that it's more open presentations made by the university about diversity, asking if diverse people want to share their experiences and create a comfortable network.* (P16)

University and Future Opportunities
Half of the interviewees talked about how university shaped their knowledge and access to future opportunities in academia or in the industry. All of them expressed that going into university, they had little to no knowledge about the different paths they could take within CS.

> *I think it would be nice for all students to know more about what they will learn throughout the degree. The first year is mostly mathematics and introductory programming. This is the basis for the rest of your degree, but if you don't know how the rest of your degree is structured or what options you may have, it may be difficult to understand what possibilities exist.* (P13)

They expressed that "*[i]n the undergraduate, it should be more projects that can help us to improve our knowledge. Projects with more practice.*" (P17). "*[A]lso, meeting professors working in different fields to learn more about what they are doing to get an idea about the future and what they are working with*" (P13) and learning about their degree options after obtaining a bachelor's degree were valuable in exploring their own path in CS.

> *These experiences help students learn more about these different areas to see if they could be interesting to work with in the future. And it doesn't matter if you have prior experience with it or not. If you don't enjoy it, you can try something different each year.* (P13)

Furthermore, getting the opportunity to be an exchange student was also highlighted as important in diversifying their knowledge in CS.

> *We need opportunities to exchange. When I was an undergraduate student, then we had only one opportunity to get out of our country and study in another country. [...] When you know these universities, then you get the chance to learn to know how other countries and states work. This helps to improve your knowledge and how you work.* (P17)

Few Girls in Computer Science

The two women interviewed in Brazil both commented on the low number of girls in CS and how that affected them. They both had different experiences with this and being in the marginalised group was not always a bad experience. An example highlighted was getting close relationships with their male peers.

For P12, the fact that there were few women amongst her peers presented some challenges in making connections with the other girls since some would change degrees or drop out, where the scarcity of girls was one of the contributing factors.

> *In some classes, I feel very isolated because I'm the only girl, and the professor is also a man. I feel like it is not my place. I am not welcome in that place. It is not always a constant thought, but it comes to my mind, and I cannot control it. I have to isolate myself in some classes and periods at university because I have faced a lack of sense of belonging [...].* (P12)

On the other hand, P14 shared that there actually were more girls than boys in her informatics course in technical high school, saying "*[...] I didn't notice any differences.*" However, when starting working in the industry she experienced a shift. She commented on the lack of women developers; "*I don't know why, but most of the development team was men. 2 women and 30 men. In the testing team, we were 70% women.*" Her experience working in testing was that they were seen as less important than the developers, which may have been tied to the testing team being a majority of women, whilst the developer team were a majority of men.

Competency and Workload

Most of the interviewees had experiences with the bias of being seen as less competent and being assumed to handle a higher workload. This theme was particularly highlighted in the context of the intersection between gender, socioeconomic status, and ethnicity.

Most of the men interviewed shared this sentiment; "*I have seen friends being assumed to be less competent who are women. It's more common for women.*" (P15). This was supported by the women interviewed, who both shared their experiences with this issue.

> *Guys doubted my capability and ability to do projects. They gave me tasks they considered easy to do because I was a woman. [...] Assumed to be less component, I face that still. In projects with guys, I get comments about my competency and ability. It's not always directly to my face, but I feel it, especially when being given easy tasks.* (P12)

Also, in a professional setting, this bias was prevalent. P14 shared her experiences from different workplaces, highlighting that

> *[My team] didn't assign me any difficult tasks. They gave me easier tasks because they assumed I had less knowledge than they did. They didn't give me what I needed to be more challenged at work and treated me like I couldn't do anything.* (P14)

She also explained how there were negative repercussions, even when she and her female colleagues excelled in their work, and shared this example from working as a tester:

> *[Working in testing], when [my colleagues and I] found a bug in the code, [the software engineers] got angry. We had a website where we registered bugs, and if we [...] made any mistakes, they made the issue invalid, and we had to register [everything] again. They got angry when we did our job as testers. [...] We found more bugs than the team in Germany. But here, the men were hostile to us. I don't know why. I think their ego got hurt, and they didn't think having somebody testing their code was good.* (P14)

Being the first or second-generation university student in the family also comes with various expectations and doubts. When P12 discussed her intersectional experience of being a woman in CS and coming from a family with financial hardships, she shared

> *[...] I experience a higher workload than others. [...] I study and work and do a lot of projects at university. I always want to do more because I worry about my family and what people at the university are doing. I want to prove myself competent. [...] I enjoy doing all these different things, but I also feel like I have to do them to belong in this space.* (P12)

This experience was also very similar for the other interviewees that came from low-income families. An example shared was that the transition from high school to university was a challenge and led to feelings of imposter syndrome at times.

> *When you have advanced and challenging classes for the first time, like calculus, and you're not used to it, you feel like you cannot handle the rest of your studies. And you think, 'This is not the place for me' and that all other classes are dependent on this, especially after failing, all though it is not true. Experiencing having classes that I wasn't good at made me feel like a failure. And I had to work really hard to keep up.* (P13)

Socioeconomic Status

All of the interviewed participants commented on the intersectional challenge and complexities related to socioeconomic status.

> *I think socioeconomic status is an important intersectional factor to look into here in Brazil to get the connection between how you see yourself as a student and how you see yourself as a person with little access to money. Here, not everyone has access to the same opportunities because of money.* (P13)

> *I would say I went through some discrimination. [...] It is common in Brazil that there is a discussion between the poor and the rich. People assume you're rich and have a good income because of the way you dress, for example. [...] Some people suppose I [come from a high-income family] due to how I dress and the way I am. It is one of the barriers I face because I have to prove to them that I don't have that. [...] Poor and rich can be very separated. People look at you differently based on if you come from a good background financially. It is not because people [who face financial hardships] don't want to have that, but it is a different situation being someone that doesn't have much [while also] trying to balance getting a degree. People like to discuss this.* (P12)

Getting into CS can be a huge barrier for people from poor and low-income families because of the expenses related to buying a computer and also the fact that they have had less access to computers than peers from wealthy families throughout their pre-university education.

> *My father and my mother could not afford a lot of [the supplies and equipment] I needed to study. So, I got involved in projects to get income to pay for things, to get a computer and things I needed. No one helped me [financially] in my studies.* (P12)

However, all of them shared how their families taught them about the importance of education and work ethic.

> *My family was very poor, but they have always seen education as the way to go to get a better life. [. . .] That they have supported me has been a really important success factor and has impacted me positively.* (P15)

Underfunded High School

The existence of class and the difference between rich and poor is very prevalent in Brazil. This is also visible in the education system;

> *I attended public school and didn't have a good foundation [for going into higher education]. Many people have a bad background related to education because there are many differences in Brazil [related to class]. [...] For example, I did not have physics classes because [my school] did not have a professor. [...] People from the same neighbourhood have different [educational] backgrounds, and it's common.* (P12)

Going to university was also a challenge academically, and the differences between students that had attended underfunded schools and students that went to private schools became much more apparent.

> *The course I had from my hometown was not so good, and when I came here to [my university], I saw the computer science programme was much better. At that time, I was feeling bad because my background was not as good as the other students.* (P17)

Work Beside Study

Half of the participants talked about their experiences with having to get an income in addition to being full-time students, which was seen as a necessity to make ends meet. "*You need to pay for food, rent, internet etc. I need to pay rent and therefore work beside my master's. Things can be expensive, and this affects my*

studies." (P16). Scholarships are also not enough to pay for their CS education, without having extra income. In some cases, work was even prioritised over classes because that is the only way they could afford university in the first place; "*I want to slow down in some classes and focus on work and projects that could give me income.*" (P12). Everyone agreed that it was very difficult to find a healthy balance between working and studying.

> *I studied during the night and worked during the day. It was hard because of no free time, but it was easier because I have a [technical] background from high school. My master's degree was hard. At that time, I worked for a research company, and they reduced my work hours to 6 hours a day, so I had a little more time to do my master's degree.* (P14)

Family Responsibilities

Some discussed how they also wanted to help support their family's income and had other family responsibilities in addition to being students; "*I lived with my sister since I was 19. I had to work to pay the bills. It was not an option to only study.*" (P14). They have had a completely different experience in university compared to their peers from high-income families and emphasised how financial stress has a negative impact on their mental health:

> *Mainly this year has been difficult with my economic situation. I lost my father [...]. I have a stressful routine, and I do a lot of things, and it is not healthy. I go to therapy, and I know my workload is too high, but I need to do it because I want to stay at the university. I need the income to help my mum and my family. I have a sister who is 15, and she needs me too. I face a high workload this year mainly because of this situation.* (P12)

Sense of Belonging

A majority of the participants had experienced a lack of sense of belonging in CS due to their intersectional identities. However, those who had not experienced this also recognised that "*[...] [p]eople are different and have different difficulties in life.*" (P15), which aligns with the findings from the SLR on this topic (see Chapter 3).

Some of the participants shared their experiences of belongingness in relation to their socioeconomic status. Examples were related to not having the same educational background, not feeling understood by peers from high-income families, but also practical challenges; "*[f]or instance that you cannot afford good food for lunch at the university, [and then] you question whether you belong here.*" (P13).

Some also discussed how openly being part of the LGBTQIA+ community could have negative consequences and result in not only a decreased sense of belonging but also a decreased sense of safety.

> *Here in Brazil, it's still dangerous to be gay/transgender. I was nervous about going to university and wondered if people would be accepting of me. My peers were supportive, but I don't know about my professors.* (P16)

Out of all the participants interviewed in Brazil, only one shared the experience of moving far away from their home city to attend university. When talking about the sense of belonging, P17 shared how moving to a completely new city to study was quite challenging.

> *At the beginning of my master's degree, when I came here, I was nervous about coming to a new city because I had never lived in another city or lived alone. [...] I had only met my advisor for one conversation before [moving]. I did not know anyone here in the city, and I was afraid. When I first met my advisor and got to know my friends, my sense of belonging increased. I had this place to work, and others were there to work too. We interacted with each other, and I started to feel like I belonged.* (P17)

A couple of interviewees also emphasised how a lack of sense of belonging can be harmful to people's mental health. Constantly having to try to fit in and conform had an overall negative impact on their sense of self.

> *I also struggled with depression and went to a psychologist. Now I am good, but it was caused by the stress that I had been dealing with, not being completely accepted in [computer science].* (P16)

Discrimination and Harassment

All of the participants in Brazil reflected upon the theme of discrimination and harassment.

Racism was a topic discussed by a couple of participants. Although Brazil is a diverse country, accounts of racism still happen; "*I think I have experienced racism in my childhood, and I think every Black person has experienced it, which is sad.*" (P13). No one had experienced this directly in relation to studying or working in CS, and P15, who also is a Black student, shared "*I don't see a lot of racism in my bubble and have not experienced it.*"

Both people identifying as women shared their experiences with sexism and harassment in CS.

> *I have heard inappropriate comments for being a woman in my courses from my peers. They said, 'You just had to go to the teacher to get a better grade', insinuating that since I was a woman, I could have 'privileges' and 'advantages'. I would say this was difficult.* (P12)

The notion that women are not capable of succeeding by themselves without getting "favours" or help from men, was also found in the SLR. Furthermore, P14 also shared how working and having children is looked down upon, as it does not fit the traditional gender norms.

> *A colleague who started at the same time as I had three kids and her boss used to make jokes. When you have kids, you have 4 months of maternity leave. One or two years later, the company started to track performance, and it turned out that she was more productive than everyone else, even with this break.* (P14)

However, when words turn into action, people of different intersectional identities could be at risk of getting into harmful situations because of power imbalance. Abuse of power and harassment also happens in CS:

> *I've had a hard experience at university, to say the least. I was in an uncomfortable situation, but I don't have a problem talking about it now because I had therapy and a professor to support me. I went through harassment by a professor. Some years ago, a professor started texting me constantly. He found my number. It was very hard to see myself in an area where I was not welcome and safe. This professor, in his position, seemed to have power. In that situation, I avoided him as much as I could, but it was uncomfortable. I talked about the situation with other professors, but it was years later [...]. Identifying what I was facing and going through was hard for me. I even blocked him [...]. Once, I had to do a test with only me and him in the room, and he asked a lot of questions. It was very uncomfortable. I didn't have courses with him after that. Later due to COVID, we were all home, and I didn't have to see him at university.* (P12)

Homophobia was also a topic discussed by some interviewees. Since people that openly were part of the LGBTQIA+ community were not widely accepted in Brazil (as of 2023), this also negatively impacted their acceptance in the CS field in Brazil.

> *A professor just looked at me and said I should be in design, not [in computer science]. And the same professor said that computer science was for 'real men' and not gay etc. I've experienced a lot of microaggressions as well during the course. I didn't understand at that time that it was discrimination. I was good at design, but I was also good at programming, and I didn't understand why they kept telling me what my place should be.* (P16)

Discrimination and harassment happen in many different forms, also in the CS field. It can be extremely difficult for people of different intersectional identities to recognise microaggressions, discrimination, and unconscious bias due to their intersecting identities. Moreover, standing up for yourself in a situation of harassment or discriminatory behaviour without it having any negative repercussions for the victim can be even more challenging, especially if a person in power was involved.

Supportive Network

All of the interviewees in Brazil discussed the importance of having a supportive network. Having a supportive network in CS was an important success factor found in the SLR (see Chapter 3) that supported intersectionality and DEI in CS.

Organised Peer and Professional Networks
Overall, the interviewees were positive about organised networks; "*[n]etworking is good because you may work together in the future. I think it's good to get in contact with different professionals.*" (P15).

The participants emphasised that organised peer networks provided a space to find people with similar experiences, interests, and intersectional identities, which increased their sense of belonging in CS. Although it was not always easy to find these networks due to, e.g., lack of information.

> *I was in a good network with other women. I heard about others' experiences, and I felt like I was not alone. Other girls have faced many difficult situations in university too. I felt like I could say something because I was on this project. When we had this activity about good practice in the academic environment, I thought that I could contribute to [creating a better environment for my peers]. So, I wrote about contacts women could have at university, how to identify harassment, how to identify others in that situation, and what we can do about it. [...] And I feel like I did something with the experience I had and the experiences I've heard about from other girls too. I think this impacted me and others positively [...].* (P12)

Learning and sharing knowledge with peers and professionals in CS was also highly valued since this allowed the participants to diversify their knowledge.

> *Getting contacts in computer science, not only in one specific area but people from different areas within computer science, is important to learn what you can do. We face different problems every day. Knowing how others think about these problems can help get a greater view of the problem.* (P15)

Organised networks that applied an intersectional approach by providing workshops about different issues related to intersectionality, positively impacted the participants. Learning about societal issues and different communities helped them understand the connection between people and CS better, especially at the university level. Moreover, these networks introduced them to how they could use their knowledge to develop technology that would help their communities. P16 shared an example of how a CS workshop about gender-neutral language was important to him, being a part of the LGBTQIA+ community.

> *At the [university research initiative], we had a workshop about using gender-neutral language, which is challenging because the Portuguese language is binary; you have feminine or masculine versions of words. Learning about different gender-neutral forms of traditionally feminine or masculine words is challenging because of how the language is structured. But we need to find a way to speak that is more inclusive for all. I could never have imagined this when I was younger, and it was really inspiring to me.* (P16)

Supportive Working Environment

An essential factor discussed by the participants was having a supportive network at their university or workplace, whether it be peers, management, professors, or supervisors.

> *For persistence, it is important to also have support from your professors. When you feel seen by your professors, and they are supporting you, you feel like you have a chance to be here no matter what other people think, including family and friends. [...] Having a professor who supports you can make a big difference in your life, and I think many students can relate to this.* (P13)

Having this type of supportive environment was also helpful in increasing the sense of belonging and well-being. P16, who was open about having depression, shared "*I had supportive professors that really helped me, and [if they were] worried about me, asked if I was okay, and it helped me complete my bachelor's.*"

Peer support also had a positive impact on the participants and their study or working environment. "*[Finding a supportive peer network] was the reason to get involved in projects. I could get a place for action and space for work. It has helped me in my journey.*" (P12). An example shared by students was how supportive peers helped them in their studies:

> *When I came to [my university], I had no knowledge about research. My advisor needed to teach me. I needed to ask my friends, too, who had experience. When I came here, then I needed to learn from zero. Most people were helpful. I am really glad for these people because it is not easy to learn.* (P17)

On the other hand, working or studying in an environment where people are dismissive and secretive was seen as a big problem within CS. CS is a highly collaborative field; thus, this does not only negatively impact the motivation and work ethic of individuals in the team, but also the overall quality of the project and its outcome.

> *I didn't like working in this team. It was more closed off, and people didn't share knowledge. When I worked as a developer, we used to share our knowledge. We used to help each other to solve problems, find solutions and automate things to make the job easier for everyone. When I worked in the network team, they didn't share anything. When I asked them, they were dismissive and didn't respond to my questions.* (P14)

Family Support

Half of the participants shared that support from family and friends was important to them. "*One very positive factor is to have supportive friends that help you not give up. You don't have to be the best, but to have encouraging friends makes it better.*" (P13).

"*I want to do something because I like it, not only to make money. I want to do something I like to do and do this every day.*" (P15). Family support, in particular, was essential for building confidence and provided a strong intrinsic motivation for these participants to reach their goals, e.g. a particular career path in CS, completing their degree, or reaching financial stability, and realising their dreams.

> *The journey was hard, so [completing my degree] will be the realisation of my dream. I think this is one of the biggest factors. It will be the result of all my challenges and work to achieve more education and independence. I think I can do more when I have my degree, and it will open paths for me, and I will have more chances to change the reality for me and my family. I will have more independence for us to have more liberty. The most important is not the situation right now but the future. [...]*

> *[M]y family shares [this dream] with me and gives me the strength to continue. My father told me that it was not just my dream but his too.* (P12)

Role Models

All of the participants talked about the importance of role models, which was another important finding from the SLR. People they identified as role models were usually someone in CS from their university or workplace, such as professors, peers, and supervisors. "*In my career, I have some friends that inspire me. They inspire me to get better and have a better career. My advisor also inspires me a lot.*" (P17)

Most of the interviewees had role models that not only inspired them to improve their current CS skills but also motivated them to learn more about their future career paths.

> *When I see my friends succeed, I see them as my role models and want to achieve that too. I also see my professor as my role model, and I get inspired by their work for my own future as a professor.* (P13)

Having access to intersectional role models that you could identify with on both a personal and professional level was also highlighted as an important factor for motivation and an increased sense of belonging.

> *I have some role models. Many of them are professors. [My professor] was the first woman I got to know that was involved in projects related to women in technology. She inspired me so much.* (P12)

The presence of intersectional role models in CS offered a sense of validation and assurance to individuals that they, too, can excel in this field.

> *I had a supervisor; she was a Black woman and had accomplished a lot of things in her life. Being supervised by a Black woman was very important to me, and it was motivating to see her succeed.* (P15)

However, the interviewees agreed that a noticeable shortage of intersectional role models exists in CS. This sentiment aligns with the findings of the SLR.

> *I don't know if I have any professors that are part of the LGBTQIA+ community. They don't talk about that. I would appreciate more role models that I could identify with and look up to.* (P16)

In response to this known lack of role models, some of the student participants shared how they had become role models for new students. P13 shared

> *I try to inform new students I meet about the different options they have later in their degree, but if this was grounded in an actual initiative or project, I think this would make a difference in students' experiences.* (P13)

Becoming a role model can involve various actions, such as participating in multiple projects, sharing experiences, and supporting fellow students. P12 became a role model to others due to her involvement in various technical and non-technical projects.

> *Other girls saw me as a role model. Girls and some guys from my class said they saw me as a role model since I was [involved in women in STEAM initiatives, sharing resources about harassment], and involved in many other [technical] projects.* (P12)

Mentorship Programs

Mentorship programs were addressed by half of the participants and were particularly important to the students interviewed.

> *I have been a part of a mentorship program through this [university initiative]. I had contact with women who have been in this field for some years, and they gave me advice, mostly career advice but also personal advice, which was very good.* (P12)

Intersectional mentoring [62], another finding from the SLR, was also discussed. P12 shared her experience being mentored by the CEO when she volunteered at a company, and how seeing a woman CEO helped her realise that leadership in CS could be a viable career path.

> *I had the support of the woman who was the CEO, and she supported me to stay in this [leadership] position. It was the first time in my life that another woman incentivised me to get a leadership role.* (P12)

Furthermore, the participants talked about how mentorships were also beneficial in figuring out what field within computer science they would want to specialise in and gaining more detailed insight into career paths in academia and industry.

> *We have [an initiative at the university] that is not about doing classical research but rather more related to companies and start-ups. They offer a lot of mentorships and courses. It's a good resource. I had a mentorship there in 2021, and I learnt a lot about the industry.* (P15)

5.2.3 Thoughts About a Networking Program

Since the interviews were held before the usability tests and the participants had gotten more information about the developed prototype, the authors also wanted to gather general thoughts about creating a new peer networking program following an intersectional approach.

From Participants in Norway

Four of the participants were very positive about the general concept of a networking program, especially since they knew this project revolved around intersectionality. They thought a networking program would be helpful and an important initiative. They saw it as a new unique concept to have an intersectional peer network.

> *When you have this interaction between students in general, the university system and the outside world, you always have different motivations. That probably would require different functionalities in terms of systems or a community. [...] I think it might be useful, and especially this intersectionality issue may be successfully addressed by a system like this.* (P2)

Three of the participants were more critical of the concept. They emphasised that people already have limited spare time and did not see themselves wanting to spend that time doing "work-related things" that may not bring them much value. They also discussed the challenges of developing a new viable product when, e.g. LinkedIn already exists, although this is a challenge for new products in general. "*I think it's a good idea, but it takes time to build trust and create a relationship. So, in a sense, it could be easier to talk with people at work.*" (P11).

The rest were relatively neutral about the concept of an intersectional networking program and rather shared important things to keep in mind when designing a network. The most important was to think about what the users would gain from the network and present some clear values and goals for the network.

From Participants in Brazil

Four of the six participants interviewed in Brazil were excited about a potential networking program. Half of these interviewees reflected on how this could be helpful in connecting the students, while the other two were excited about how a network program could connect more people of intersectional backgrounds.

> *I know that there are a lot of people like me in this area, but there are no examples close to me. By having a network like that we could give more hope to people who face this challenge.* (P16)

5.3 Observations

For the usability tests, the authors utilised the guidelines by Gomoll *et al.* [78]. During each usability test, one of the authors was the test leader and the other author was the observer. The test leader explained the process of usability testing and read the scenarios and tasks aloud to the participant. The observer took field notes when the participant solved the tasks from the usability test guide. Feedback from each usability test was then analysed and improvements to be done to the prototype were identified.

During the design and creation process, there were a total of five iterations. Iteration 0 was the first iteration based on findings from the SLR and brainstorming at the start of the development process, while Iteration 4 suggests the final prototype for this thesis. The following subsections, Section 5.3.1 to Section 5.3.9, present the design process chronologically, alternating between iterations and their associated usability tests.

5.3.1 Iteration 0

The first iteration was developed based on research findings in the SLR [19, 20] (see Chapter 3), and not user feedback. However, this still aligns with the design and creation strategy, since Oates *et al.* [50] argues that design and development should be based on research. The authors developed this Figma prototype version by brainstorming possible solutions to develop a product to support DEI in CS through an intersectional approach. Inspiration was found from similar websites related to the product and by following the design principles presented by Sharp *et al.* [77] in Section 4.2.5.

Figure 5.3 is the first page introduced to the user when entering the website DiversIT. While scrolling down the page, the user can read about what DiversIT is and what it offers as a product.

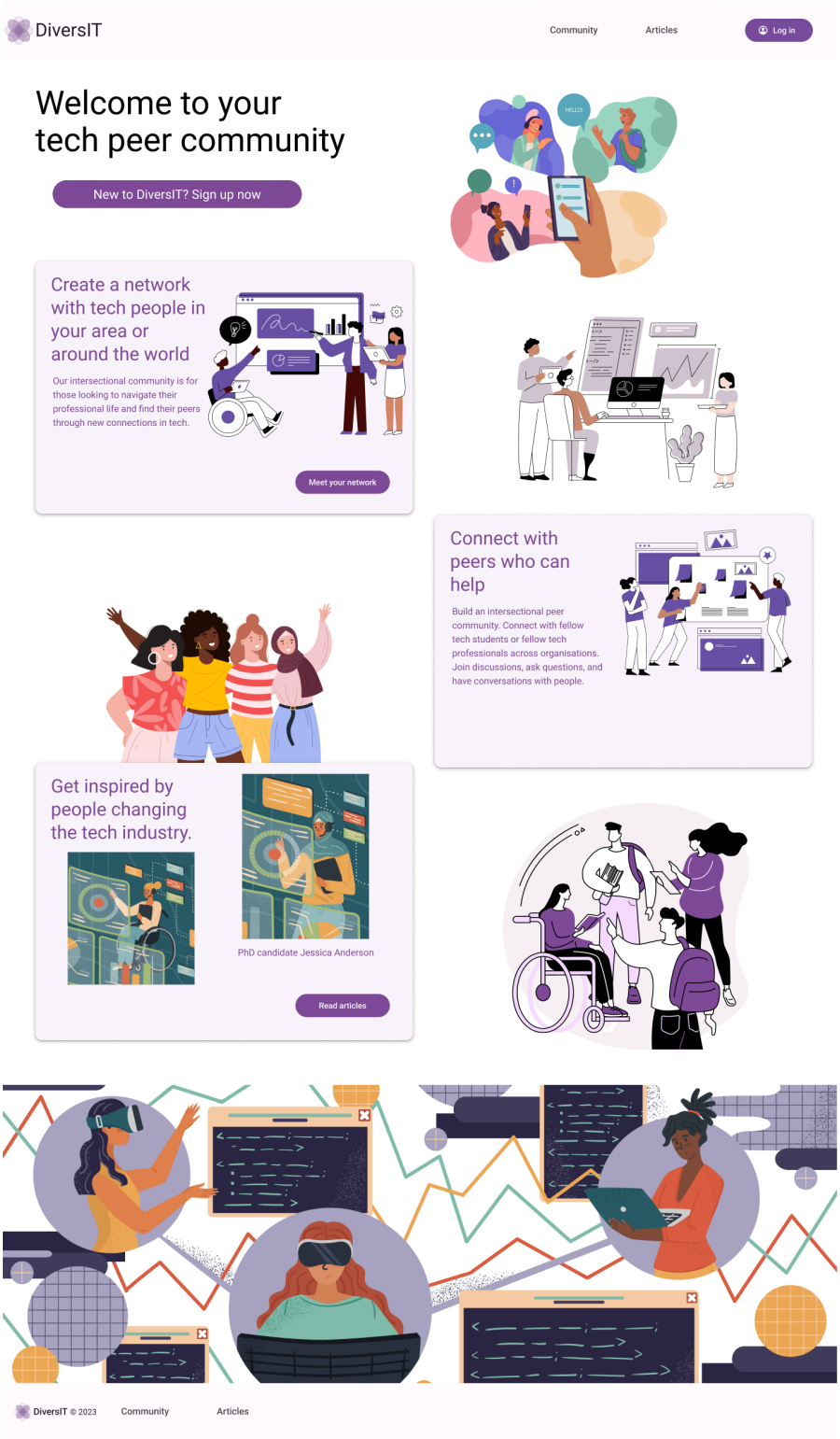
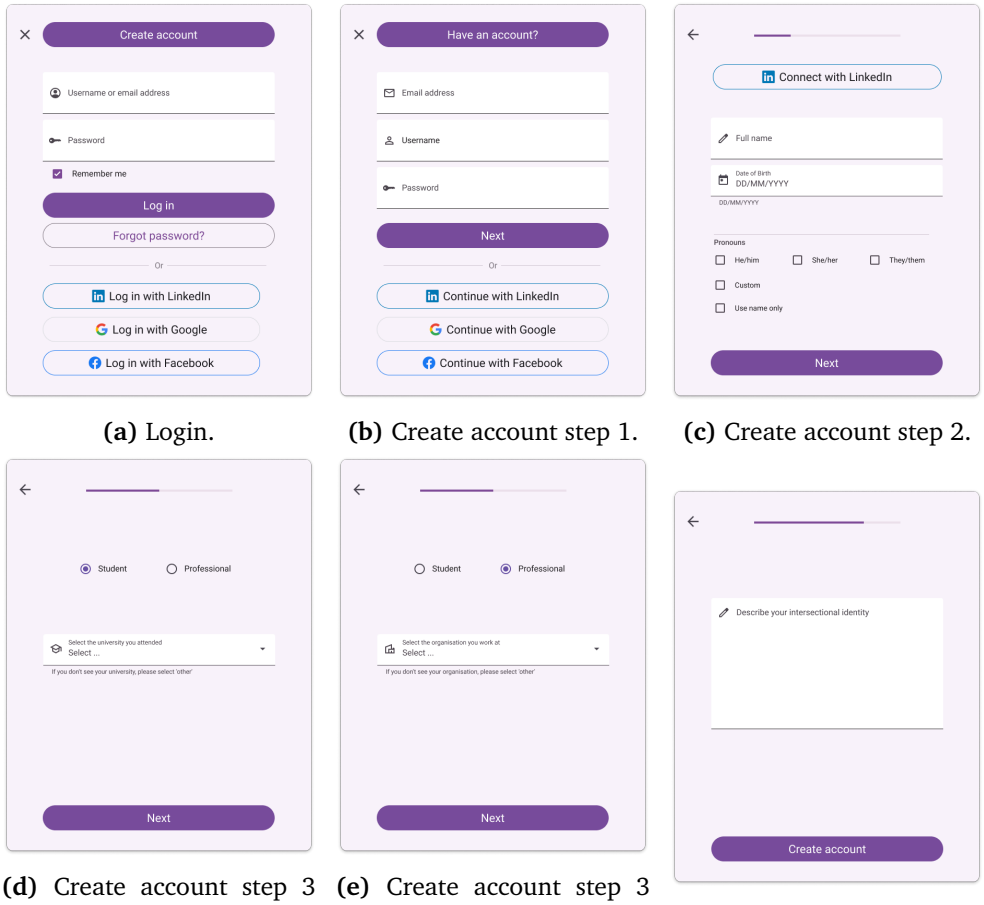


Figure 5.3: Front page of DiversIT.

When pressing the "Log in"-button or "New to DiversIT? Sign up now"-button, a popup window appears on the screen to log in or create a new account as presented in Figure 5.4. Figure 5.4a is the first popup window. Here the user can choose between logging in with an existing user, LinkedIn, Google or Facebook, or create a new account. If the "Create account"-button is clicked, the process continues to Figure 5.4b where the user can start filling in an email address, username and password. Here it is still an option to instead log in with a third-party service, or log in with an existing account. By clicking the "Next"-button, the user can in Figure 5.4c fill in the full name, birth date and preferred pronoun. The pronouns are added to this page as DiversIT wants to focus on diversity and be including to all intersectional identities in CS. Both Figure 5.4d and Figure 5.4e are versions of the third step in the process of creating a new account, depending on which radio button is chosen. The students can select their university in the dropdown menu, as seen in Figure 5.4d, while the professionals can select their workplace in the dropdown menu, as seen in Figure 5.4e. The last step of creating an account, presented in Figure 5.4f, contains a text field where the user can describe their intersectional identity. When clicking the "Create account"-button, the user is then logged in with their new account.



(a) Login. **(b)** Create account step 1. **(c)** Create account step 2.

(d) Create account step 3 (student). **(e)** Create account step 3 (professional). **(f)** Create account last step.

Figure 5.4: The process of logging in or creating a new account.

Figure 5.5 shows the header attached on all pages of the website that works as a navigating tool throughout the prototype. By pressing the DiversIT logo, the user navigates back to the front page in Figure 5.3. When the user presses the "Community"- or "Articles"-tab, the popup to log in or register (see Figure 5.4) appears as feedback to the button clicks, constraining the user from accessing *Community* and *Articles* without being logged in. This constriction is meant as a way to motivate new users to register to get access and build trust within the community, as it is only accessible to those who are registered.

Figure 5.5: Header when not logged in.

When a user is logged in, the header changes to Figure 5.6. Now, if the user clicks the "Community"-tab, the *Community* is accessible as presented in Figure 5.8. The *Articles* page, visualised in Figure 5.7, is also available to the user when clicking the "Articles"-tab in the header.

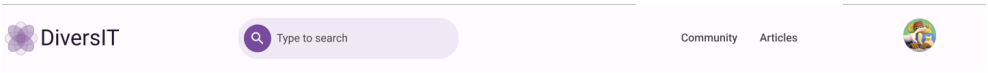


Figure 5.6: Header when logged in.

The *Articles* page, shown in Figure 5.7, contains articles about DEI in CS. On this page, role models with different intersectional backgrounds are presented to increase awareness of intersectionality. In general, it presents an intersectional platform where users can get inspired by reading others' stories, hearing about projects, and exploring initiatives focusing on DEI.

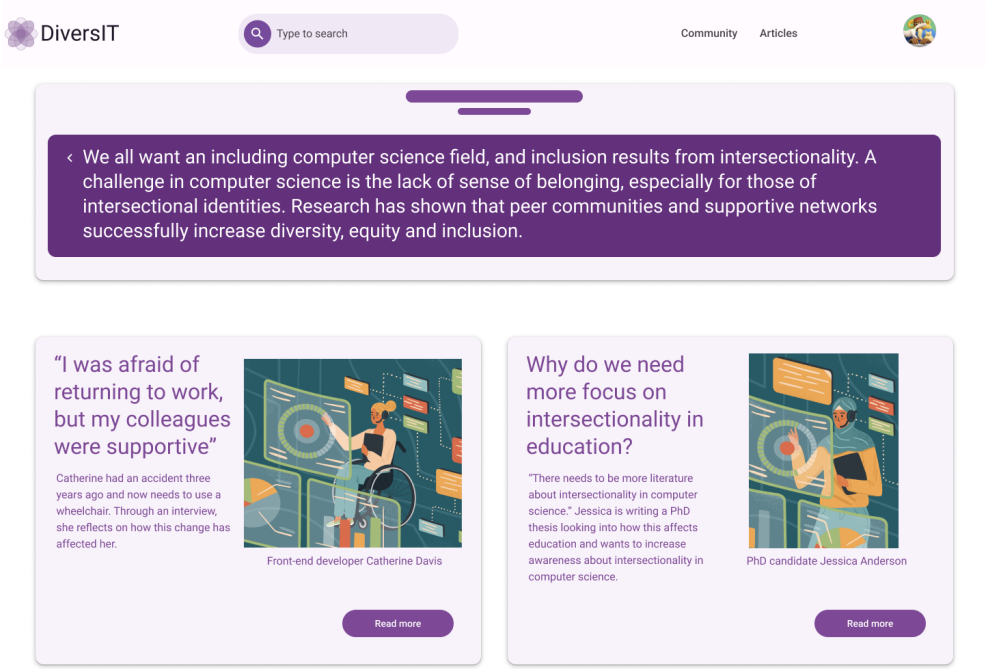


Figure 5.7: The Articles page presents inspiring role models and other articles.

From analysing the brainstorming in comparison to the SLR and existing technical solutions, it was decided that a supportive peer network would be the main focus of the prototype. The *Community* aims to fulfil the mission of supporting this focus. Figure 5.8 presents the *Community* page of DiversIT. The *Community* consists of different prompts posted by users. Arrows in the figure show different interactions that can be done in the forum. Users can add a new prompt by pressing the "Add new prompt"-button, and others can interact with prompts by adding a response.

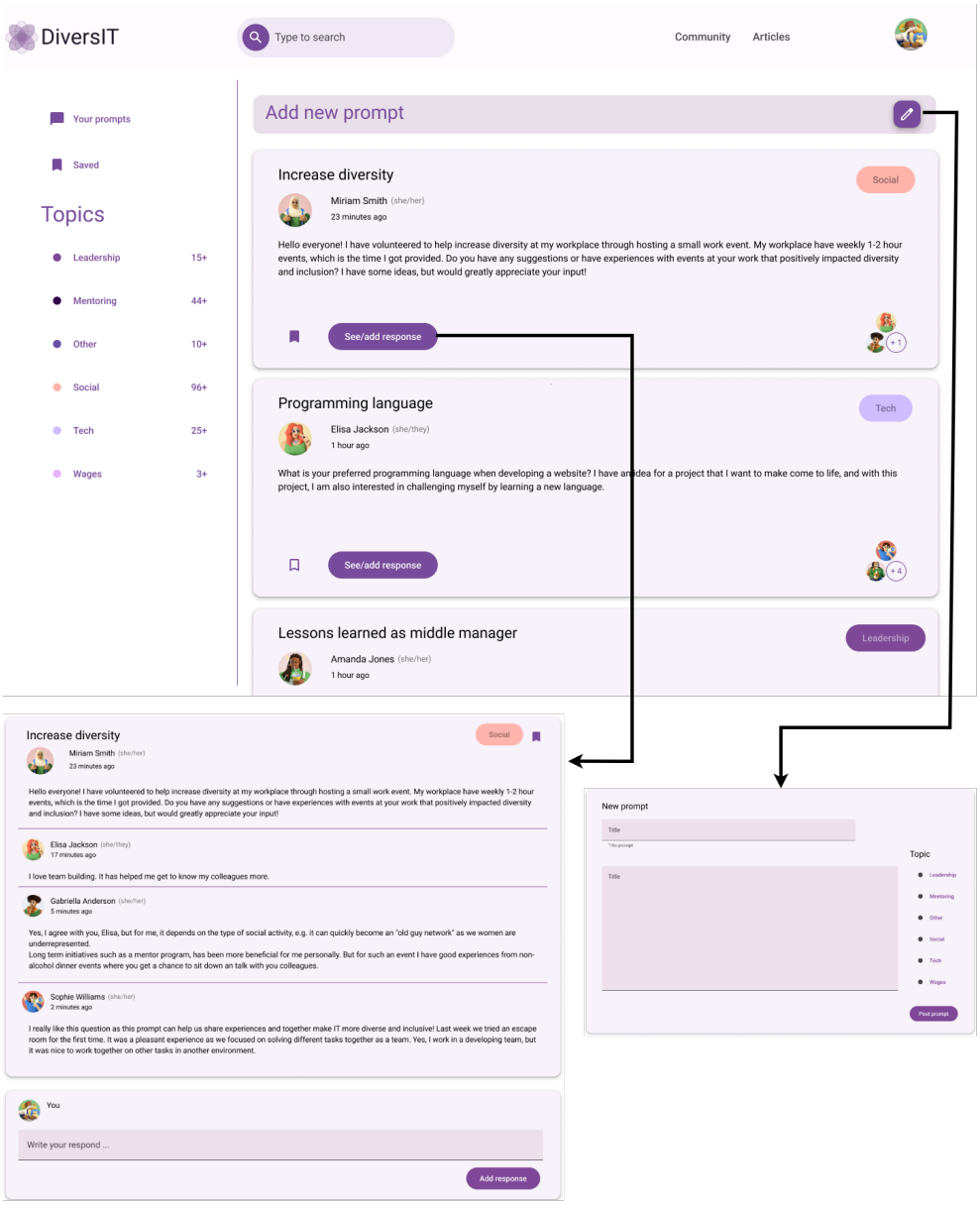


Figure 5.8: The Community page shows how to add a new prompt and add a response to an existing prompt.

Each prompt in the *Community* is categorised into different topics, which can be used as filters for the prompts. Figure 5.9 shows the filter functionality where "Social" is the selected topic. To easily access certain prompts, the user can save prompts by bookmarking them, and find them again by clicking the "Saved"-button in the menu. The user can also easily find the prompts they have posted to DiversIT by selecting "Your prompts" in the menu.

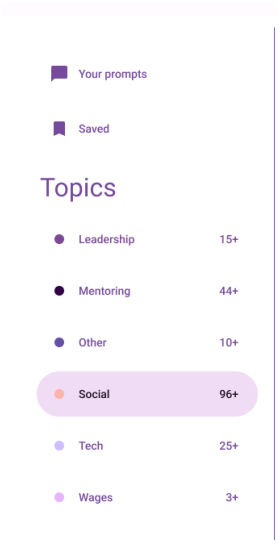


Figure 5.9: Topics in the Community menu bar.

Iteration 0 of DiversIT was tested on four participants during the data gathering. Based on their feedback, presented in Section 5.3.2, improvements were implemented for Iteration 1.

5.3.2 Usability Test 1

Four participants, referred to as P1, P2, P3, and P4, usability tested the initial prototype under the framework established in the usability testing guide, detailed in Section 4.5.3 and Appendix D.4. This subsection presents the observations and feedback from the tests.

The participants were initially introduced to the website's homepage. P4 favourably appraised the interface's aesthetic elements, noting the appeal of its illustrations and colour scheme. From these illustrations, P3 stated "*I can see that it is a website for people like me*", which promoted a sense of belonging. P3 thought it was a visually attractive website that people want to be a part of and it looked professional. This underlines the importance of Norman's design principles [70, 77] such as visibility and affordance that contribute to creating a professional and engaging platform. The participants commented that having DEI as a goal was something positive since this made DiversIT more reliable compared to its counterparts. However, P1 and P2 voiced uncertainties regarding the website's intent and what type of community the website offered. This lack of clarity was also present for P4, who was explicitly looking for an *About* page informing about the purpose, but this did not exist. This first impression that the participants got about the website implies that the UX goal learnability needs to be improved to make the users work out how to use the prototype when presented to DiversIT.

Notably, all the participants expressed reservations about immediate registration. P1 was looking for more information about the website and commented that the goal and purpose of the website were not clearly described, which points to a lack of visibility. The limited content availability before registration was a source of frustration for P2, as P2 expected that there would be at least some articles and information to incentives the user to register. P1 confirmed the same thought as P2 and did not want to be forced to register on the website. Further, P1 reflected that people should receive something valuable when signing up. Resources should be on the website to get people interested and do something more exclusively. The fact that nothing was accessible due to not being signed in also triggered P3 to stop using the website. The participants, in general, were frustrated that there were too many constraints limiting interactions when a user first wanted to explore the website before registering. Also, P4 specifically wanted to get a clear understanding of the website before registering.

P2 was sceptical informing about which organisation the participant worked at to DiversIT during registration, highlighting the importance of addressing privacy concerns for both the workplace and intersectionality. It is critical to create trust in the system and trust in the people. P2 further asked about anonymity and how that would work if people have an identity connected to their users. Due to the focus on intersectionality, P4 reflected that informing the user about the security and how the data is stored is essential.

P3 chose to register with LinkedIn as P3 stated that this makes it easier with an already existing account. Later in the test, P3 reflected on the difference between LinkedIn and DiversIT, noting the potential for LinkedIn to become an echo chamber, where the comments become bragging and less valuable. P3 was more optimistic about the potential of DiversIT.

After logging in, P1 navigated to the *Articles* page and explored the page. While the articles available initially got P1 excited over the page, the participant was confused about the type of available articles. P1 also shared that, e.g., when creating presentations for management, she had always missed having an international collection of articles.

Navigating the website was understandable for all users when logged in, as the header redirected them to the pages they wanted to access. All participants in this usability test executed task 1.3 without a problem. They all navigated to *Community*, found the prompt by Miriam Smith and added a response. The common understanding of navigating indicates that the website's navigation scored high on efficiency and utility. On the other hand, as only half of the participants used the scrolling functionality when first navigating on the front page, the scrolling functionality can be seen as needing more visibility. P4 reflected upon this by commenting that the participant used a computer mouse for the test but had noticed that there was no visible scroll bar.

When asking the participants about the prototype's potential to increase DEI in CS, the participants expressed optimism, but some practical considerations needed to be encountered. P1 stated "*I could imagine myself using it to network to exchange ideas and get help*", and P3 thought it was an interesting concept, providing a low threshold to communicate with others in the field. For instance, different work-related events can feel like they are only for those with high ambitions, creating a high threshold to join, but P3 further stated that this website has potential to reach everyone. In addition to the envisaged use of DiversIT for networking, P3 also lauded its potential to bridge the gap between students and professionals. However, they also acknowledged the inherent challenges community-based systems face and the importance of effective marketing strategies.

5.3.3 Iteration 1

Based on the feedback and observations from the first usability test, the Iteration 0 prototype was further developed in Iteration 1. A general theme from the test was that the participants were sceptical about registering, as the website's purpose needed to be clearly described. Therefore, an improvement made to the prototype was to create a separate *About* page with the vision and mission of the website, which one of the candidates was explicitly looking for during the test. Figure 5.10 shows this added page to the prototype aiming to increase the website's effectiveness as it allows the user to learn more about the website more easily by increasing the visibility of the purpose.

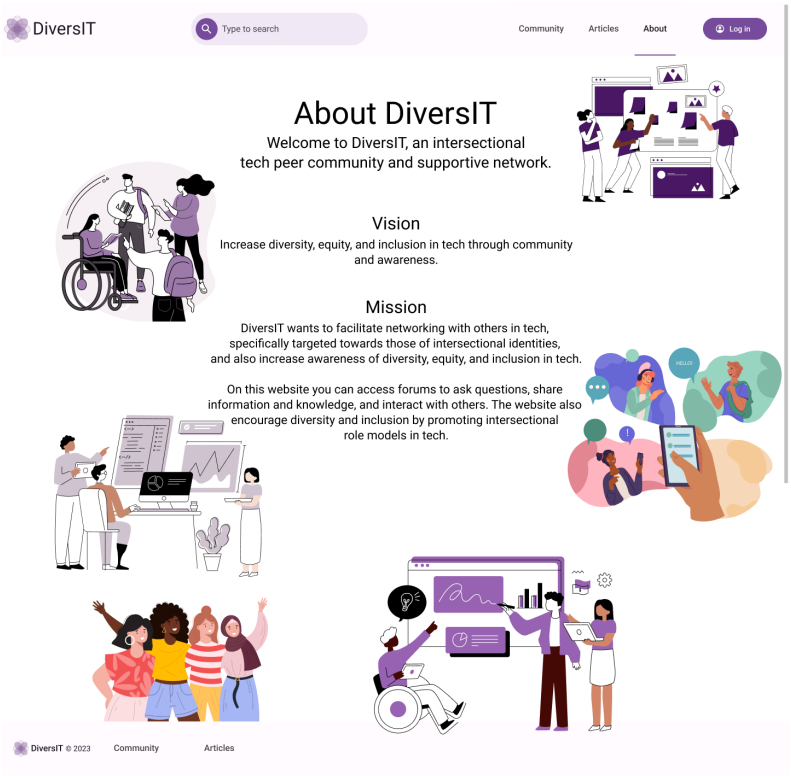


Figure 5.10: About page informing about the purpose of DiversIT.

The header is updated to access the *About* page as presented in Figure 5.11. A third button was added in the same format as *Community* and *Articles*, as all of these navigate to a new page. In Iteration 0, when the user tried to access *Community* and *Articles* without being logged in, the only option shown was the popup to register an account. Based on feedback from the usability tests, these buttons now navigate to separate pages. To still offer the community exclusively to the registered users, this page is still not accessible without being logged in, but in this iteration, the user can navigate to an informative page about the community as shown in Figure 5.12. When the user is logged in, the navigation to *Community* and *Articles* works in the same way as in Iteration 0, although *Articles* is available in both states.

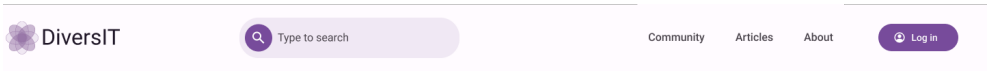


Figure 5.11: Updated header with added About-tab.

Figure 5.12 presents the page the user navigates to when clicking the "Community"-tab in the header while not being logged in. Here the user receives more information about the *Community* and what can be expected when creating an account.

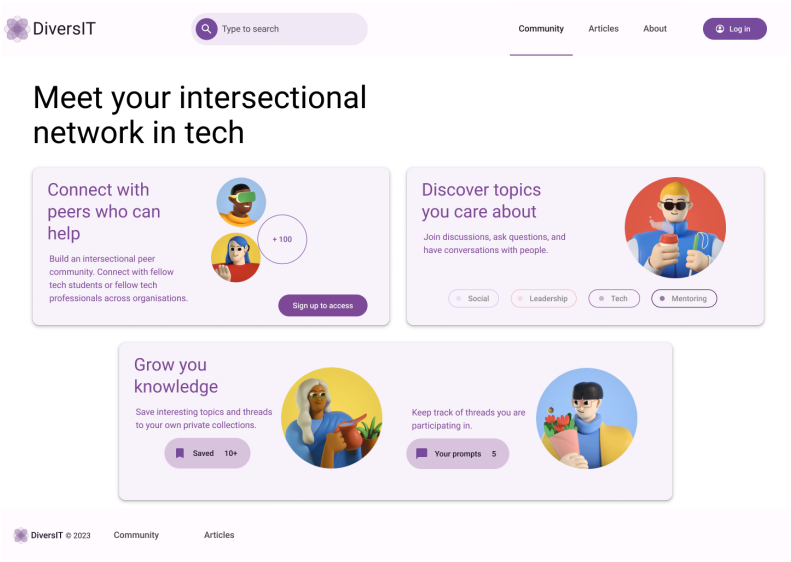


Figure 5.12: Community visible to the user when not logged in.

As only half of the participants used the scrolling functionality on the page, and one commented that there was no visible scroll bar, a scroll bar was added to Iteration 1. Figure 5.3 illustrates the updated front page where a scroll bar is added to the right of the display.

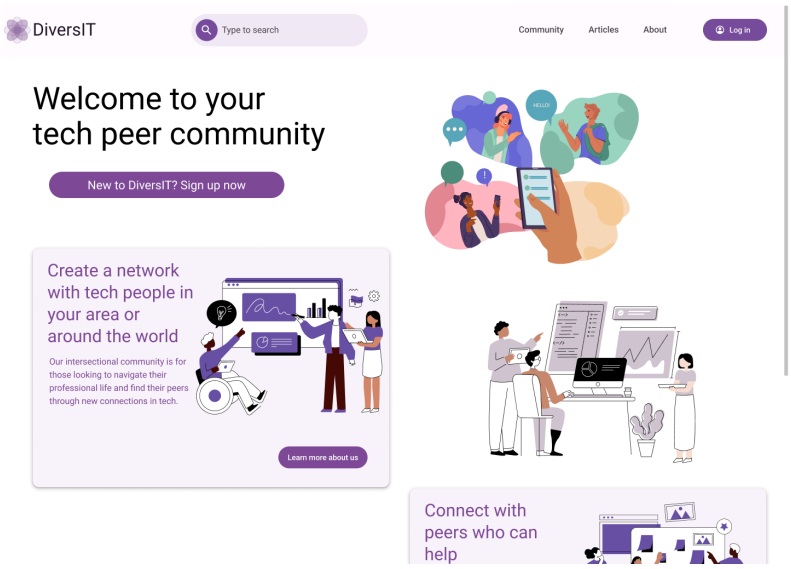
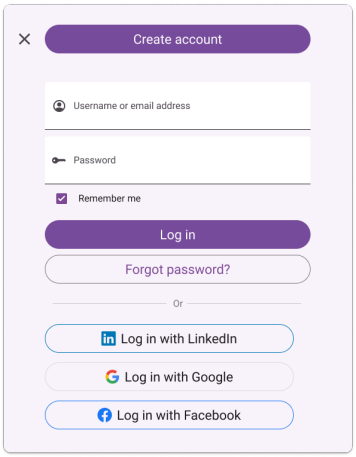
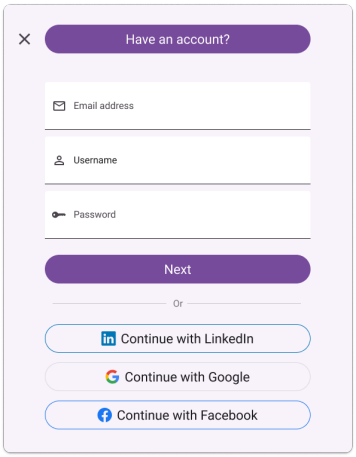


Figure 5.13: Scrolling at the front page.

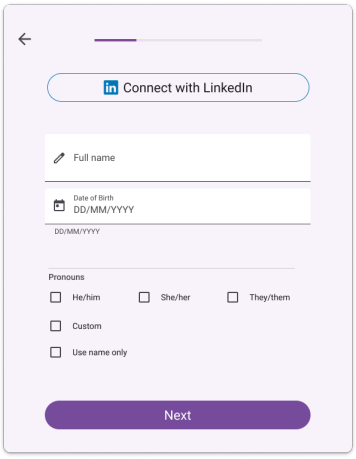
One participant was sceptical about giving away information about their workplace. The process of logging in or registering has been updated in this iteration as shown in Figure 5.14. The number of popup frames is reduced from six to four. The last three frames in Figure 5.4 were merged into one frame in Figure 5.14d. So now, regardless of selecting student or professional, the only option further in the signup process is for the user to select their current or prior university. In addition to this change, the open text field describing the intersectional identity was moved to an earlier page to save space and shorten the process of registering to DiversIT.



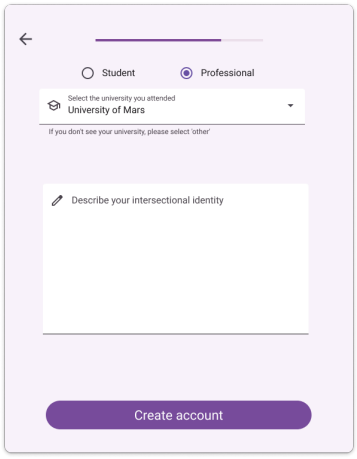
(a) Login from Iteration 0.



(b) Create account 1 from Iteration 0.



(c) Create account 2 from Iteration 0.



(d) Create account 3 new to Iteration 1.

Figure 5.14: The process of logging in or creating a new account.

In addition to the implementations mentioned above, an improvement made to the prototype was to make the fields, especially the text fields, become more intractable. A limitation of Figma is that a user cannot use the keyboard to write in the prototype, e.g., in a text field. This was confusing to many of the participants. To limit this constraint, functionality was added to the prototype giving feedback to the user when clicking a text field by making dummy text appear.

Two suggestions for improvement were not implemented. To still value this feedback and possibly be used in later iterations, the issues were added to the product backlog. Table 5.4 displays the product backlog after Iteration 1. PBI1 will not be the priority for the high-fidelity prototype but rather noted as a focus in future work when the product is developed beyond this thesis.

Table 5.4: Product backlog after Iteration 1.

ID	Issue
PBI1	The user should be informed about the security of the website and how the data is stored.
PBI2	There should be a possibility for the user to be anonymous.

5.3.4 Usability Test 2

Participants P5, P6, P7, and P8 were the candidates for the second usability test to examine the Iteration 1 of the prototype. It is important to note that P7, due to being blind, was unable to interact with the Figma prototype. Hence, an alternative usability test was conducted where the prototype was verbally described, and the participant reflected on the website based on the tasks from the usability test guide. The researchers considered this a valid alternative usability test as the goal of creating the prototype was to investigate if the prototype had the potential as a technical solution to increase DEI in CS. P7 also provided valuable insight into the developing process, particularly concerning the accessibility of visual content such as pictures and videos.

Task 1.2 from the usability test guide explored participants' willingness to register after the first impression when investigating the website. P7 would consider registering if DiversIT was an already existing platform, depending on how the participant first heard about the website. P7 also queried the necessity of this platform when alternatives exist. Later in the tests, P8 commented that the *Community* forum looks like other pre-existing forums, and it is not immediately clear why it differs from these. Although the second usability test participants had a better initial understanding of the website than those in the first test, they struggled to identify it as a distinct product. P5 would maybe register, but P5 had the impression that the website does the same as LinkedIn, and the website looked similar to existing forums within the participant's workplace. P8 preferred to explore exist-

ing topics before registering, expressing dissatisfaction with the inability to do so without logging in and commenting that it should be explained why a user cannot explore more before registering.

Upon registration, P8 preferred following the registering process without using the other options and commented that the participant preferred to avoid socials for registering. P8 appreciated the inclusion of pronouns in the registration form but would further in the process have preferred an example of what to write in the "Intersectional identity" open text field.

Opinions diverged concerning the website's perceived utility based on initial impressions. P7 expressed scepticism "*In general, I am not a big of things made for us who are 'easily discriminated', but if this covers a need where it feels safer and easier, then I could be positive*", pointing out how this could be more excluding than including. P8, on the other hand, perceived potential value and could consider DiversIT helpful; "*I can find people based on similar interests and I can learn from them*". Both came with important suggestions, regarding safety and security. P7 articulated the need for sensitivity in this space, noting that previous experiences may disincline users from being open. P8 proposed including a privacy statement, information on who is behind the website, and a code of conduct to alleviate these concerns.

Overall, the participants demonstrated that the website was easy to navigate. P6 found the website purposeful, user-friendly, and easy to navigate, aligning with Norman's design principles [70, 77]. P5 underlined this by complementing the design aesthetics and intuitive UI. However, P6 and P8 stated that the front page came across as overwhelming, suggesting incorporating features such as hiding information behind buttons and making sure that information was not halfway visible at first glance due to long pages.

In Iteration 1, the *Community* was only accessible to those who were logged in, while *Articles* were open to all. P5 felt that this restriction was reasonable. The fact that the *Community* was restricted to only those with an account was fair enough, P5 expressed. The implementation to navigate the user to an alternative, informing *Community* page when not being logged in, had a positive effect on the website's usability.

Another observation made during the test was when P6 tried to access the profile page, which did not exist, by clicking the profile picture. In this iteration, there was no functionality to show the profile or for logging out, which was experienced as a constraint.

P5 saw the potential in DiversIT as a useful supplement to other initiatives for sharing experiences, an opinion supported by P6 if the website is marketed towards the target audience. P7 recognised the prototype's potential if it achieved user engagement, serving as a platform for support and inspiration. However, P8 expressed scepticism about the website's novelty and questioned its capacity to affect change in the larger CS community.

5.3.5 Iteration 2

Due to time limitations between Iterations 1 and 2, only a few improvements were made to the prototype. Feedback suggesting improvements not implemented during this iteration was added to the product backlog. The updated product backlog is presented in Table 5.5. Design for universal accessibility is a limitation with Figma as one participant with a dis/ability could not test the prototype in the same manner as the others. PBI3 will be kept in the product backlog to suggest focusing on the topic when the prototype is coded into a final working product.

Table 5.5: Product backlog after Iteration 2.

ID	Issue
PBI1	The user should be informed about the security of the website and how the data is stored.
PBI2	There should be a possibility for the user to be anonymous.
PBI3	Focus on universal design for accessibility.
PBI4	The front page should be reorganised to make it clearer to read and state how DiversIT differs from other similar platforms.
PBI5	A code of conduct should be added to the website.
PBI6	Information about who is behind the website should be added.

One of the participants from the usability test experienced constraints when pressing the profile picture in the header. The participant expected to see the user profile, but there was no functionality for this yet, signifying low affordance. The expected functionality was added in Iteration 2. Figure 5.15 illustrates this added functionality when clicking the profile picture. A popup appears as feedback to the interaction showing the user's profile. The user can here decide whether to publicly show the written intersectional identity to others in the *Community* or not. This improvement was added to motivate people to participate in the *Community* even if they were uncomfortable sharing all their information. Logout functionality was also added to the profile page, as it is critical to let the user be able to sign out. To further test this new functionality in the usability tests, task 1.4 was added to the usability test guide (see Appendix D.4), encouraging the participants to log out.

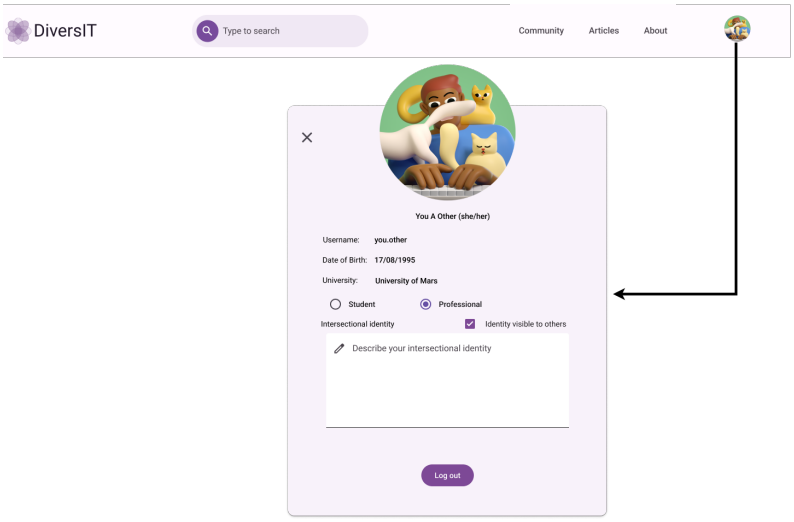


Figure 5.15: Added profile popup and functionality to log out.

The functionality to show others' profiles was also added to the prototype. When a user clicks the profile picture of someone in a prompt, then a popup appears showing the profile. Figure 5.16 illustrates this functionality. The profiles of others look similar to the user logged in, but when viewing others' profiles, then the user cannot change the fields as in their own profile.

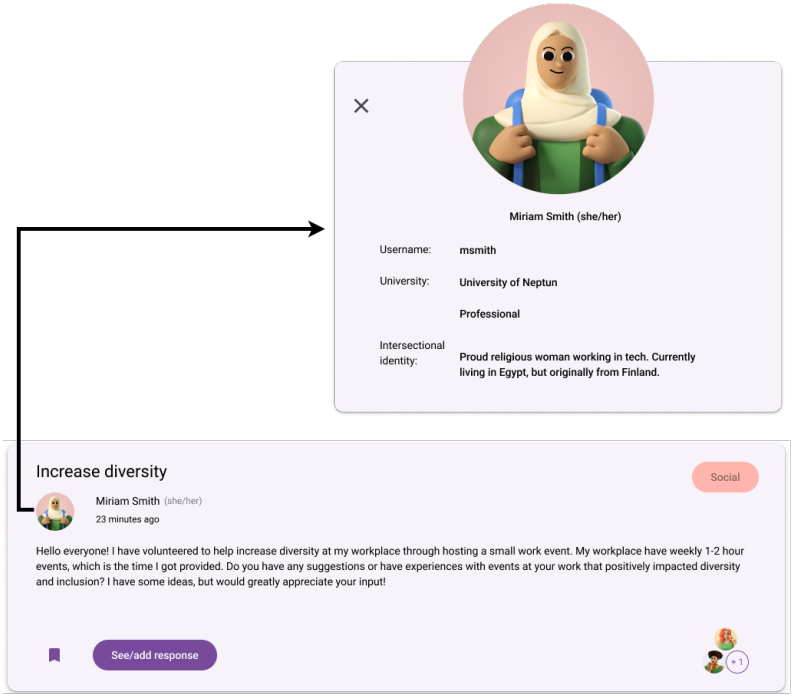


Figure 5.16: Seeing another user's profile.

5.3.6 Usability Test 3

The third and last group of participants in Norway included participants P9, P10, and P11, testing the Iteration 2 of the prototype. The initial impressions of DiversIT were generally positive among two of the participants. P9 admired the website's aesthetics and UX, commenting on its professional look. P10 felt inspired to join the community due to its appealing appearance and representation of diverse individuals. However, P11 raised concerns about the broadness of the website's target audience, questioning the feasibility of building associations with such a diverse user base. P11 further stated "*It is good that you can network with people from all over the world, but I am unsure if it is too wide. Maybe it just does not fit my needs. This might be because I am an old man.*"

P9 introduced a three-second rule, emphasising the importance of an immediate impact on a user, compelling them to explore further within the first three seconds of viewing the website. The participant suggested improvements to attract people to pause and look at the website. When P9 examined the front page more carefully, the site's purpose was clear upon reading the content.

In previous usability tests, there was feedback that having pictures and information halfway visible on the front page made it look overwhelming. P10, on the other hand, understood the functionality of scrolling due to the pictures and information only being hallway visible at the bottom of the page. P11 appreciated the site's readability, finding the font size, colours, and background contributing to a good UX. However, P11 felt the design could have been clearer because too many pictures and elements were visible simultaneously, which points back to the feedback from previous usability tests of some elements being overwhelming.

P10 demonstrated significant engagement with the prototype by independently exploring the site and performing all tasks, including creating an account and responding to prompts. The fact that the participant explored DiversIT on their own initiative is positive because it hints at DiversIT having an engaging UI and being an appealing concept, supporting the prototype having high usability.

In contrast to this, P11 struggled to locate the prompts in the *Community*, in task 1.3. In the process of creating an account, P11 was confused about why the LinkedIn button appeared on the second page when the participant had not chosen to use LinkedIn. Furthermore, identifying which buttons were clickable was also an issue. Another observation made during the usability test was that P10 was confused with whether the prompts in *Community* were only from friends they had on DiversIT, or if this was a feed showing prompts from everyone. All of these observations indicated that DiversIT still had instances of low visibility, consistency, and affordance.

Reflecting on the potential impact of DiversIT, P10 thought that the website could have helped the participant to earlier get motivated to battle for diversity in CS without the underlying fear concerning how boys would react. P9 was also optimistic, stating "*I think it has potential because it could be used to generate better professionals, and having more skills as professionals break barriers.*" He also reflected on the use of topics in the *Community*, suggesting that there should be subcategories of the topics to organise the posts more easily. P9 also stressed the need for increased visibility of intersectional issues, believing that current challenges are causing missed opportunities.

5.3.7 Iteration 3

Suggestions for improvements from the third usability test and issues from the product backlog were added to Iteration 3.

Previous feedback was conflicting related to if the front page was clear or not. In an attempt to make the page less overwhelming, the half-visible information on the page was moved further down, to give the front page a clean look at first glance. This change made more information visible only when scrolling. Since some commented that this half-visible information indicated to the user that there was a possibility to scroll on the page, an arrow pointing down at the bottom of the page was added to increase the affordance and visibility of the functionality.

Figure 5.17 shows the new front page. Based on the changes made, the user will hopefully get the impression that it is a tech-peer community. The only visible text box is "Create a network with tech people in your area and around the world", which enhances the probability of the user focusing on this aspect to decide if DiversIT is a website to explore more or not. Based on feedback from different participants regarding the amount of text and illustrations, the researchers concluded that the ratio of illustrations and text was okay since they together help illustrate different aspects of DiversIT. Therefore, having sufficient informative text, was a priority in this design. However, it was pointed out that when including illustrations and images, utilising a universal design [81] is important to also ensure accessibility, e.g., alternative text for illustrations, but this is not possible to implement in Figma.

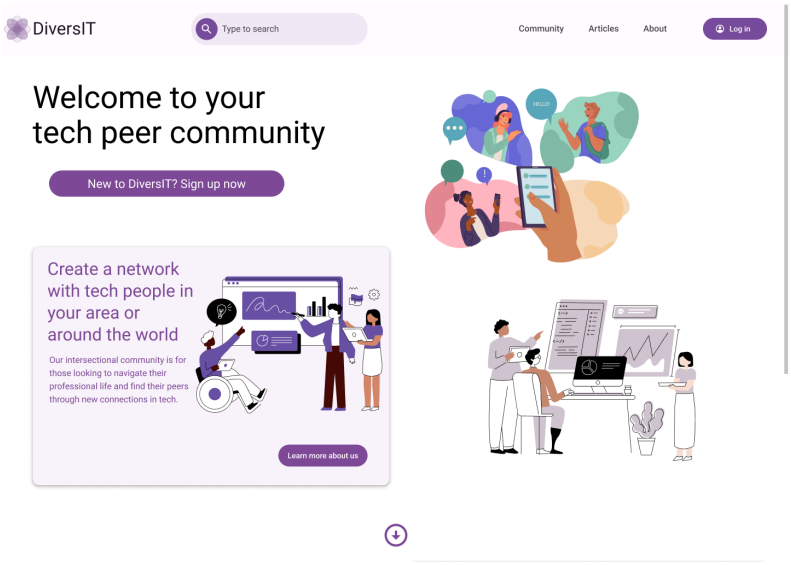


Figure 5.17: Updated front page for a clearer first impression.

One of the participants needed clarification when registering a new account. According to the participant, an unnecessary button was visible, giving the user the option to "Connect with LinkedIn" even though the user wanted to register without using other social platforms. For Iteration 3, this LinkedIn button was removed at the second step of creating a new account to reduce the confusion. The new popup frame for this step is presented in Figure 5.18.

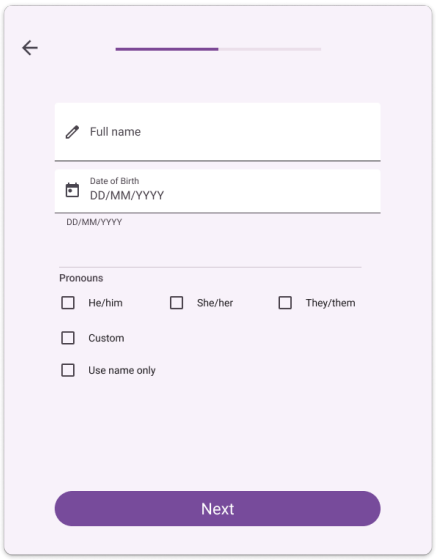
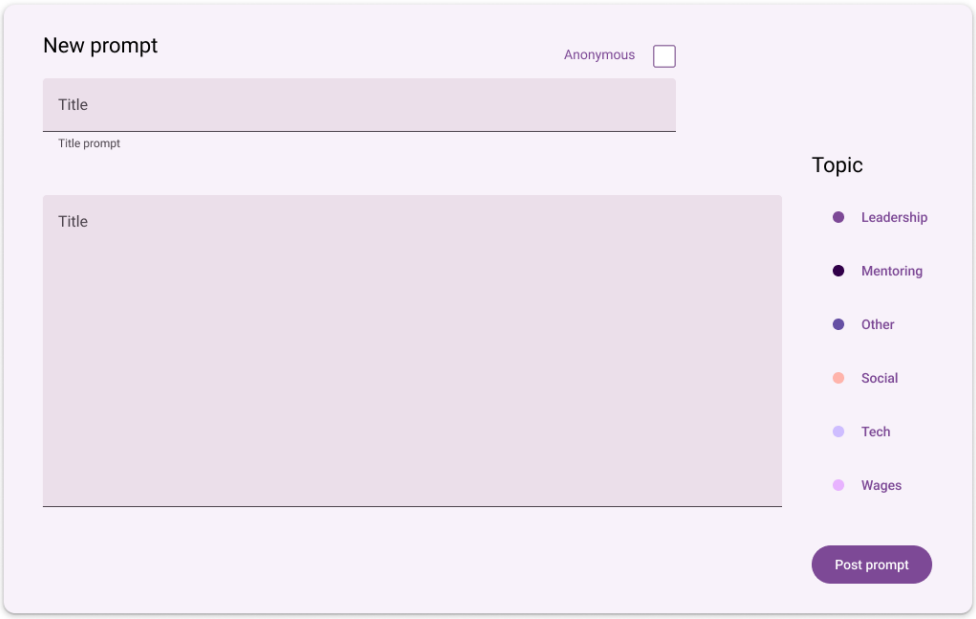


Figure 5.18: LinkedIn button removed at the top of the popup in create account.

From the first usability test, the question of anonymity was addressed. A checkbox was added as an option, as illustrated in Figure 5.19, to allow the users to be anonymous when posting a new prompt or responding to an already existing prompt. The default mode was not checked, as DiversIT wants to promote intersectionality by being open in a supportive network. There is an understanding that some users can be uncomfortable posting vulnerable information. Still, hopefully, by adding the opportunity to be anonymous, more people can get comfortable sharing their experiences and challenges.



(a) Anonymous checkbox when posting a new prompt.

(b) Anonymous checkbox when adding new response.

Figure 5.19: Option to post anonymously.

There was suggested to add a code of conduct to DiversIT, as this is common on many forum pages. Figure 5.20 presents the added code of conduct. The page can be found by pressing the "Code of Conduct"-button in the footer.

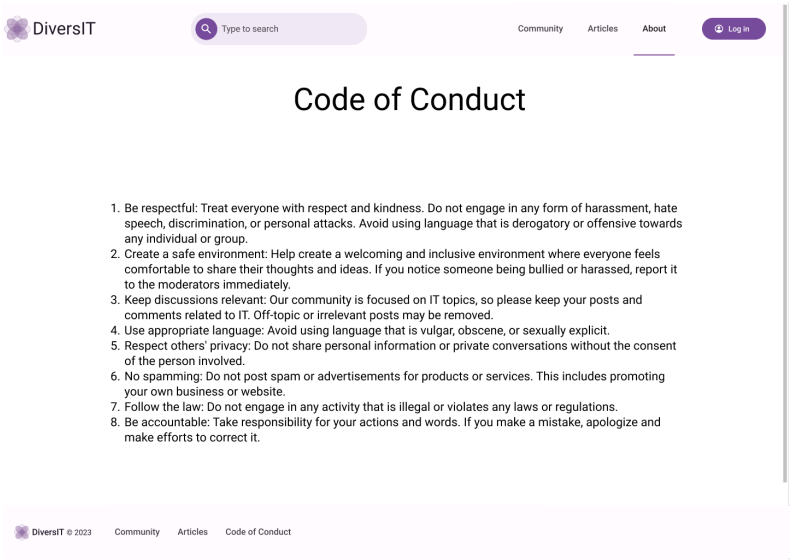


Figure 5.20: Code of conduct for DiversIT.

Based on feedback, it was unclear on the *Community* page which elements were clickable buttons and which were not, which conflicted with Norman's design principles of visibility and consistency [70]. The buttons on the left menu page were updated in this iteration as presented in Figure 5.21. The labels for each prompt, showing the prompt's topic, got an updated design to ensure consistency, affordance and memorability.

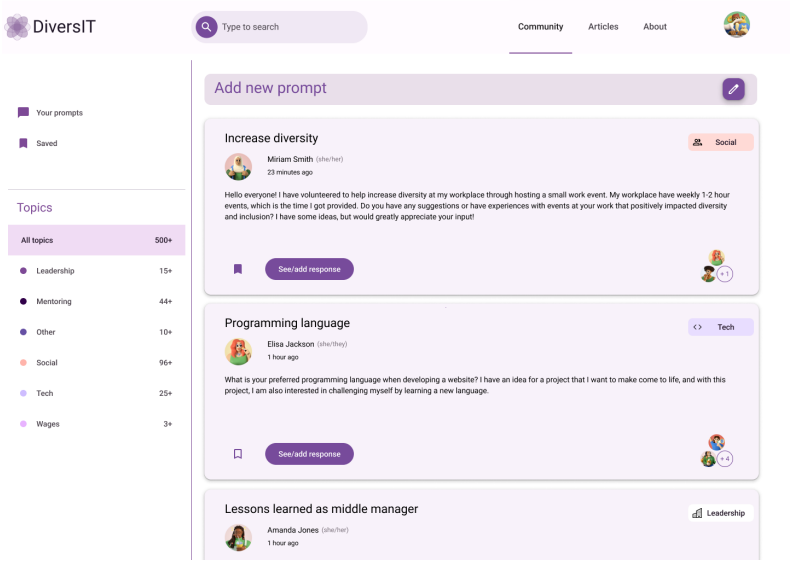


Figure 5.21: Clickable buttons in the menu and topic labels for prompts updated.

The updated product backlog is presented in Table 5.6. Multiple issues were removed from the previous version and implemented in this iteration. PBI7 was added as a new issue, but not implemented in the prototype since this is more relevant for scalability in a fully functional website, rather than in a Figma prototype. It could be added to an up-and-running DiversIT with many accounts and prompts, but designing more subcategories at this stage would not impact the scalability of DiversIT. Therefore, the authors deemed this issue as something that could be implemented in future work.

Table 5.6: Product backlog after Iteration 3.

ID	Issue
PBI1	The user should be informed about the security of the website and how the data is stored.
PBI3	Focus on universal design for accessibility.
PBI6	Information about who is behind the website should be added.
PBI7	There should be subcategories for the topics.

5.3.8 Usability Test 4

The fourth and final iteration of usability tests was conducted in Brazil, involving six participants, P12, P13, P14, P15, P16, and P17, examining Iteration 3 of the DiversIT prototype. The initial impressions were largely positive. P12 and P17 admired the design; "*I love this design. I desire to explore, and it gets me involved with it.*" (P12). P13 understood the website as a space for people from diverse backgrounds, as evidenced by the inclusive illustrations. P12 and P14 highlighted the website's potential for providing a variety of perspectives from different countries. P14 and P17 viewed DiversIT as a community-building tool, with P17 noting its role as an information source about the intersectional peer community.

P13 reflected that DiversIT is a place where the participant can learn. When navigating to the *About* page by clicking the "Learn more about us"-button on the front page, the participant was confused about who "us" were. While exploring the site, P13 appreciated the availability of articles even for unregistered users, and P15 found it interesting to see what others had contributed. According to P17, DiversIT is a place to get inspired. While still not being logged in, P13 and P17 provided positive remarks about the *Community* page (see Figure 5.12). To increase curiosity related to the *Community* to make people sign up, P17 suggested adding a screenshot of a logged-in version of the *Community* to show the users what to expect when being logged in.

Three of the participants tried to use the search functionality in the header when being on the front page. P13 and P15 commented that they did not know what it was for, and because of this, did not consider the search bar as an intuitive

functionality. This indicates a lack of affordance and effectiveness in the design. P14 and P16 were confused by the non-clickable labels under "Content Topics to Explore" on the front page. The labels were updated in Iteration 3 to not be confused with buttons, but the new design was not updated on the front page, confusing the participants because of a lack of consistency.

P13 appreciated that the sign-up is a popup, not a separate page, and commented that the registration process was quick and easy. During registration, P12 appreciated the possibility of signing up with LinkedIn. Further in the registration process, P13 thought it was great with pronouns as an option not to assume things about people, which P14 also commented on as a great feature. These comments indicate that the registration process showed elements of the UX goals effectiveness and utility. However, the participants also pointed out issues, which showcased poor consistency, affordance, and visibility. The top button in the popup, when creating an account or logging in, confused P15 as it both looked like a button and a heading. P17 got confused about this same button and suggested that the button's placement should be below the text input fields. The button in the prototype hid the progress bar that appears on the next popup pages. The fact that this progress bar did not start at zero per cent when first appearing confused P17.

P12 executed task 1.3 without a problem and stated that the process was intuitive. P16 also agreed with this, although the participant found the *Community* to be a bit confusing before logging in, but more evident after. When posting an answer to the prompt, P13 actively chose to use the functionality to be anonymous, which P14 also commented on. P13 could personally see himself asking questions and answering in the *Community*. At the same time, P16 was more sceptical of the possibility of being anonymous; "*I don't know if it's good to have the option to be anonymous. It seems contradictory to the site's purpose.*" (P16). P14 was critical to the number of prompts the *Community* possibly could contain; hence it could be hard to find specific prompts when there are many users. P14 further reflected that the existing functionality for saving prompts is suitable for structuring the information overload when having many users.

When asked if they wanted to join DiversIT, P12 expressed interest, while P13 and P17 were interested with the condition of getting recommendations or the site's popularity. Regarding DiversIT's potential to increase DEI, P12, P13, and P16 voiced positive opinions. "*Yes, I love it. I like the design, and I think it is intuitive. I like the possibility of reading the articles and the chance to be or not be visible to others.*" (P12). "*I feel that this is professional, and the users can communicate in an accessible way.*" (P13). P16 agreed that the concept presented through the prototype has potential as "*[m]any people with intersectional factors (e.g., gay) look for peers online. When you can talk with people who understand, it's easier, compared to having to explain to people*" (P16). The participant thought that DiversIT looked like a social network for people in tech to find others in CS and aims to be more inclusive. P16 further commented on *Articles* as a positive feature, which can show

different experiences, such as mental health or diversity in CS education. However, P15 was uncertain about DiversIT's value on its own, and saw it more as a blend of LinkedIn and Twitter, suggesting the concept needed differentiation from existing social media platforms. P16 also suggested an improvement to the prototype, to make it available in different languages and translations, "*[t]ranslating would make this page more accessible and available to more people.*"

5.3.9 Iteration 4

The final prototype was completed in Iteration 4. Improvements implemented to the prototype based on feedback from Section 5.3.8 are presented in the first part of this section, while the entire prototype is presented in the rest of this section.

Improvements Done After Usability Test 4

The participants found it confusing whether or not the labels on the front page under "Content Topics to Explore" were clickable buttons. These labels represent the same labels found in the *Community*, which were improved in the previous iteration, but were not updated with the new design on the front page. In this last iteration, these were updated as shown in Figure 5.22, to make the design of the labels similar to those in *Community* and achieve consistency as one of Norman's design principles [70]. Other improvements done to the landing page of DiversIT were removing the search bar on this page and reformulating the text on one button from "Learn more about us" to "Learn more about DiversIT".

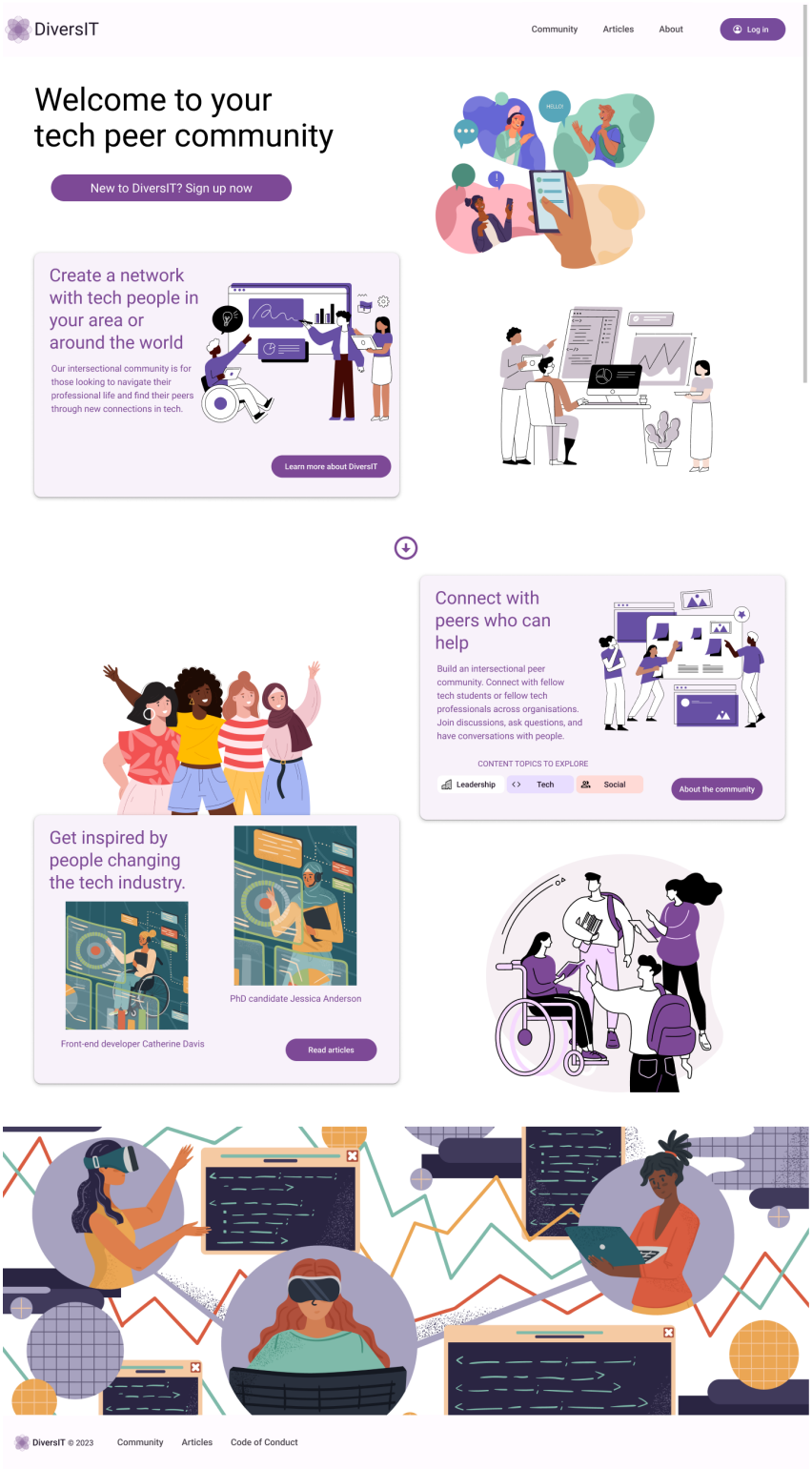
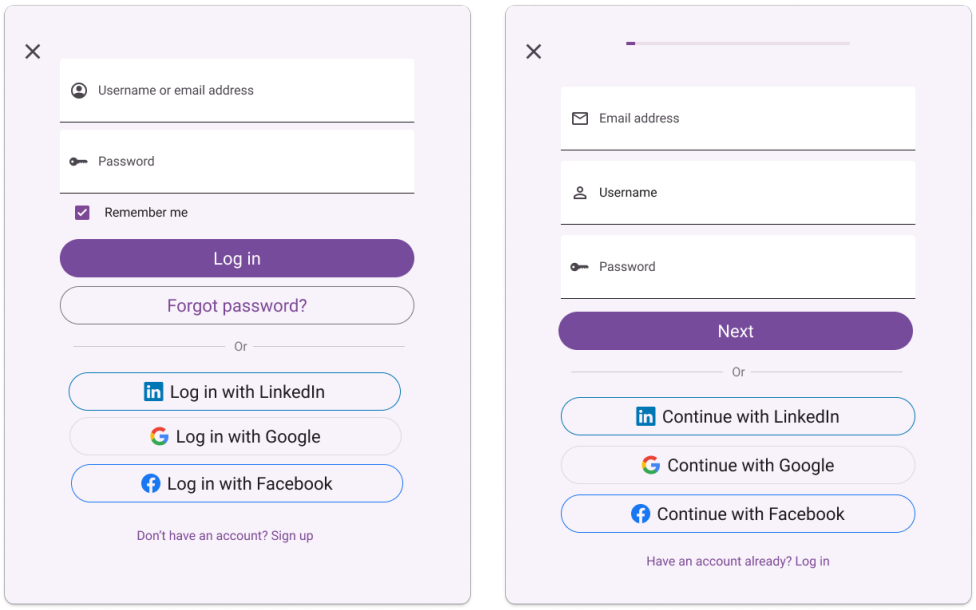


Figure 5.22: Improved front page based on feedback from Usability Test 4.

The first page of the popup for registration and login was updated in this final iteration, as shown in Figure 5.23. The top buttons to change between the states of sign-in and sign-up were moved and changed to smaller text links, following the design of other known websites where a user has to create an account, increasing the consistency of DiversIT. As creating a new user is a process with multiple steps, the progress bar was added to the first popup page in addition to the existing pages of the process.



(a) Updated login popup. **(b)** Updated first popup of create account.

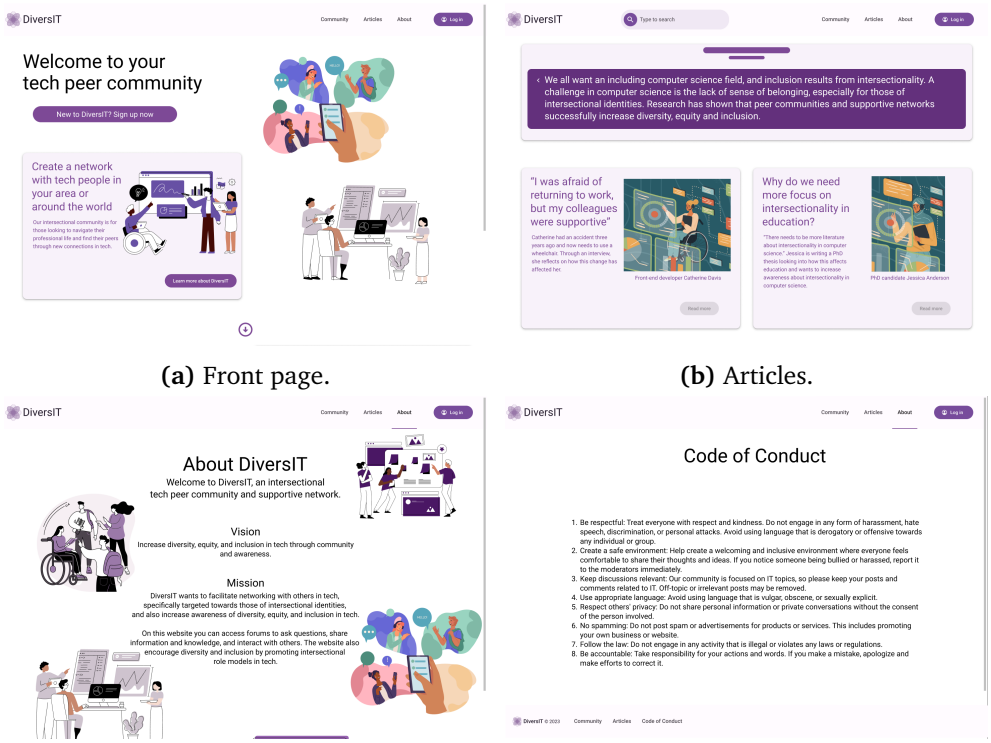
Figure 5.23: The top button was moved and replaced with the progress bar.

There were no new elements added to the product backlog. The product backlog after all prototyping iterations are presented in Section 5.3.7 in Table 5.6

The Final Prototype

DiversIT aims to increase DEI in CS by creating a supportive intersectional community online where peers worldwide can communicate, ask questions, discuss topics relevant to the field and be supportive of each other. With a focus on intersectionality, the researchers want to express a website that is welcoming and appealing to individuals of intersectional backgrounds by showing diversity in the illustrations and example prompts presented in the prototype. The high-fidelity Figma prototype aims to test DiversIT as a concept to be further coded and developed.

Figure 5.24 presents an overview of DiversIT. The first page a user sees is Figure 5.24a gives the user a first impression of the website and its functionalities. The user can scroll down the page to read more information in the text boxes. Figure 5.24b shows the *Articles* page. Here the user can read articles from the field where role models of diverse backgrounds will be presented. Based on the findings from the SLR [19, 20] and the conducted interviews, role models whom people can identify with, especially intersectional role models, are essential. The *Articles* page tries to assist in this, in addition to motivating, engaging, and raising awareness of intersectionality. A separate *About* page was added to DiversIT not to overwhelm the user with information on the front page. Figure 5.24c informs the user about the vision and mission of DiversIT. As a prominent part of DiversIT is a *Community* where the users can interact with each other, Figure 5.24d was added to the prototype, informing the users about the code of conduct for the website. All pages presented in Figure 5.24 are accessible through links on the front page, the header, or the footer.



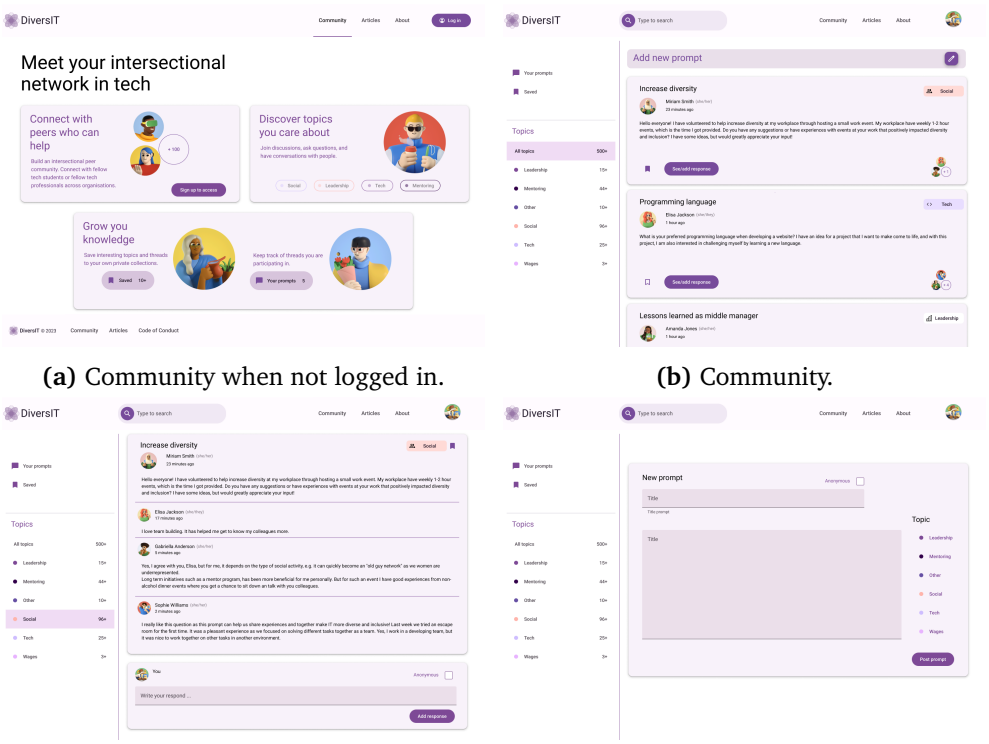
(a) Front page. **(b)** Articles.

(c) About. **(d)** Code of conduct.

Figure 5.24: An overview of the prototype.

As mentioned, the *Community* part is an essential factor of DiversIT as a prototype. Figure 5.25 presents the *Community* where the logged-in users can interact with each other. As the *Community* is only visible to those who have registered an account, Figure 5.25a provides a user who is not logged in with information about

what the user can expect when logging in without sharing any prompts of existing users. Figure 5.25b presents the *Community* when the user has logged in and has full access to it. All the prompts are grouped into different topics, which work as a filtering system to easier find relevant prompts. A user can also save a prompt for easier access at a later time. By clicking on the "See/add response"-button, the user navigates to Figure 5.25c, where the user can read responses made by other users and contribute to the discussion by adding a response. A user can also add a new separate prompt by clicking the "Add new prompt"-button in Figure 5.25b, navigating to Figure 5.25d.



(a) Community when not logged in.

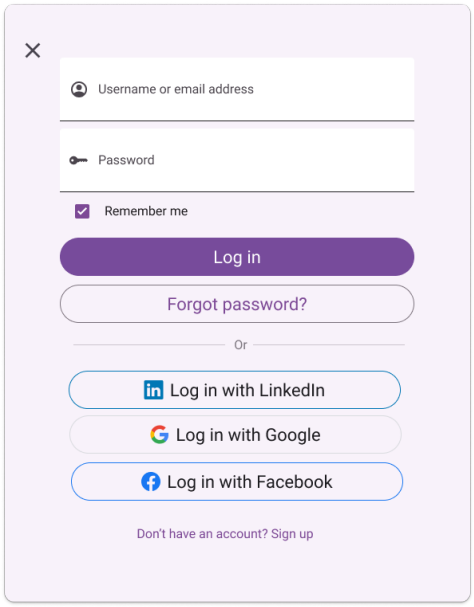
(b) Community.

(c) See and add responses to a prompt.

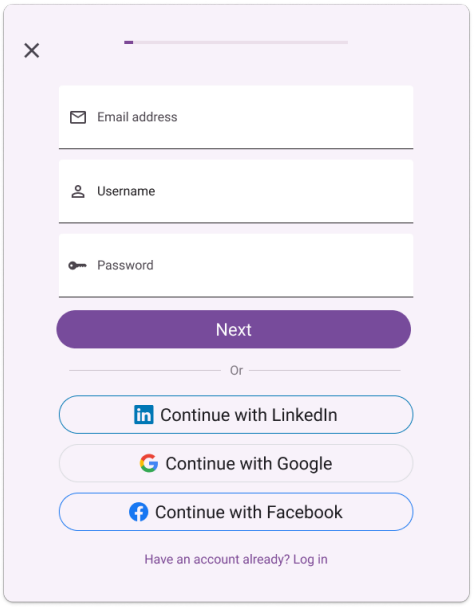
(d) Add a new prompt to the Community.

Figure 5.25: Overview of the Community.

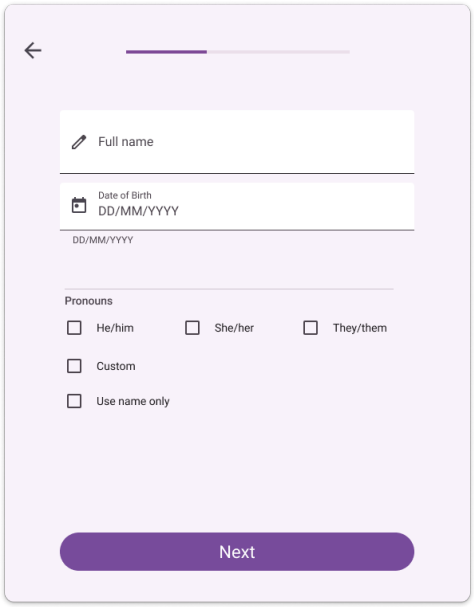
This process of logging into DiversIT is presented in Figure 5.26. Users can log in through the popup shown in Figure 5.26a using their username and password or using third-party accounts. If a user does not already have an account on DiversIT, the user can navigate to Figure 5.26b, the first step in creating an account. Step 2 and 3 in the process is presented in Figure 5.26c and Figure 5.26d.



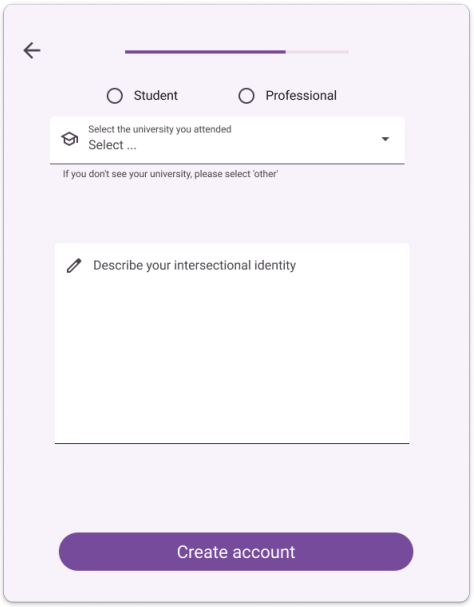
(a) Login.



(b) Create an account step 1.



(c) Create an account step 2.



(d) Create an account step 3.

Figure 5.26: The process of logging in or creating a new account.

An interactive demo of the final prototype can be found in Figma[1].

[1] https://www.figma.com/DiversIT

Chapter 6

Discussion

This chapter discusses and evaluates the findings from the design and creation process presented in Chapter 5. Section 6.1 discusses findings from the interviews related to RQ1 and RQ2, looking at challenges and success factors in relation to intersectionality in CS. DiversIT, the prototyped website, is evaluated and discussed in Section 6.2 based on findings from the usability tests. Lastly, a review of the limitations of this research is presented in Section 6.3, and the implications of this research and practice are presented in Section 6.4.

6.1 Challenges and Success Factors Related to Diversity, Equity, and Inclusion in Computer Science

The CS students and professionals that participated in the interviews in Norway and Brazil shared their different experiences in relation to intersectionality in CS. Through the analysis of the interviews conducted in this thesis, the importance of DEI came across as essential in creating an environment in CS where every voice has a space. Furthermore, these experiences shared illuminated the nuances and complexities of intersectional identities from different cultural and societal perspectives, uncovering that transformation at an interpersonal and systemic level is necessary for CS to align with the SDGs [4, 31–33] by 2030.

It is important to preface that the participants did not relate to any type of victim mentality, nor did they believe that every part of the current CS culture is inherently bad. However, they acknowledged that there exist systemic and interpersonal barriers that may have negative implications for certain intersecting identities in their access to opportunities in CS, and talked about DEI to create technology for everyone.

6.1.1 Identified Challenges

The main challenge found was a lack of sense of belonging related to bias, discrimination and harassment, which also could lead to feelings of isolation and self-doubt. Regardless of intersectional identity, most of the participants had experienced different accounts of bias, whether it be implicit or explicit bias, that had some negative implication on their studies, career, or general scope of opportunities in the CS field. In Norway, this was most common in the form of implicit bias, whereas in Brazil, participants shared more examples of explicit bias. Many of the examples were related to not fitting the stereotype of who a computer scientist is. This was reflected in the analysis from both Norway and Brazil in that most individuals, regardless of intersectional identity, who were not perceived as "fitting the CS stereotype" had to work more to get access to the same opportunities as their peers who "fit the stereotype". Examples shared were not being offered the same salary for doing the same work as their peers, being given easier tasks or administrative tasks, or not being seen as a valuable member of the team. Having to continuously prove that you belong in CS to get the same validation as those deemed to be in the dominant group was also an issue found in the literature [5, 6, 53, 57, 59, 63]. Although not all participants had experienced this themselves or had only experienced it at certain points in their CS journey, this was still a significant finding from the interviews. Having to prove their competency as a byproduct of bias resulted in, e.g., overworking, self-doubt, and feelings of imposter syndrome. Some experiences shared were: the feeling of needing to be an expert on a topic to discuss it with their team, but even when being the expert, one might still get dismissed and undermined; or that if one could handle a technically challenging workload, they should also be able to take on extra administrative responsibilities.

The participants also highlighted that mental health should be more widely discussed in CS since overworking is a rising issue that may disproportionately impact marginalised people in the field due to the different challenges discussed. This is further supported by the fact that mental health was not fully acknowledged as an intersectional factor in the figure adapted from the UN [4] or in the framework by Sánchez-Gordón *et al.* [22] (see Section 2.1). For example, a lack of belongingness in the field could, in some cases, lead to mental health issues, and having to continuously prove your competency could result in burnout. However, mental health does not only encapsulate issues regarding psychological safety but also people with mental health conditions. Having more openness about general mental health will also promote more understanding towards neurodiverse people and people with mental health conditions in CS.

In Brazil, multiple participants reported having to work alongside their studies due to their socioeconomic status. For some, this was critical as they had to support themselves and their family financially. One participant stated that this affected their school performance and mental health, but the participant did not

have any other choice to make ends meet. On the other hand, in Norway, working while being a student was only discussed in terms of internships to gain practical work experience, but the issue of money was never brought up. Thus, class and socioeconomic status is a factor that is more prevalent in Brazil, which also may have a greater impact on who has access to pursuing CS in higher education and later career.

In Norway, some of the participants discussed diversity quotas, a government measure that requires companies to have diverse hiring, which most of the participants saw as a negative measure. This was due to the fact that "being hired in a quota" feels like an erasure of skills and value the individual actually brings to the company. Statistically, however, statutory quotas have had a significant positive effect on diversity in Norwegian companies [82], since in most cases, due to implicit bias, anyone perceived as belonging to a marginalised group would have less probability of being hired even when having similar or better skills than others. More diversity also positively impacted them and their peers, pointing out that, e.g., people that had been working in CS for a long time were positive to this change and saw it as an asset. Furthermore, positive bias in combination with hard work did provide some participants with opportunities that may not have been available had it not been for their intersectional identity and the increased focus on diversity in different CS companies.

Nevertheless, diversity is not equity and inclusion, and Seierstad *et al.* [82] stresses that diversity quotas only is a stepping stone for change; cultural change in organisations is essential to reach DEI. There needs to be an inclusive culture and a supportive network that respects individuals from different backgrounds. A workplace that also prioritises equity and inclusion is more likely to attract diverse applicants to their teams, which leads to higher productivity, more innovation, and a better understanding of the final user's needs [83]. Since inclusion is a byproduct of intersectionality [3], implementing intersectional approaches in CS could be the next step in promoting cultural change and helping eliminate biases that create barriers for people of different intersectional identities.

In order to reach the targets of SDG 4, 5, and 10 [4, 30–34] (see Section 2.3), it is important to recognise the impact of broader societal issues on individuals' experiences and work towards creating a more supportive and inclusive CS field for everyone. The challenges discussed in the interviews support the findings from the SLR [19, 20], that CS is not a meritocracy, and biases from society do indeed negatively impact the field. Additionally, the different interview findings also highlight the importance of looking at intersectionality in CS in different cultural contexts to fully understand its complexities since challenges are slightly different in each country.

6.1.2 Identified Success Factors

The main success factors found were having a supportive network, role models, and being in a diverse environment, which increased the sense of belonging, intrinsic motivation, and well-being. The participants emphasised that CS is a highly collaborative field, and working with people and creating solutions for people is one of the main aspects of CS. This also aligns with the findings from the SLR [19, 20], where having a strong sense of belonging was an essential success factor for people of intersectional identities in CS in relation to retention in the field and mental health [3, 5, 6, 54–58, 60–62, 64].

The participants mostly found role models in their CS community; examples mentioned were peers, professors, management, and executives. Having intersectional role models, someone that shared a similar identity and experience, was seen as highly valuable by the participants that had experienced it. This was especially important in the cases where the individual did not see themselves represented in the CS field. Overall, finding role models, whether it was based on intersectional identity, technical skills or both, was important to increase the sense of belonging, which also helps maintain individuals' authentic professional identity [62].

Having a supportive peer community was the most important factor for retention in CS. Since teamwork is an essential part of CS, a supportive peer community covers both the social and work aspects of studying or working in CS. Changing the workplace was a common solution when lacking this sense of community from a professional's perspective. However, for students, not having this sense of community and belonging with peers was more likely to result in dropping out, which then continues the cycle of having a lack of diversity in CS.

Realistically a big shift in CS will not happen instantly but gradually over many years. Being aware of this, the interviewees also suggested different tools they found helpful in promoting both peer community and authentic professional identity. Mentorship programs were one suggestion, although experiences with this were mixed. Mentorships were mainly seen as a possible tool that could be useful for students and CS professionals in their early careers, which also aligns with findings in the SLR [6, 54, 57, 59, 61, 62]. Most were also positive to initiatives that promoted peer and professional networks, such as conferences, initiatives across different workplaces or departments, internships; where students get to build skills and create new networks with peers and professionals; and other measures where intersectional communities in CS were in focus.

However, an issue with both formal mentorships and networks is that they are not necessarily available to everyone, either because there is a selection process or because these initiatives do not exist in their local community. Therefore, informal peer networks were found to be the most valuable to all participants. This provided an organic sense of belonging by creating a unique intersectional com-

munity of support; consisting of peers, friends, and role models. Nevertheless, informal networks, especially in the context of intersectionality in CS, maybe even more inaccessible since this assumes that there already is a diverse study or work environment, which according to both the interviews and the SLR [19, 20] is not usually the case in CS. When the participants were asked about their thoughts on the development of a supportive networking prototype, they were positive about the idea overall. This supports the researchers' decision to go further, through the design and creation strategy, in developing DiversIT, a website for intersectional supportive peer networks. The fact that supportive networks were significant in both the SLR and the analysis supports that a web platform also has potential in the market.

6.2 Evaluation of DiversIT as Digital Support to Increase Diversity, Equity, and Inclusion

In the prototyping stage of design and creation, DiversIT was developed in five iterations, with usability tests conducted after each design sprint. Each iteration and the results of each usability test are presented in Section 5.3.

Findings from the interviews, discussed in Section 6.1, underline how a supportive intersectional peer network [62] strongly correlates to a strong sense of belonging, indicating that there is a potential market demand for DiversIT as a digital product. During the interviews, the participants were generally optimistic about the idea of a networking platform, and the majority remained positive about the concept after interacting with the prototype during the usability test. These findings indicate the potential of DiversIT to help strengthen DEI within CS.

Despite the generally favourable impressions of the prototype, some participants were more critical of the website. Notably, those who reported fewer intersectionality related challenges in the interviews tended to be more critical of DiversIT. On the other hand, participants who experience challenges related to their intersectional identity seemed enthusiastic about DiversIT, envisioning themselves as regular users. As one participant stated, it can be hard to develop a product tailored for everyone, as the target group is wide because intersectionality varies greatly. Therefore, as the majority liked DiversIT, it could be considered a valuable product for further development.

In the first usability tests, participants focused more on the website's functionality, noting that the site's purpose was not immediately clear. The prototype was subsequently improved through multiple iterations and feedback from the usability tests, resulting in a better high-fidelity prototype than the one presented in Iteration 0. As a testament to this improvement, later usability tests garnered less negative feedback regarding the website's purpose, indicating enhanced usability.

Introducing a new product like DiversIT to the market does come with some challenges. Regardless of whether the participants saw themselves using this product or not, the participants provided useful feedback on the design and future technical aspects that are important to consider. Some of the participants drew parallels between the tested prototype and LinkedIn, while others viewed it as a unique concept due to the focus on intersectionality and DEI. It was noted by the participants that successful marketing of a new peer network could be challenging, especially since a community requires active user engagement for its success. Furthermore, following universal design principles and the Web Content Accessibility Guidelines (WCAG) standard [81] to assure that the website is perceivable, operable, understandable, and robust; also follows the quality attribute accessibility, which is essential for usability across different intersectional identities.

The prototype underwent testing in Norway and Brazil, facilitating space triangulation that provided feedback from users with different cultural backgrounds and perspectives, which helped identify potential usability issues and areas for improvement. Having such geographical diversity in the testing also helped in evaluating the adaptability of the product in different environments, which is essential as DiversIT want to create a networking platform connecting peers in CS who identify with intersectionality from all over the world. Although space triangulation was time-consuming, its significant benefits made the researchers want to prioritise it, since it can lead to a better-designed prototype that meets the needs and expectations of a diverse range of users.

6.2.1 Evaluation Based on User Experience Goals

In alignment with the UX goals presented in Section 4.2.5, the prototype demonstrates effective interaction design. Following, is an enumeration of the desirable aspects achieved based on the observations and feedback from the usability tests:

- **Engaging**: DiversIT came across as engaging for the participants, where multiple participants explicitly expressed that the provided information made them want to interact with the website.
- **Helpful**: Based on the impressions from the participants, the website came across as helpful. DiversIT can be divided into two main parts; the *Community* and *Articles*. The *Community* works as a supportive network to help those who feel a connection to intersectionality increase their sense of belonging. The *Articles* provides articles to inspire and help increase the awareness of intersectionality in the field.
- **Motivating**: The users can find motivation from other users in the *Community* or by reading articles.

- **Enhancing sociability**: The website provides an increased sense of belonging through the *Community* and the articles promoting diverse, intersectional role models.
- **Cognitively stimulating**: DiversIT can come across as cognitively stimulating as the users may discuss challenges related to CS and intersectionality in addition to reading articles.
- **Provocative**: Articles are thought to be provocative and inspiring.
- **Emotionally fulfilling**: The participants expressed engagement over the website due to its focus on DEI. The users can contribute positively to an online community.

In contrast, the potential undesirable aspects and associated risks to DiversIT include:

- **Frustrating**: Some participants expressed that the website was difficult to understand, but this was improved through multiple iterations.
- **Making one feel guilty**: It was commented that sensitive information may be difficult to discuss online, and intersectionality revolves around sensitive information.
- **Unpleasant**: As the website handles sensitive information, the website could feel unpleasant or unsafe to use, and therefore a code of conduct was added to the prototype.
- **Patronising**: This could occur if a user does not feel supported in the *Community*.

By evaluating the desired and undesired aspects, the developed prototype comes across as a website with good interaction design. However, in further development of DiversIT into a fully functional website, it is crucial to remember that the website handles sensitive data and acknowledge the risks this brings.

6.3 Limitations

A limitation of the SLR was that the search query only searched for papers with the keyword *intersectionality* in the Scopus database. As a result, any papers that addressed intersectionality in CS without explicitly using the term in the abstract, title, or keyword were not included in the search results. This may indicate that the term intersectionality is predominantly used in the US at the time of writing this thesis. Furthermore, only performing searches in Scopus, although this is one of the world's largest literature databases, may also have limited the number of papers found.

The greatest limitation regarding the interviews was that they needed to be held in English. In Norway, some of the participants asked to conduct the interview in Norwegian, and since both researchers also speak Norwegian, this was not an issue as it made the interviewee more comfortable. However, the quotes from these interviews had to be manually translated by the researchers after being transcribed. This could have introduced some unintentional bias since the researchers had to interpret the essence of what the participant was saying, in order to properly translate the quotes to English. In Brazil, there was a language barrier, since none of the researchers spoke Portuguese, and therefore, could not help if a participant struggled with expressing themselves in English. To minimise the barrier as much as possible, the researchers got assistance from a person in Brazil who spoke Portuguese and English and could help during the interviews. Since the interviews potentially discussed sensitive topics, each interviewee was asked prior to their interview whether they wanted additional assistance from the person who spoke Portuguese. According to Oates *et al.* [50], the interviewers need to make a comfortable and supportive environment for the interviewee to help minimise stress as this can increase the chance accurate and useful information is provided.

Other possible limitations identified during the interview and usability test sessions, were stress caused by time constraints and interruptions, affecting the researchers and the participants. In Brazil, the researchers did not have full control of the room used to execute the interviews and usability tests. This was noticeable during one interview in particular, where multiple people entered the room and interrupted the session. Every time someone interrupted, the interview was paused, but these interruptions happened outside the researchers' control. This resulted in significantly less time to complete the interview and usability test as planned, and the participant was noticeably stressed in the situation.

A limitation related to using Figma as a tool for designing the prototype for DiversIT is that users cannot write in input fields within the prototype. Through the usability tests, this confused the participants when they e.g. tried to create an account. To reduce this limitation as much as possible, dummy text was added to the input fields when the user clicked on the fields. The limitation made it challenging to test the overall usability of the input elements. Another limitation is the fact that if the user pressed somewhere in the prototype, then it became visible where the user could click. This could potentially spoil the honest UX as it made the prototype feel less like a real application, resulting in the user being less critical of the UI. In one usability test, this was a distracting factor and took the focus away from the actual design and interactions being tested.

Lastly, this thesis does not look into perspectives from e.g., transgender and non-binary people, because no participants with these intersectional identities expressed interest. Although the findings provide some perspectives from the LGBTQIA+ community, these do not fully encompass these experiences, nor do they reflect experiences outside the gender binary.

6.4 Implication of Research and Practice

One finding from the SLR was that there is a dearth of literature about intersectionality in CS. Writing this thesis and publishing the SLR increases the awareness about intersectionality in CS and provides more literature to the field. Furthermore, this thesis also highlights that applying an intersectional approach in the CS field is an important step towards reaching the SDGs.

The published paper was presented at the GE@ICSE conference in May 2023, where the researchers got feedback on the work and could increase awareness in front of an international audience. Through the SENOBR project, the researchers got to present the thesis in April 2023 at a workshop in Manaus, Brazil. The feedback from this workshop presentation was positive and the participants thought that it was good that the DEI discussion is happening around the world.

This thesis may be the basis for forthcoming master's theses in the period autumn 2023 to spring 2024.

Chapter 7

Conclusion

In this master's thesis, the authors looked into how to increase diversity, equity, and inclusion (DEI) in computer science (CS) using an intersectional approach. The preliminary phase included an systematic literature review (SLR) [19, 20] where the authors analysed the literature related to intersectionality in CS. The SLR concluded that there is a dearth of literature related to intersectionality in the field of CS, and indicated that there is a knowledge gap on the topic at a global scale. This thesis helps fill this gap in knowledge by gathering analysed data to provide insights on how intersectionality better can be understood and acknowledged in the CS field. Interviews and usability tests were conducted in both Norway and Brazil to get a more diverse understanding of the complexity of intersectionality.

7.1 RQ1: What Are the Main Intersectional Challenges in Computer Science?

Several key themes emerged when addressing the first research question (RQ). At the core of these challenges lies the lack of a sense of belonging, often intensified by various forms of bias, discrimination, and harassment. Participants across different intersectional identities recounted experiences of explicit and implicit bias negatively impacting their studies, careers, and overall scope of opportunities within CS. Connected to these obstacles was an added pressure to continuously prove one's worth within the CS field, which could lead to overworking, self-doubt, and feelings of imposter syndrome. Participants also emphasised the need for increased focus on mental health within the CS field, indicating another challenge observed in the analysis. Moreover, the challenge of socioeconomic status was particularly significant in Brazil, with several participants having to work alongside their studies to support themselves and their families.

The main intersectional challenges in CS are complex and multifaceted, deeply embedded in societal biases and systemic barriers. By highlighting and addressing these challenges, the field can work towards a CS environment that is truly representative and inclusive, providing equal opportunities for everyone, regardless of their intersecting identities. Acknowledging the complex nature of intersectionality is critical for accomplishing DEI and for reaching the Sustainable Development Goals (SDGs), as many factors matter in defining someone's unique experience and identity.

7.2 RQ2: What Factors Are Important to Overcome These Challenges and Succeed in Computer Science?

Addressing RQ2, the analysis of the interviews uncovered several success factors and strategies that could help individuals with different intersectional identities navigate the challenges in CS, found in RQ1.

Having a supportive network emerged as a crucial factor for success and retention in CS. Participants highlighted the importance of strong connections with peers and role models within the CS community. Role models played a particularly significant role, especially those with similar intersectional identities and experiences. Seeing oneself represented in the CS field, either through peers or prominent figures, was identified as a critical factor in maintaining one's authentic professional identity and strengthening the sense of belonging.

An intersectional approach is required to fully reach DEI in CS. Boosting supportive networks, fostering a culture for DEI in organisations, and promoting intersectionality are crucial elements in this process. Furthermore, initiatives facilitating supportive intersectional communities and promoting open discussions about mental health and other intersectional challenges are also crucial. By focusing on these factors using an intersectional lens, the field of CS can become more diverse, inclusive, and equitable.

7.3 RQ3: How to Design and Develop Digital Support to Increase Intersectionality in Computer Science?

RQ3 looked into how a digital prototype could be a tool to address the challenges and success factors identified in this thesis. The prototyping phase followed the design and creation strategy through five iterations and used usability testing to get feedback for improvements throughout the development. DiversIT, a website designed in Figma, aims to help increase DEI in CS by facilitating an intersectional peer community and promoting intersectional role models.

The prototype has led to a promising outcome in terms of having the potential of increasing DEI in CS, which aligns with the desired objectives of this thesis. Valuable feedback gathered from usability testing, as well as knowledge from the SLR and interviews, formed the foundation for subsequent improvements in each iteration, ensuring the development of DiversIT targeted the audience's needs. The fact that a supportive network was one of the most significant success factors in overcoming intersectional challenges and barriers in CS indicated that there is a potential need in the market for DiversIT. Based on the feedback from the users, the researchers conclude that the developed prototype has the potential to promote intersectionality and increase DEI in CS.

7.4 Future Work

This thesis may be used as the foundation for forthcoming master's theses, which will be under guidance by the same supervisors as in this research. The study presented in this paper included multiple interviews looking into intersectionality in both Norway and Brazil. However, there is still a need for more data and literature about intersectionality in CS from a global perspective. Thus, continuing the work of conducting interviews to gain more knowledge about the current status of DEI and intersectionality in CS, could be considered for future research.

The website prototype, DiversIT, got promising feedback after the usability tests, which also opens up for further development of the concept. Although some issues suggested for improvements during the usability tests were not implemented in the prototype, the final version of the product backlog, in Table 5.6, has these listed. As DiversIT focuses on intersectionality and the fact that personal data related to this is sensitive, it is important to have accessibility and security as quality attributes, in addition to usability, when further developing the prototype into a fully functioning website. Following a universal design approach, using guidelines from Web Content Accessibility Guidelines (WCAG) and the Authority for Universal Design of ICT[1] is highly recommended to ensure the usability and accessibility of the website. Furthermore, scalability, for supporting increased user activity; and interoperability, for easily integrating this solution with other existing products; could be other quality attributes to consider.

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Appendix A

Project Description

Design and Develop Digital Support for Inclusion

To be accepted as a master's student, you need to participate in the 9th ACM Celebration of Women in Computing womENcourage. Welcome to the 9th ACM Celebration of Women in Computing: womENcourage™ 2022, that is going to take place in Larnaka, Cyprus, 21-23 September 2022! You will have to write a poster (Letizia Jaccheri will help you) and the costs of your travel will be refunded.

This project/master's thesis will build on the existing bulk of knowledge about gender and diversity in software development (TDT10) to provide increased knowledge and solutions based on empirical studies with Norwegian and International IT industries, the public sector, or entrepreneurial companies. Specifically, in this project/master thesis, the student(s) will propose one or more goals to investigate.

The student(s) will

- Design, implement and evaluate new tech solutions which contribute to solving the problem of inclusion in tech

The supervisor will provide the student(s) with Initial Literature and help the student(s) to access stakeholders and initial data.

Appendix B

ACM WomENcourage 2022

Design, Implement and Evaluate New Tech Solutions Which Contribute to Solve the Problem of Inclusion in Tech

MARIT F. HANSEN* and SANDRA HELEN HUSNES*, Department of Computer Science, Norway

In this paper we have done a literature review on the under-representation of women in Computer Science in the context of the UN Sustainable Development Goals. The main issue found that girls are less exposed to opportunities in STEM and are less likely to consider this as a career path.

Additional Key Words and Phrases: Inclusion, Computer Science, Women

1 INTRODUCTION

According to statistics among ICT specialists in all EU Member States, women are strongly underrepresented [2]. Gender is only one aspect of inclusion, and there is also intersectionality to consider when looking at empowerment of underrepresented groups in the tech field [6]. Awareness of the lack of representation, and the different challenges that are faced by women from all backgrounds is an fundamental in helping the Computer Science field move forward [2][6].

This paper is the preliminary study for our master thesis "Design and Develop Digital Support for Inclusion", looking at connection between gender stereotypes, exposure to STEM in education, intersectionality, and the current representation and inclusion of women in Computer Science. The final goal of our work is to Design, implement and evaluate new tech solutions which contribute to solve the problem of inclusion in tech.

2 RESEARCH QUESTION

Focusing on the lack of representation of women in technology, the paper discusses the research question: "How to encourage more girls and young women to choose Computer Science in higher education and as a profession?".

3 LITERATURE REVIEW

The Sustainable Development Goals created by United Nations are goals for achieving a sustainable future for all, where the fifth goal is Gender Equality and the tenth goal is Reduced Inequality [4][3].

Still, the majority of students in higher education at the Master's level in the field of Computer Science are men. The female student enrolment is only around 20% [2]. The lack of representation of women in technology supports that we still have a long way to go before reaching the Gender Equality or Reduced Inequality goals by 2030.

There are initiatives that specifically target women inclusion in higher education today. Ada is a project at NTNU that focuses the inclusion of women in male-dominated studies in STEM and motivates women to graduate [5]. Ada has helped to almost double the female share of students in STEM through various measures such as, technology

*Both authors contributed equally to this research.

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Manuscript submitted to ACM

days, personal meetings with role models, and coding events [2]. Thus, projects like Ada continues to be an essential contributor to women's contentment in tech studies. These initiatives not only encourages more young women to apply to technology studies where male students are the majority, but are also integral in helping reach the goals of Gender Equality and Reduced Inequality by 2030, through promoting more inclusion in tech both at an educational and professional level.

It is important to acknowledge that achieving more inclusion through female representation is just the tip of the ice berg, as LGBTQ+ community and people of different cultural, ethnic, and religious backgrounds, face similar but also different biases in the tech industry [6]. So, when looking at female inclusion in Computer Science, one should also recognise intersectionality in order to adequately help and empower all women within the field.

In children's stories, the stereotypical female characters are generally described as being socially skilled, where the focus is often placed on their physical appearance. On the other hand, male characters are described as problem solvers and are active, intelligent, and brave [7]. This description of the gender in children's stories can give them unconscious stereotypes and biases of the genders and gender roles from an early age. Technology and ICT are fields under continuous improvement. One theory why more men than women apply for higher education in this field could be that according to children's stories, men should be more capable of handling problems and are inherently more intelligent.

According to research where the participants played games related to Computer Science, it was concluded that the students became more interested in Computer Science as a potential career option [8]. Stereotypically, boys play more computer games than girls. The research states that this could be related to an interest in the study program Computer Science. By exposing more girls to similar games as in the study, more girls might consider this a future career option.

Programming is included in the school curriculum across the EU. Arguments for this action are to equip children with the necessary skills related to the time we are living in, the future need for qualifications, and gain knowledge to understand the process of digitising society [1].

Since it is in the curriculum, children of all backgrounds can be more exposed to the possibility of IT studies, which further implies that more women might apply for studies related to Computer Science in the future.

4 CONCLUSION/FURTHER WORK

As seen in the literature review, women are underrepresented in Computer Science and professions related to this, where women of intersectional identities are even more underrepresented. In general, more girls need to be exposed to Computer Science and the technology field at a young age and get the same encouragement as boys to show interest in STEM. As shown in the research, this can be done by exposing more girls to games that are related to the field. Including programming in the school curriculum will also be an important driving force introduce the possibility of Computer Science studies to all children, and build a positive relationship between girls and STEM early on.

Future work for this extended abstract is to have a deeper look into the research question; "How to have more girls choose Computer Science as their higher education studies and profession" through the master thesis "Design, implement and evaluate new tech solutions" which contribute to solve the problem of inclusion in tech.

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Design and Development for Inclusion

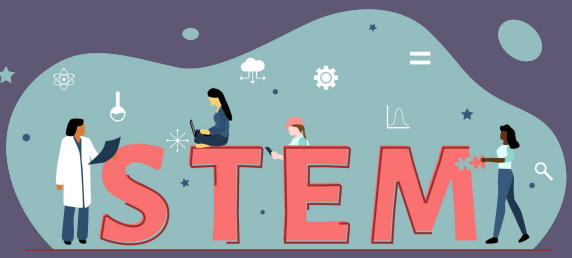
Marit Fredrikke Hansen and Sandra Helen Husnes

According to statistics among ICT specialists in all EU Member States, women are strongly underrepresented [1]. Gender is only one aspect of inclusion, and there is also intersectionality to consider when looking at empowerment of underrepresented groups in the tech field [2]. Awareness of the lack of representation, and the different challenges that are faced by women from all backgrounds is an fundamental in helping the Computer Science field move forward [1][2].

The Sustainable Development Goals created by United Nations are goals for achieving a sustainable future for all, where the 5th goal is Gender Equality and the 10th goal is Reduced Inequality [3][4]. Most students in higher education at the Master's level in Computer Science are men, with female enrolment only being around 20% [1].

When looking at female inclusion in Computer Science, one should also recognise intersectionality in order to adequately include all women within the field. Acknowledging that female representation is just the tip of the iceberg as members of the LGBTQ+ community, different cultural, ethnic, and religious backgrounds, face similar but also different biases [2].

> How to encourage young women to choose Computer Science in higher education and as a profession?



> Introduce children to STEM in school _

> Highlighting female role models and their importance within the field _

NTNU | Norwegian University of Science and Technology

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Appendix C

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Intersectionality in Computer Science: A Systematic Literature Review

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***Abstract*—Gender equality, as well as Diversity, Equity, and Inclusion (DEI), in computer science (CS) is primarily limited to binary gender diversity. It is known that women are heavily underrepresented in CS, but substantial parts of the DEI issues are still unexplored. Intersectionality provides a more nuanced perspective of equality as it acknowledges exclusion and discrimination coming from overlapping layers of people's identities, e.g. gender, ethnicity, dis/ability, nationality, socioeconomic status, age, religion, and sexuality, in combination. It is important to address systemic barriers, bias, and stereotypes in CS through the lenses of intersectionality. There is a growing literature on challenges of women and binary gender diversity in CS, but a limitation to many of these investigations is that they look at only one dimension of discrimination rather than the complexity of intersectional challenges. That is why the research objective of this study is to provide information on the relation of intersectionality and CS, using the Systematic Literature Review methodology. The results show that there is still scarce research explicitly connected to the concept of intersectionality in CS, but awareness is increasing. The SLR also reveals various challenges and success factors related to intersectionality, which call for further attention.**

***Index Terms*—Intersectionality, Diversity, Inclusion, Computer Science, Systematic Literature Review**

I. Introduction

Tech companies often join the Diversity, Equity, and Inclusion (DEI) conversation because it is beneficial for their image as an employer, but in general, the conversation usually stops at binary gender diversity [1] [2]. When researching diversity in computer science (CS) (as well as related fields such as software engineering (SE), information and communication technology (ICT), information technology (IT), informatics, computing, etc.), it is important to do so through an intersectional lens, to fully understand the complexities and nuances of the issues and their possible solutions. Intersectionality encompasses how overlapping factors of a person's identity, e.g. ethnicity, nationality, disability, gender expression, sexuality, religion, and socioeconomic background, affect individuals in their daily lives, contributing to discrimination [3]. Overwhelmingly, diversity in CS is understood as gender diversity, within the frames of UN's Sustainable Development Goal (SDG) 5, Gender Equality [4]. Statistics from Europe show that women are still highly underrepresented in CS. In order to reach the 5th SDG – gender equality – within CS, intersectionality must also be a part of the solution [5]. Binary gender is only one dimension of inclusion, whereas intersectionality considers multiple dimensions of a person's identity and the complexities of how these parts intersect leading to exclusion. With an intersectional approach, DEI can lead to greater creativity and success in CS [6]. Furthermore, having diverse developers helps prevent the creation of software that perpetuates harmful stereotypes and/or bias.

The research objective of this paper is to provide knowledge about intersectionality in CS, both at the university and professional levels. Relatively many studies research the inclusion of women and binary gender diversity within the CS field [7] [8], and several acknowledge that a recurring limitation in this research area is staying within the binary and ignoring the concept of intersectionality [9] [10]. Thus, few studies about diversity in CS look beyond one dimension and consider the complexity of challenges linked to and explicitly attributing them to intersectionality. These factors motivated the following research questions (RQs):

- **RQ1:** What recent research exists that explicitly embraces intersectionality within computer science?
- **RQ2:** What are the main intersectional challenges in computer science?
- **RQ3:** What factors are important to overcome these challenges and succeed in computer science?

To address the research questions **RQ1**, **RQ2**, and **RQ3**, a Systematic Literature Review (SLR) was performed to review primary studies within this project scope and to understand intersectionality in CS. The principles by Kitchenham were used to perform the SLR [11].

The structure of this paper is as follows. Section II presents the background, which elaborates on diversity in CS. The research methods are presented in Section III. Section IV

presents the results from the SLR, and Section V discusses these findings in relation to the research questions, as well as the limitations. Lastly, Section VI concludes the paper by reflecting on the research questions and future works.

II. Background

A. Intersectionality

Intersectionality was a term first introduced by Kimberle Crenshaw [12], to address the intersections between multiple overlapping components of a person's identity, e.g. nationality, ethnicity, dis/ability, gender expression, sexuality, religion, socio-economic background etc., and how the combination of these identity segments affect their everyday lives leading to exclusion [3]. Crenshaw found that some of the challenges Black women in the US faced remained hidden when looking at only race or gender as a source of discrimination. Instead, it was necessary to consider the combination of these identity factors together, which is how the Theory of Intersectionality was born. The overlapping factors, such as religion, gender & sexuality, socio-economic status, ethnicity, indigeneity, nationality, dis/ability, and education, affect one's experiences as a whole. The combination of these factors can account for the individual's unique disadvantages and challenges.

When commenting on SDG 5 and striving for DEI, the UN underlines the importance of intersectionality, in order to leave no one behind and use our resources better [5].

B. Diversity in Computer Science

By the 21st century, technology has become ubiquitous, penetrating people's daily lives. To make software fit a wider range of users, it is essential to have diversity within the development team. Studies show that diversity leads to greater creativity and success[1]. Even more importantly, a team that is not diverse enough is likely to produce software that is based on and maintains bias. One example of this is face recognition algorithms, where females, especially females with darker skin tones, were left out during development, as well as assessment. Multiple face recognition algorithms were reported to work with an accuracy over 90%, which is classified as high accuracy, but this meant only for male subjects with lighter skin tones. As opposed to this, female participants with darker skin tones had up to 34.4% worse accuracy [13]. It is important to have diversity in CS to ensure the product created can be universal and suitable for a wider range of user group. In order to overcome this technical and social problem, an intersectional approach accounting for the overlap of (in this specific case, at least) gender and race would be necessary.

Computer Science is considered to be a homogeneous field, with professionals who are predominantly white, heterosexual, Global Northern, young, middle-class, cis-gendered men [14]. Although historically women and women of color had a great part in computing, as the profession grew more prestigious, it became more and more white and male-centered, pushing others out of the field through the means of discrimination [15] [16] [17]. "Erasure is not merely an issue of representation, but a foundation on which systematic racism, misogyny, and inequity rely" [15].

[1]https://www.diversityintech.co.uk/the-benefits-of-diversity-in-tech

III. Research Method

In order to uncover the relation between intersectionality and exclusion in CS, we chose the methodology of systematic literature review. We decided to explore papers that do research specifically and explicitly on intersectionality in the frames of CS, either within academia or industry. The advantages to using SLR as a research method are that it identifies gaps in current research and suggests areas for future research activities. Moreover, it synthesises existing research in a fair manner; thus, reproducibility of the systematic review is enhanced and bias reduced [11].

A. Identification of Research Questions

The research objective of this paper is to provide knowledge about intersectionality in CS, both at the university and the professional level, as well as to contribute to research that acknowledges the complexity of intersectional challenges beyond the one-dimensional narrative in CS. We were interested to see to what extent CS has embraced the term of intersectionality which has been widely around in other disciplines [12] [18] [19]. Based on this rationale, the authors defined three RQs, presented in Table I.

Table I

Research Question	Motivation
RQ1: What recent research exists that explicitly embraces intersectionality intersectionality in computer science?	To determine how much CS has started to embrace the concept of intersectionality that Social Sciences has widely been using.
RQ2: What are the main intersectional challenges in computer science?	To focus on the experiences of university students and improve retention and sense of belonging.
RQ3: What factors are important to overcome these challenges and succeed in computer science?	To understand how to design protocols including intersectionality in CS careers and education for increased diversity.

B. Data Collection

The authors used Scopus, the largest electronic database of peer-reviewed academic, to search for primary studies because it supports the usage of complex search queries and provides an exhaustive selection of peer-reviewed studies and published books. After four trial searches, the authors identified *intersectionality* as the most essential keyword for the search query to align with the RQs.[2] Table II presents the final search query used in this SLR.

Table II
Search string applied in Scopus database.

Database	Search string applied	Result
Scopus	`TITLE-ABS-KEY( intersectionality ) AND (LIMIT-TO( SUBJAREA, "COMP" ))`	244

[2]We understand that this poses limitations to the search, as papers addressing intersectional challenges without mentioning intersectionality, are left out.

C. Selection of Studies

The search query used in Scopus (see Table II) retrieved 244 studies. The selection process is illustrated by Figure 1.

The authors first filtered the results to only include studies in English that were from 2018 or later since studies from the past five years would provide the most relevant and updated research. This first filtration retrieved 195 possible primary studies. These studies were exported to Endnote, a tool used to manage papers obtained throughout the literature search [11].

After the full texts of the possible primary studies were retrieved in Endnote, the inclusion and exclusion criteria were defined based on [11], to guide the screening of the titles and abstracts, which was performed in parallel by the authors to ensure the reliability of the inclusion decisions and help avoid selection bias.

Inclusion criteria:

1) The paper addresses the RQs.
2) The paper is published in 2018 or later.
3) The paper has intersectionality as a keyword.
4) The paper has subject area computer science.

Exclusion criteria:

1) Papers not in English
2) Papers about computer science or technology that does not discuss intersectionality.
3) Duplicated work presenting a similar result by the same author.

After completing the parallel screening process, a second screening was performed by the authors on any studies that were deemed as relevant only by one of the authors, opening a discussion on which of these potential primary studies should be included further in the selection process as recommended by Kitchenham [11]. This led to the number of papers being limited to 74 following the first and second screening of titles and abstracts.

The next stage of the SLR was to define the quality criteria to further assess the "quality" of the potential primary studies [11]. By looking at the introduction, discussion, conclusion, headings, tables, and figures of the 74 papers, a more thorough screening process could take place. Each paper was given a quality score between 0 and 2 by the authors, where *0* meant the paper was excluded, whilst *2* meant the paper was included. Any paper that got a score *1* by all authors or a score *1* and *2* was discussed further based on the quality criteria after the parallel screening was complete. After the quality assessment process, 16 primary studies remained. The list of the selected studies is in Appendix A.

Given the rigorousness of the selection process in an SLR, it was expected that a large number of papers would be excluded. The final number of primary studies selected for this SLR could further support that there is a gap in research explicitly concerning intersectionality in CS.

D. Data Extraction and Monitoring Progress

After completing the selection process, the SLR resulted in 16 primary studies. The data extraction and monitoring process consisted of filling out a data extraction form to record the information obtained by the authors from the primary studies. Random samples of the studies and their results were cross-checked by the authors to promote quality [11].

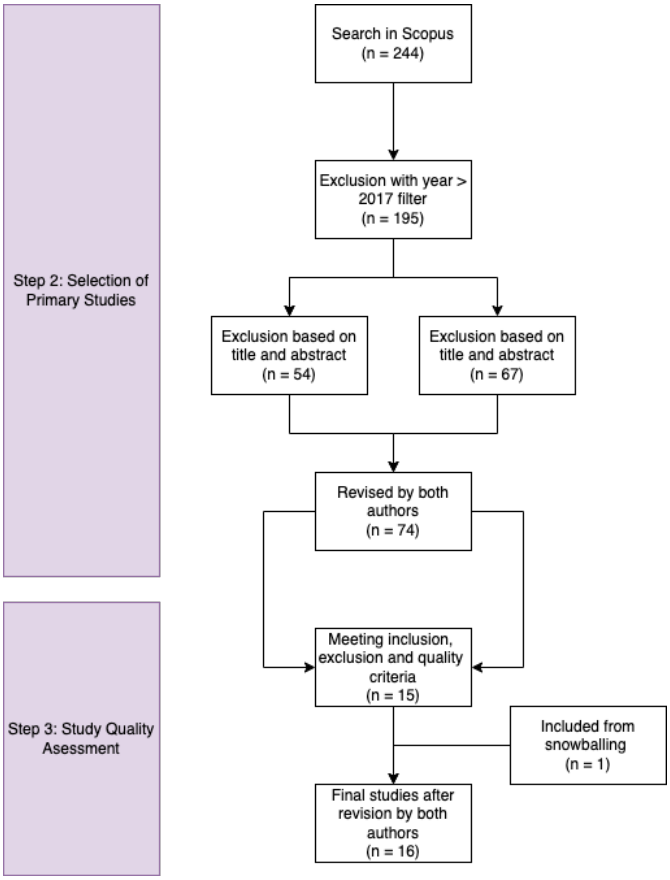

Figure 1. Study selection process

IV. Results

This section presents the results obtained from the 16 primary studies in the SLR, providing new insight into intersectionality in the CS field. The overview of the findings for each RQ is displayed in Appendix B.

A. RQ1: What recent research exists that explicitly embraces intersectionality within computer science?

The search query as defined in Table II was used to investigate what recent research existed explicitly about intersectionality in CS. We identified 16 relevant studies between 2018 and 2022.

The earliest research on intersectionality in CS, according to Scopus, is from 2009. Between then and now, the highest frequency of research contributions to this area was in the period of 2018 and 2022, which justifies our inclusion criterion of focusing on papers published in or after 2018. The recently growing number of papers, as well as the fact that 75% of the papers included in our SLR were published in the

last three years (2020-2022), indicate that the awareness of intersectionality is increasing.

At the same time, when we look at where the data are from, we find a less promising trend. Due to the specificities of cultural contexts, it is relevant to consider intersectional data from a wide range of cultures. 13 of the 16 studies, that is, 81% have gathered their data in the US; that is, only a small portion of the world is represented. The only 3 studies from outside of the US are from Ireland (two studies) and India (one study), which means that the Global South is severely underrepresented.

It is important to note that even if all selected studies focused on intersectionality, it varied what identity segments were actually addressed. Figure 2 visualizes the factors used in the studies when examining intersectionality. Most of the studies have ethnicity and gender as factors in their data generation when looking at intersectionality. The two studies that are placed only within the gender group do have another factor called "minority," which can encompass all of the factors initially presented in Section II-A as it is the participants' subjective choice.

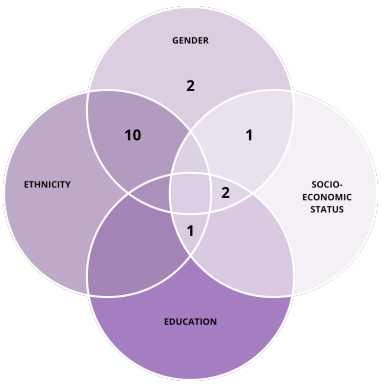

Figure 2. Venn diagram presenting the intersectionality factors in the studies.

Regarding the methodology used to gather data, 56% of the studies in the SLR used a quantitative analysis approach. 6 of the papers applied the method of triangulation, which enhances their validity as two or more data generation methods were used to corroborate their findings. Of these 6 papers, an equal number were mixed, qualitative, and quantitative studies, and 50% used the survey strategy.

B. RQ2: What are the main intersectional challenges in computer science?

Many of the studies revolve around how underrepresented groups face stereotypes, discrimination and bias as challenges they had to overcome in CS. S02, S08, and S10 point out that (within the US context) especially Black women experience the feeling of being the only one [20] [21] [22]. This emphasizes that female CS students face a lower sense of belonging and that Black students face an even lower sense of belonging than White students, as discussed in S09 and S16 [23] [24]. S12 explicitly looks into the difference between being a woman, being Black and the intersection of being both Black and a woman in the US, further emphasizing how intersectional challenges are intertwined [25].

C. RQ3: What factors are important to overcome these challenges and succeed in computer science?

The results related to RQ can be categorized into two main groups. According to the studies, the primary means of overcoming intersectional challenges are a sense of belonging and mentoring. Some other success factors were also mentioned that do not fall into the above two groups. More specifically, 12 out of the 16 papers discuss solutions related to a sense of belonging, as an important factor for overcoming challenges that arise from intersectional differences; 6 studies were related to mentorship; and 6 suggested other solutions as tools to overcome such challenges, also helping to increase diversity in CS.

V. Discussion

A. Principal Findings

There is a dearth of research about intersectionality in CS (synthesised from [20] [26] [22] [16] [27] [25] [28]). When comparing this to the research on intersectionality in general, there is a clear and steady increase in papers being published on the topic between 2018 and 2022. In this timeframe, research on intersectionality has doubled, while research on intersectionality in CS has quadrupled. It must be noted, though, that most of the studies found in the SLR were from the US and that most studies about intersectionality in CS, overall, are from the US. The increased interest to research intersectionality in these years can be tied to the broader social context and specifically events like the #MeToo movement and the Black Lives Matter movement.

The #MeToo movement had an important impact on the tech industry as well, as it highlighted the misogynistic work culture in Silicon Valley high-tech firms. This disproved that CS was a meritocracy [22] [16], and uncovered how the companies had extensive knowledge about and were enabling sexual harassment in the workplace [29] [30] [31]. These issues were also highlighted in the SLR. S10 and S11 state that upholding the false notion that CS is a colorblind meritocracy is dismissive of intersectional experiences and enables an inequitable workplace [22] [16]. S08 and S13 also state that many tech companies continue to perpetuate this misogynistic culture in CS throughout the hiring process and at the workplace (e.g. by only using male computer scientists and engineers in the hiring process), thus not improving the recruitment and retention of underrepresented people [21] [27].

2020 was also an important year for intersectionality. This year marked the beginning of the COVID-19 pandemic and the resurgence of the Black Lives Matter movement. Both of these events opened a new conversation concerning inclusion and intersectionality. S05, S07, and S09 support that the pandemic was an important factor that decreased the sense of belonging in CS, but also highlighted how marginalised people

continuously have had a lesser sense of belonging in CS from being students and into their professional careers [32] [33] [23]. Furthermore, S07, S02, and S03 state that the resurgence of the Black Lives Matter movement placed intersectionality on the agenda through a call to action from the CS community to be an active leader of change for equity, which further proved that oppression and ignorance had enabled CS to hide behind the false narrative of being a meritocracy [33] [20] [26].

Even if the issue has been put on the agenda more in the past years, it has been the case mainly in the US. In addition, most studies (9 out of 16) address only the intersection of gender and ethnicity. In fact, when comparing the intersectionality framework (see subsection II-A) with the primary studies, only half of the intersectionality factors were discussed in all of the papers combined. This supports that there is a clear gap in research regarding intersectionality in CS.

All 16 studies in the SLR addressed intersectional challenges in CS.

S11, S08, S10, S02, and S05 found that people of underrepresented identities in CS were more likely to be talked down to, have their qualifications questioned, and experience imposter syndrome as a result of low expectations either in the workplace or in their studies [16] [21] [22] [20] [32]. Moreover, a lack of diversity in the workplace is considered to lead to blatant discrimination and a lost sense of belonging. It is indicated that marginalised people are more likely to miss out on opportunities of advancement, due to promotional practices built on informal networks [16] [22].

Female students face a lower sense of belonging, as discussed in S09, and studies from the US found that Black students face an even lower sense of belonging than White students, especially when they are both Black and women [23] [21] [22] [27] [20] [24]. According to the study, women who self-identified as a minority experienced a lower sense of belonging in CS education [23]. In an industry context, S01 also discusses this explaining how Indian women face more constraints as CS professionals due to societal expectations and traditional gender roles [34] than Indian men. One interviewee in S11 recounted an experience of receiving a harmful stereotypical comment from a male colleague; “I love having you on my team because if we have a problem, I can ask you to handle it because they’ll be afraid of an angry Black woman” [16]. This shows that harmful stereotypes that exist in CS further decrease a person’s sense of belonging through objectification and dehumanization. Being underrepresented not only means isolation but a lack of having role models and a support system that understands the complexities arising from intersectionality.

15 of the 16 studies identified factors that can help overcome intersectional challenges in CS. These success factors were grouped into three different categories: a sense of belonging, mentorship, and other means.

Having a sense of belonging was found as a success factor in most of the studies analysed in this SLR. The importance of having a network of support was discussed in S13, as being around other people of similar intersectional backgrounds makes one feel less isolated [27]. These networks could be in the form of a peer community since this simultaneously creates a CS network and a social network, presented in S14 [35]. Having a social network in CS was found critical in increasing the probability of choosing CS in higher education [35] [33] [25] [26]. Moreover, the academic/professional CS network was essential in building career confidence and technical skills [35] [21] [16] [36] [27] [32]; further supporting retention in CS. Thus, the network that a person is involved in can help increase their sense of belonging since they can identify with or have empathy for different intersectional experiences while also contributing to a richer, more inclusive environment in CS.

Another prominent success factor found through this SLR was mentorship programs. Mentoring could act as a tool to support diversity in CS and help increase the sense of belonging. In terms of mentoring, intersectional mentorship from S14 was suggested as an extended version of academic and professional mentoring since this supports and acknowledges intersectional issues, and systemic barriers in CS [35]. Awareness and empathy for the background of the mentees are important to have a good mentee-mentor relationship because the mentor understands the mentee’s specific concerns [35], which strengthens the effect of mentoring as well as the mentee’s sense of belonging. Additionally, mentorships were found to be especially important in the early career stages, as mentors could be proactive in sharing imperative information with the mentee about their personal experiences in CS, the work culture, in addition to providing advice and guidance on coping mechanisms or advocate for career advancements [16] [21] [22] [27]. Hence, these factors should be considered when developing and implementing a mentorship program that promotes DEI.

Intersectional mentoring could lessen discriminatory occurrences since this would implicitly increase diverse hiring and use intersectional experiences to define an inclusive and equitable environment. So when creating a mentor program, it is important to reflect on how the mentors and mentees should be matched together. Regarding cross-ethnic and cross-gender, S11 points out that women have greater difficulty with these types of mentor relationships since this could lead to power imbalance in the mentor-mentee relationship [16].

B. Limitations

As discussed earlier, there is a scarcity of research on intersectionality in CS. It must be admitted that the low number in our SLR can also be attributed to the fact that we used Scopus only, which is the largest database but not the only one. In our future works, we will perform a more extended search.

Another reason for the low number of papers can be explained with the fact that we focused on papers explicitly mentioning intersectionality. This also meant that our search did not include papers that address intersectional challenges without mentioning the term itself in their titles, abstracts, or

keywords. While this limitation results in a darker picture, it must also be mentioned that many of the excluded studies (such as [37], [38], [39]) typically address race and gender, only two segments of intersectional challenges, which is in line with our findings.

Most of the studies in our SLR tend to concentrate only on two identity factors of intersectionality, mainly ethnicity and binary gender. There was little to no discussion of dis/-ability, different nationalities, sexuality, or gender expression. Some studies that were left out due to our explicit focus on intersectionality as a term do work with more than two identity segments, such as gender, ethnicity, and culture [40], or on less researched identity segments such as transgender individuals [41]. Therefore, a more extended search would possibly be able to bring more results and a more positive picture of the field.

VI. Conclusion

In this paper, the authors analyzed the literature related to intersectionality in CS. 16 primary studies from the period 2018-2022 have been selected and reviewed.

Even if there are many studies on binary gender diversity in CS by now, there is a clear shortage of research in connection with and explicitly about intersectionality, which would provide a broader and more nuanced perspective of what diversity would mean in CS. Multiple studies in our SLR expressly comment on the scarcity of research done in the field. The earliest research found on intersectionality in CS is from 2009, but the number of papers started to rise mainly in the past couple of years, which motivated the selection of our research period. This shows that the awareness of intersectionality is increasing in CS and that academic attention is most probably influenced by social issues, e.g. #MeToo, the COVID-19 pandemic, and Black Lives Matter.

However, most of the studies found in the SLR were still only from the US, which is a problem, as the issue of intersectionality is complex and context-dependent. Multiple views on the situation should be represented through the literature to fully understand intersectionality in CS since each country has differing views, norms, and intersectional challenges.

The intersection between binary gender and ethnicity was discussed the most in the primary studies. However, none of the studies reflected on the experiences of having more than two intersecting identities. In total, only 4 intersectional factors were discussed in the 16 studies, but, e.g. dis/ability was not researched together with other factors even though it is considered the world's most significant minority. To increase diversity in CS, all factors of intersectionality must be in focus, and there needs to be more awareness of intersectional challenges, such as bias and stereotypes, as well as more research from all parts of the world.

Multiple studies have shown that a lack of diversity leads to discrimination and a lack of sense of belonging among underrepresented identities, which is a concern and a challenge in CS. A lower sense of belonging is also the result of systemic barriers based on stereotypes, bias, and imbalanced power dynamics, e.g, exclusion from informal networks, unrealistic expectations based on traditional gender roles and/or stereotypes, and the lack of role models and support. In general, the CS field still does not acknowledge the power of intersectionality – and/or is less aware of the term itself – exploring how challenges arise differently depending on people's intersecting identities.

In many studies, having a supportive network has been addressed as a solution to the low sense of belonging experienced by individuals in underrepresented groups. Multiple studies suggested mentorship programs as a concrete example of overcoming challenges and succeeding in CS. When a mentee of an intersectional background has a mentor that understands and has empathy for the mentee, the mentee feels more included in the CS environment, especially in the early stages of their career, which can lead to better retention and a more diverse field.

As further studies, we would like to extend our search to include more papers, even if they fail to acknowledge the term, in order to see if the picture gets more complex or less grim. In addition, building on research dealing with intersectionality in CS, we aim to develop a research protocol (including both an interview guide and a questionnaire), to deepen the understanding of the main intersectional challenges, considering three different factors: gender, ethnicity, and socio-economic status. This year, we plan to execute this study in Norway and Brazil, with the hope to extend it even further. Since CS undergraduates in Brazil face significant differences in socio-economic status, this could bring different challenges. We intend to contrast the new results with the findings of this study, contributing to a more robust body of knowledge about intersectionality in CS.

Acknowledgment

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APPENDIX A
STUDIES INCLUDED IN THE SLR

S01 S. Dhar-Bhattacharjee and H. Richardson (2018), "A tour of India in one workplace: Investigating complex and gendered relations in IT"
S02 Y. A. Rankin, J. O. Thomas, and S. Erete (2021), "Black women speak: Examining power, privilege, and identity in CS education"
S03 S. Lunn, L. Zahedi, M. Ross, and M. Ohland (2021), "Exploration of intersectionality and computer science demographics: Understanding the historical context of shifs in participation"
S04 Y. A. Rankin and N. Han (2019), "Exploring the plurality of black women's gameplay experiences"
S05 K. Kramarczuk, J. Plane, and K. Atchison (2021), "First-generation undergraduate women and intersectional obstacles to pursuing post-baccalaureate computing degrees"
S06 T. Fletcher, A. Green, R. Quintero, and E. Arroyo (2020), "Intersectionality at minority-serving institutions (MSIs): A longitudinal analysis of female student participation within engineering and computing"
S07 C. Mooney and B. A. Becker (2021), "Investigating the impact of the COVID-19 pandemic on computing students' sense of belonging"
S08 S. J. Lunn, E. Zerbe, and M. S. Ross (2022), "Need for change: How interview preparation and the hiring process in computing can be made more equitable"
S09 C. Mooney and B. A. Becker (2020), "ense of belonging: The intersectionality of self-identified minority status and gender in undergraduate computer science students"
S10 J. O. Thomas, N. Joseph, A. Williams, C. Crum, and J. Burge (2018), "Speaking truth to power: Exploring the intersectional experiences of black women in computing"
S11 K. McGee (2018), "The influence of gender, and race/ethnicity on advancement in information technology (IT)"
S12 M. Ross, Z. Hazari, G. Sonnert, and P. Sadler (2020), "The intersection of being black and being a woman"
S13 Y. A. Rankin and J. O. Thomas (2020), "The intersectional experiences of black women in computing"
S14 B. Spencer, A. Rorrer, S. Davis, S. H. Moghadam, and C. Grainger (2021), "The role of 'intersectional capital' in undergraduate women's engagement in research-focused computing workshops"
S15 M. A. Jarrell, R. G. Anaraky, B. P. Knijnenburg, and E. M. Ash (2021), "Using intersectional representation and embodied identification in standard video game play to reduce societal biases"
S16 A. Nguyen and C. M. Lewis (2020), "Competitive enrollment policies in computing departments negatively predict first-year students' sense of belonging, self-efficacy, and perception of department"

APPENDIX B
MAPPING OF RESULTS FROM THE SLR

ID	RQ1: Research							RQ2: Challenges		RQ3: Success Factors	
	Country	Intersectionality			Method			Internal	External	Internal	External
		Included factors	*Aborted factors*	*Limitations*	*Strategies*	*Data generation*	*Data analysis*				
S01	India, UK	Gender (binary) Socioeconomic Class and caste			Case study	Interviews Observations	Qualitative		Expectations		Paternity leave Equal pay
S02	US	Black women Gender (binary)			Survey	Interviews	Qualitative	Belongingness Expectations	Stereotypes Assumed competency Discrimination Exclusion		
S03	US	Ethnicity Gender (binary) Socioeconomic		Non-binary Dis/ability LGBTQIA+	Survey	Documents	Quantitative		Enrollment rates Retention Lack of literature	Sense of belonging	Mentorship Peer community Role models Intersectional research
S04	US	Black women Gender (binary)		Non-binary	Survey	Interviews Questionnaires	Mixed	Dehumanisation	Stereotypes in games	Sense of belonging	Intersectional approach
S05	US	Women and non-binary Socioeconomic First-generation student	Non-binary Ethnicity		Survey	Questionnaires	Quantitative	Imposter syndrome Belongingness	Sexism Racism Exclusion	Sense of belonging	
S06	US	Ethnicity Gender (binary)			Survey	Documents	Quantitative	Feeling isolated		Sense of belonging	
S07	Ireland	Minority Gender (binary)	Non-binary LGBTQIA+ Ethnicity Dis/ability Nationality Religion Mature student		Survey	Questionnaires	Quantitative	Belongingness		Sense of belonging	
S08	US	Ethnicity Gender (binary)			Survey	Interviews Questionnaires	Qualitative	Belongingness	Sexism Stereotypes Lack of diversity	Sense of belonging Inclusive thinking	Mentorship Diverse leadership
S09	Ireland	Minority Gender (binary)	Non-binary LGBTQIA+ Ethnicity Dis/ability Nationality Religion Mature student		Survey	Questionnaires	Quantitative	Belongingness	Expectations	Sense of belonging	
S10	US	Black women Gender (binary)			Case study	Interviews Observations	Quantitative	Belongingness Expectations	Sexism Racism Discrimination Exclusion		Mentorship Intersectional approach
S11	US	Ethnicity Gender (binary)			Survey	Interviews	Qualitative		Sexism Racism Exclusion Stereotypes Expectations Assumed competency	Sense of belonging	Mentorship Sponsors Diverse leadership
S12	US	Black women Gender (binary)			Survey	Questionnaires	Quantitative			Sense of belonging	
S13	US	Black women Gender (binary)			Survey	Interviews	Mixed		Exclusion	Sense of belonging	Mentorship Intersectional approach
S14	US	Ethnicity Gender (binary) Socioeconomic			Survey	Interviews Questionnaires	Mixed	Belongingness	Enrollment rates Discrimination Stereotypes Sexism	Awareness Sense of belonging Authentic professional identity Competency	Mentorship Peer community Intersectional approach
S15	US	Ethnicity Gender			Design and creation	Observations Questionnaires	Quantitative		Assumed competency Sexism Racism	Awareness	
S16	US, Canada	Ethnicity Gender (binary)	Non-binary LGBTQIA+		Survey	Questionnaires	Quantitative	Belongingness Experience	Exclusion	Sense of belonging	

Appendix D

Data Gathering

D.1 Application to NSD

Sikt

Notification Form

Reference number
765968

Which personal data will be processed?

- Name (also with signature/written consent)
- Date of birth
- Email address, IP address or other online identifier
- Sound recordings of people
- Background data that can identify a person
- Racial or ethnic origin
- Religious beliefs
- Health data
- Sex life or sexual orientation

Describe which background data that can identify individual persons you will be processing

Personens alder, kjønn, yrke, utdanning, nasjonalitet, etnisitet, religion, seksuell orientering, funksjonshemning, sosioøkonomisk situasjon.

Lydopptak for transkribering av intervju (vil anonymiseres og slettes).
Video av intervju, kun gjort om personen samtykker.

Project information

Project title

Masteroppgave for MTDT - Design and Develop Digital Support for Inclusion

Project description

TDT4501 - Datateknologi, fordypningsprosjekt
TDT4900 - Datateknologi, masteroppgave

Research intersectionality in Computer Science. Design, implement and evaluate new tech solutions which contribute to solving the problem of inclusion in tech.

Explain why it is necessary to process personal data in the project

Vi ønsker å vite hvordan studenter og personer i IT-bransjen fra underrepresenterte-/minoritetsgrupper opplever studiet, arbeidslivet og overgangen mellom disse, samt undersøke mangfoldsaspektet (intersectionality) innen IT. For å samle inn informasjon ønsker vi å gjennomføre intervjuer og brukertester. Personopplysninger som alder, kjønn, yrke, utdanning, nasjonalitet, etnisitet, funksjonshemning og religion kan derfor være relevant informasjon å hente inn for å få perspektiver om mangfold. Vi ønsker å gjennomføre intervjuer og brukertester både fysisk og over digital videosamtale, da det avhenger av om intervjuobjektene har en hensiktsmessig reisevei. Om intervjuobjektet samtykker, vil det også bli tatt opp video av intervjuet som skal brukes videre i prosjektet.

External funding
Ikke utfyllt
Type of project
Student project, Master's thesis

Contact information, student
Sandra Helen Husnes, sandrahh@stud.ntnu.no, tlf: 97663386

Data controller

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

Project leader (academic employee/supervisor or PhD candidate)
Letizia Jaccheri, letizia.jaccheri@ntnu.no, tlf: 73593469

Will the responsibility of the data controller be shared with other institutions (joint data controllers)?
No

Sample 1

Describe the sample

IT studenter på universitet.

Describe how you will recruit or select the sample

Vi har samlet en liste over IT studenter gjennom vårt nettverk fra NTNU, ACM WomENcourage-konferansen, SENOBR prosjektet, og observasjoner og kontakter fra LinkedIn.

Age
18 - 30

Are any of these groups included in the sample?
- Vulnerable groups.

Personal data relating to sample 1
- Name (also with signature/written consent)
- Date of birth
- Email address, IP address or other online identifier
- Sound recordings of people
- Background data that can identify a person
- Racial or ethnic origin
- Religious beliefs
- Health data
- Sex life or sexual orientation

How will you collect data relating to sample 1?

Personal interview

Attachment

Interview Guide (Student).pdf

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

Legal basis for processing special categories of personal data
Explicit consent (General Data Protection Regulation art. 9 nr. 2 a)

Explain your choice of legal basis

Other

Describe

Brukertest av prototype. Målgruppen (utvalget) vil teste funksjonalitet, interaksjon og forståelse av innhold. Testansvarlig vil inneha en obeserverende/veiledende rolle. Resultatene fra hver deltaker i brukertesten vil bli registrert og beskrevet i prosjektet. Hver deltaker vil være anonymisert.

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

Legal basis for processing special categories of personal data
The source of data will not include special categories of personal data

Explain your choice of legal basis

Information for sample 1

Will you inform the sample about the processing of their personal data?
Yes

How?
Written information (on paper or electronically)

Information letter

NSD_information_letter.pdf

Sample 2

Describe the sample

Personer som jobber i IT-bransjen

Describe how you will recruit or select the sample

Vi har samlet en liste over personer som jobber i IT bransjen gjennom vårt nettverk fra NTNU, ACM WomENcourage-konferansen, observasjoner fra LinkedIn og i media.

Age
18 - 80

Are any of these groups included in the sample?
- Vulnerable groups.

Personal data relating to sample 2
- Name (also with signature/written consent)
- Date of birth
- Email address, IP address or other online identifier
- Sound recordings of people
- Background data that can identify a person
- Racial or ethnic origin
- Religious beliefs
- Health data
- Sex life or sexual orientation

How will you collect data relating to sample 2?

Personal interview

Attachment

Interview Guide (Professionals).pdf

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

Legal basis for processing special categories of personal data
Explicit consent (General Data Protection Regulation art. 9 nr. 2 a)

Explain your choice of legal basis

Other

Describe

Brukertest av prototype. Målgruppen (utvalget) vil teste funksjonalitet, interaksjon og forståelse av innhold. Testansvarlig vil inneha en obeserverende/veiledende rolle. Resultatene fra hver deltaker i brukertesten vil bli registrert og beskrevet i prosjektet. Hver deltaker vil være anonymisert.

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

Legal basis for processing special categories of personal data
The source of data will not include special categories of personal data

Explain your choice of legal basis

Information for sample 2

Will you inform the sample about the processing of their personal data?
Yes

How?
Written information (on paper or electronically)

Information letter

NSD_information_letter.pdf

Third Persons

Will you be processing data relating to third persons?
Yes

Describe the third persons

Foreldre til intervjuobjektene. Foreldres utdannelse eller fødeland.

Type of data relating to third persons
- Background data that can identify a person
- Racial or ethnic origin

Which sample will give information relating to third persons?
- Sample 1: IT studenter på universitet.
- Sample 2: Personer som jobber i IT-bransjen

Will third persons consent to the processing of their data?
No

Will third persons receive information about the processing of their data?
No

Explain why third persons will not be informed

Dette blir kun innhentet om person fra utvalg identifiserer seg selv med foreldrenes bakgrunn, f.eks. er den første i familien som tar høyere utdanning, er norskfødt der én/begge foreldre har innvandrerbakgrunn. De er kun indirekte identifiserende og at en vil anonymisere fortløpende.

Documentation

How will consent be documented?
- Electronically (email, e-form, digital signature)

How can consent be withdrawn?

Ta kontakt med letizia.jaccheri@ntnu.no

How can data subjects get access to their personal data or have their personal data corrected or deleted?

Ta kontakt med letizia.jaccheri@ntnu.no

Total number of data subjects in the project
1-99

Approvals

Will you obtain any of the following approvals or permits for the project?
Ikke utfyllt

Processing

Where will the personal data be processed?

- External service or network (data processor)

Who will be processing/have access to the collected personal data?

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

Which data processor will be processing/have access to the collected personal data?

Microsoft OneDrive benyttes til lagring av intervjuene og brukertestene, og Microsoft Teams benyttes til gjennomføring. NTNU har en databehandleravtale med Microsoft, og alle tjenestene er beskyttet med passord. Vi transkriberer intervjuene selv og er de eneste med tilgang til intervjuopptakene.

Will the collected personal data be transferred/made available to a third country or international organisation outside the EU/EEA?
No

Information Security

Will directly identifiable data be stored separately from the rest of the collected data (e.g. in a scrambling key)?
Yes

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

- Personal data will be anonymised as soon as no longer needed
- Restricted access
- Multi-factor authentication

Duration of processing

Project period
01.11.2022 - 31.12.2023

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

Which anonymization measures will be taken?

- Personally identifiable information will be removed, re-written or categorized
- Any sound or video recordings will be deleted

Will the data subjects be identifiable (directly or indirectly) in the thesis/publications from the project?
No

Additional information

D.2 Consent Form

Are you interested in taking part in the research project

"Intersectionality in Computer Science"?

Purpose of the project
You are invited to participate in a research project on intersectionality in computer science. "Intersectionality describes overlapping or interdependent systems of discrimination related to age, disabilities, ethnicity, gender, geographic location, sex, socioeconomic status, sexuality, etc." (http://genderedinnovations.stanford.edu/terms/intersectionality.html). In this consent form, you get information about what participation will mean to you and the project's goal.

The research project is a master's thesis at the Department of Computer Science (IDI) at NTNU, which researches intersectionality in computer science. The master's thesis is a part of the NTNU project "Software for a Better Society" led by Professor Letizia Jaccheri. The goal of the master's thesis is to design and develop a program to improve diversity, equity, and inclusion in computer science.

The following two research questions will be the focus of the *interviews*:

- RQ1: What are the main challenges with intersectionality in education in computer science?
- RQ2: What factors are important to overcome these challenges and succeed in careers in computer science?

The following research question will be the focus of the *usability test*:

- RQ3: How to design and develop digital support to increase intersectionality in computer science?

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

The master's thesis is written by Computer Science students Marit Fredrikke Hansen and Sandra Helen Husnes at the Department of Computer Science at NTNU. The project is supervised by Professor Letizia Jaccheri and co-supervised by Post-Doctoral Researcher Anna Szlavi.

Why are you being asked to participate?
You have been asked to participate in this interview because you are within one of the target groups: studying computer science (or adjacent studies) or working in technology.

What does participation involve for you?
If you choose to participate, you will participate in a personal interview and usability test, either in-person or online. The full session is estimated to be approximately 1 hour and will be held in English.

The first half is the interview, which is estimated to be approximately 30 minutes. You will be provided with a semi-structured interview template before the interview. The interview will be audio recorded with a recording device.

The second half is the usability test of a website prototype, which aims to help increase inclusion and diversity in computer science through facilitating peer community and a supportive network, as suggested by prior research on intersectionality in the field. The purpose of the usability test is to observe whether the prototype's functionality is understandable to the user. The usability test is

estimated to be approximately 30 minutes. The usability test will be audio recorded with a recording device. An observer will also be present to take notes during the usability test that will support the data analysis.

Participation is voluntary
Participation in the project is voluntary. If you choose 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 choose 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 will process your personal data in accordance with data protection legislation (the GDPR).

The data material is stored in OneDrive, where NTNU has a data processing agreement with Microsoft. This means that all services are password protected with two-factor authentication. Only the people listed in this consent form (students and supervisors) will have access to the data.

Participants will not be identified in the final publication. Personal data will be anonymised unless you, as a participant, explicitly consent to be identifiable in the final publication.

What will happen to your personal data at the end of the research project?
The planned end date of the project is 31.12.2023. All data material collected for this purpose will be anonymised, and recordings will be deleted.

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 NTNU, Data Protection Services 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:
- NTNU – Norwegian University of Science and Technology via supervisor Letizia Jaccheri, by email (letizia.jaccheri@ntnu.no) or phone +47 73 59 34 69.

- NTNU – Norwegian University of Science and Technology via master's student Marit Fredrikke Hansen, by email (maritfha@stud.ntnu.no) or phone +47 40 55 57 91.

- NTNU – Norwegian University of Science and Technology via master's student Sandra Helen Husnes, by email (sandrahh@stud.ntnu.no) or phone +47 97 66 33 86.

- Our Data Protection Officer: Thomas Helgesen (thomas.helgesen@ntnu.no).

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

- Data Protection Services, by email: (personverntjenester@sikt.no)
  or by telephone: +47 53 21 15 00.

Yours sincerely,

Marit Fredrikke Hansen
(Master's student)

Sandra Helen Husnes
(Master's student)

Marit F. Hansen

Sandra Helen Husnes

Consent form – Interview

I have received and understood information about the project Intersectionality in Computer Science and have been given the opportunity to ask questions. I give consent:

- ☐ to participate in an interview
- ☐ to be asked questions about intersectional factors, such as gender, nationality, ethnicity, religion, sexuality, dis/ability, socioeconomic background, or educational background.

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

(Signed by participant, date)

Consent form – Usability test

I have received and understood information about the project Intersectionality in Computer Science and have been given the opportunity to ask questions. I give consent to participate in a usability test where an observer will take notes.

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

(Signed by participant, date)

D.3 Interview Guide

Interview Guide

Intersectionality in Computer Science

Research Questions:

RQ1: What are the main challenges with intersectionality in computer science?

RQ2? What factors are important to overcome these challenges and succeed in computer science?

Intersectionality definitions:

“Intersectionality describes overlapping or interdependent systems of discrimination related to age, disabilities, ethnicity, gender, geographic location, sex, socioeconomic status, sexuality, etc.” (http://genderedinnovations.stanford.edu/terms/intersectionality.html).

In Norwegian:

Interseksjonalitet er «et perspektiv som brukes for å se på krysninger av ulike diskrimineringsgrunnlag som for eksempel kjønn, seksualitet, etnisitet, klasse, religion og funksjonsevne, og hvordan disse samvirker og påvirker menneskers handlingsrom og muligheter. Som skeiv kvinne kan man møte andre former for diskriminering enn man møter som heterofil kvinne, og som melaninrik kvinne eller som funksjonshemmet kvinne kan man igjen møte andre typer diskriminering. Ofte kan ulike former for diskriminering samvirke, slik at man ikke bare møter, for eksempel, rasisme pluss sexisme, men snarere egne uttrykk for rasisme og sexisme som samvirker.» (https://balansemerket.no/ordliste/interseksjonalitet/).

Semi-Structured Interview Questions

- How would you describe your intersectional identity?
- Can you describe your background related to studies and interests in computer science?
- Could you describe your experience as a computer science student/professional so far?
- Have you experienced any challenges or barriers because of your intersectional identity?
    - Such as:
        - Isolation or lack of sense of belonging
        - Discrimination
        - Stereotypes
        - Negative bias
        - Assumed to be less competent
        - Assumed to handle a higher workload that others
        - Racism
        - Or other factors.
    - Could you describe these experiences?
- Could you describe any success factors that have positively impacted your experience in computer science?
    - Which factors do you attribute to your ability to persist in the field of computer science, either from your experience or in an ideal world?
- Could you tell us about your experiences with, e.g., mentorship or other networks that have been helpful as support, a role model, or any other initiative that has positively impacted your experience in computer science so far?
- What do you think about a networking program for computer science students and professionals to help connect with peers and others in the field?
- Professionals only:
    - What initiatives do you wish existed when you were a student that you think could have been beneficial for the career you are in now?
- Students only:
    - What initiatives do you wish were available to you as a student that you think could be beneficial to your studies and future career?
- Do you have any other thoughts or comments?

D.4 Usability Testing Guide

Usability Testing Guide

1. Introduce yourself
(Introduction done before interview).

We have created a prototype for a website called DiversIT, which aims to help increase inclusion and diversity in computer science through facilitating peer community and a supportive network. I, the test leader, will read the test cases. As the test subject, your task is to try to navigate through the website to solve the test cases.

2. Describe the purpose of the observation and set the participant at ease
The purpose of this usability test is to observe whether the prototype's functionality is understandable and does not leave users feeling confused. It is not your fault if you do not understand how to do something during the test, but it is we that have not created a good prototype or an easily understandable solution.

3. Tell the participant that it's OK to quit at any time
It is voluntary to participate in this usability test, and you can quit the test at any time.

4. Talk about the equipment in the room
We have created a Figma prototype to carry out the test. Interacting with something in the prototype simulates how you would interact with a real website, just like you are used to. There is also one observer in this room with a computer. This is only to take notes of what functionality in the prototype works well or needs improvement.

5. Explain how to think aloud
During the usability test, it is very important that you not only tell us what you are doing but also why you are doing it. This will help us understand any faults in our design. As an example, imagine that you are in an emergency and call 113. In this situation, you e.g., say that you are doing chest compressions, but it is also very important to explain why you are doing chest compressions. The ambulance needs to know if the person e.g., were in a drowning accident, to be prepared when they come to help you.

6. Explain that you cannot provide help
I will not be able to provide any help during the test. This is because the goal is to find out what you think about the app. Again, it is very important that you think out loud throughout the test and tell us what you do and why, so we can make note of any issues that could be resolved after the test. You can of course ask to have the tasks repeated, and you can ask questions before and after the test.

7. Introduce the product
During this test, you are going to complete 1 test case with a scenario and different tasks. We will read the scenario out loud before you do the associated task. When the task is completed, we will read the next task. You will be able to refer to the scenario when you are doing a task.

8. Ask if there are any questions before you start; then begin the observation
Do you have any questions before we start? No? Begin test.

9. Describe the tasks
Task1.1
You stumbled upon the website DiversIT the other day. You want to explore the website and see what it could offer.
What is your first impression of the website and its purpose?

Task1.2
You have been looking for a network of peers to discuss various topics with, which you cannot really find at your current workplace.
Would you want to register to find out more?

Task1.3
You started reading some of the forums and found an interesting post by Miriam Smith. They would like to increase diversity at their workplace and have posted at DiversIT asking if people have tips on happenings they can arrange or event suggestions.

You have a suggestion for a fun inclusive event that you want to share with Miriam and the others in the thread.
How would you solve this task?

Task1.4
You borrowed your friend's computer to check DiversIT, but don't want them to be able to access your account when you return it.
How would you solve this task?

10. Conclude the observation
The usability test is now complete.

- Do you have any additional comments or thoughts?
- Do you think this prototype has potential to increase diversity and inclusion in computer science? Why? Why not?

Thank you for participating in our usability test. The results will be used to further develop the app design.

Comment: In conclusion, we will also ask the test subject additional questions if they had specific problems with particular parts of the test or because of the design.

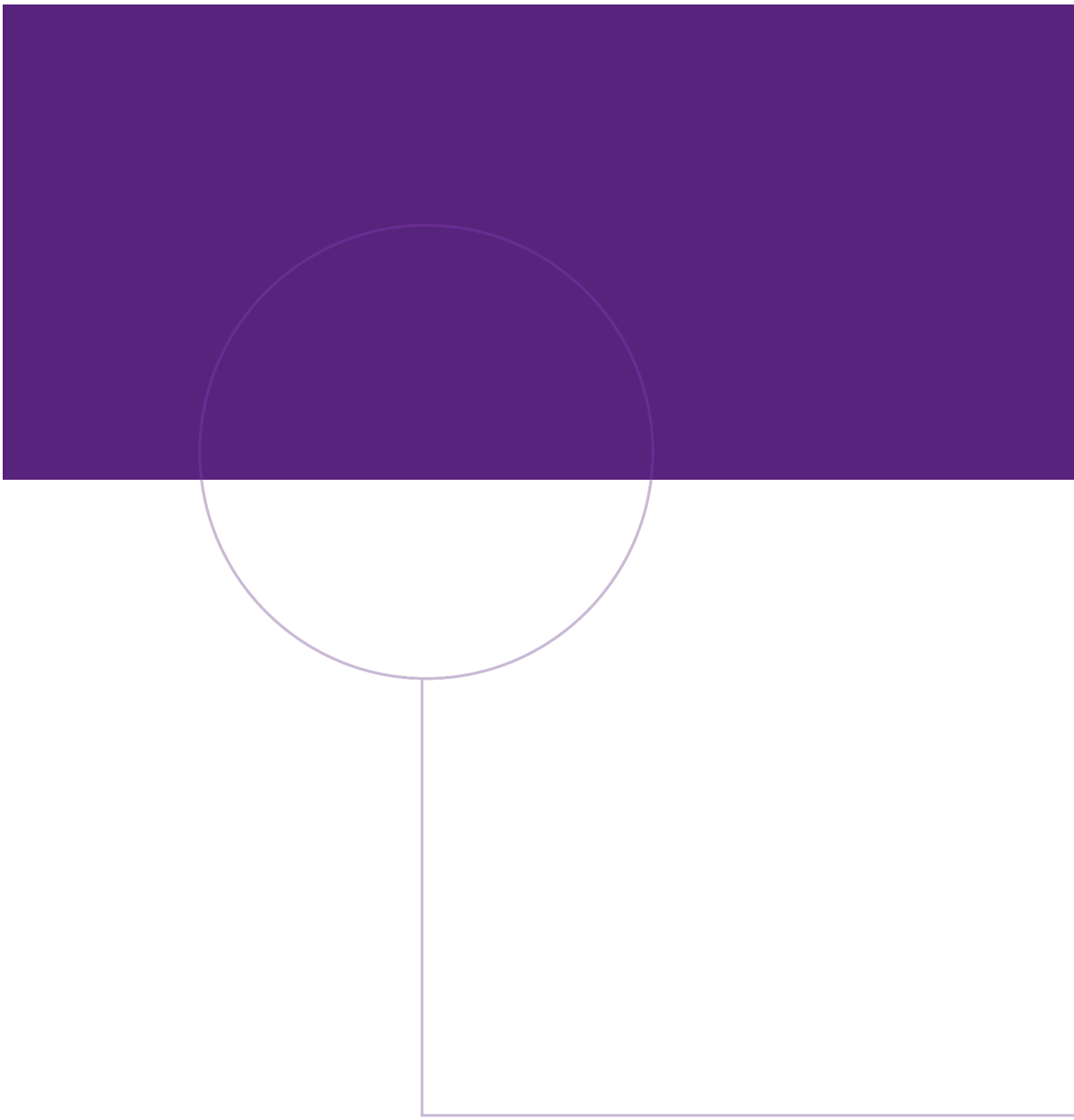
11. Use the results.

Appendix E

Identities Interviewed Participants

Table E.1: Demographics of the interviewed participants.

Location	ID	Gender	Sexuality	Socio-economic Status	Ethnicity	Nationality	Dis/ability	Education	Mental Health	Age	Parenthood
Norway	P1	Woman				Foreigner		International student Technical college Engineer parents			Single mum
	P2	Woman				Foreigner European origin		International student		Studied many years ago	
	P3	Woman	Queer								
	P4	Woman				Foreigner Asian origin		International student			
	P5	Woman								Studied in the mid-90s More difficult to change work	
	P6	Woman	Bisexual					International student	ADHD	Youngest in the management group	
	P7	Man					Blind				
	P8	Man			White	Foreigner European origin		Technical college		Mature student	Free of kids
	P9	Man			White	Foreigner European origin				Youngest in the room	
	P10	Woman			Coloured						
	P11	Man					Visually impaired			Studied in the 90s	
Brazil	P12	Woman		Poor	White				Goes to psychologist		
	P13	Man	LGBT+	Poor	Black						
	P14	Woman								More difficult to change work	
	P15	Man			Black			Parent in CS			
	P16	Man	Gay		White				Depressed		
	P17	Man		Poor							



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